## DESIGNING THE "OLMEC FRAME": sacred surveying of Mesoamerican volcanos, pyramid shaped landscape domains, major site locations, hearth maps and positioning of site features and their orientations

### Abstract

This work rests on the assumption that prehistoric Mesoamerican societies had the technical ability to accurately survey lines across great distances of landscape. To begin to imagine what symbolic formalized patterns, possibly used ritually, might have been created, two approaches are followed, neither of which has precedence in the field of archaeology. First is "design simulation" where the architect as researcher begins with a roughly chronological list of important early Mesoamerican sites, both natural and built, as points in the landscape. The challenge is to design large scale, geometrically "systematic" patterns that connect them in a kind of evolving "Olmec Frame". Second, using custom software, it is possible to make "probability" tests comparing numbers of the simplest of geometric patterns among existing sites, here three-point alignments, with numbers created by replacement random points in test areas of the landscape. The simulation discovers the possibility that if one records the azimuths used to locate sites in the larger landscape, this list becomes a means of discovering patterns of site design that include "pyramid landscape" and "hearth" shapes. Patterns associated with sky maps are considered as well. For a designer, the simulation process in Mesoamerica is itself compelling but does not constitute archaeological proof that any element of the frame was actually an artifact. Two results of the probability tests, however, clearly point to a strong likelihood that some large-scale patterns were not random. One involves three-point alignments of distant sites to Tikal's Temple IV point, and the other, very surprisingly, shows that points connected by the "frame" as a system are unusually robust in creating numbers of alignments with other non-frame (Mayan) sites that dramatically exceed the random.

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### 0.1 Introduction

- 0.1.1 "Orientating Bonamak"
- 0.1.2 Strategy of this work: design simulation and testing probabilities of alignments

## 1. Simulating Frame Design in the Mesoamerican Landscape

1.1 Coincidental geometric patterns among most prominent mountains and alignments with the sun 13

- 1.1.1 Cerro Gordo: "north" / "above"
- 1.1.2 Lake Atitlán: "south"/ "below"

1.1.3 Atitlán X and the great diagonal, a coincidental connection between North/Above and South/Below

- 1.2 Cultural extensions of coincidental natural frame elements 26
  - 1.2.1 The Lake Atitlán landscape and Bassey-Sweet's ideas of Mayan Hearth
  - 1.2.2. Chocolá's integration with the Toliman center point and San Pedro
  - 1.2.3 Izapa: linking Tacana-Tajamulco with Atitlán and Atitlán X

1.2.4 La Venta as first defined landscape domain of an Olmec frame: a larger scale coincidental equinox base line and related meridian

1.2.5 San Lorenzo as meridian apex: a second great coincidental diagonal and new *medio* point

1.3 Revision of La Venta frame via unifying Atitlán Medio: homologues of pyramid and hearth landscapes/maps as urban design 46

1.3.1 Unification of the two great diagonals: La Venta, Piedras Negras, (and Monte Alban?)

- 1.3.2 Palenque's site positioning and hearth identites with Piedras Negras
- 1.4 The coincidental alignment of El Chiflón cascades with La Venta and Atitlán X: hearth homologues at El Mirador and Tikal 63
  - 1.4.1 La Danta / El Mirador and the site prominence of an evolved Mayan Hearth
  - 1.4.2 Tikal's Emulation of the Atitlán X Meridian and Addition of a New Hearth
- 1.5 Copán as southern hearth: linkage to Atitlán X, Tikal and Calakmul 83
  - 1.5.1 Copán's location as unifier of the great diagonals
  - 1.5.2 An Extreme of Hearth Map Expression
  - 1.5.3 Do stela/altar locations associate with azimuth patterns?
  - 1.5.4 Calakmul as northern terminus of the Olmec Frame: alignment with Tikal and Copán
  - 1.5.5 Calakmul's great pyramid as hearth waterfalls?

## 1.6 The Architecturalization of Teotihuacan: its offspring and the absence of Mayan hearth maps 110

1.6.1 Origins of Teotihuacan's orientation

1.6.2 Takalik Abaj and Kaminaljuyu as base vertex points for a landscape pyramid domain with Atitlán X as apex

- 1.7 Azimuths as calendar and relation to sky maps 121
  - 1.7.1 How were Olmec Frame elements recorded?
  - 1.7.2 Sky maps and time
  - 1.7.3 Temple 22's integration with the Copán hearth grid

## 2. Probability Exercises

2.1 Analysis of three-point alignments among 50 early Mayan sites 138 2.1.1 Background and Site selection

2.1.2 Comparing three-point alignments among existing sites with random sets

- 2.1.3 Using Doyle's Middle Pre-Classic E-Group sites to test alignments
- 2.1.4 Alignments with Tikal and San Bartolo as focii

2.2 Testing points on the "Olmec Frame" against the first group of Mayan locations 160

2.2.1 Four categories of existing points: natural features, major sites, benchmarks and other early sites tested against random points

2.2.2 Adding tentative alignments from probability testing to the Olmec Frame record

# 3. Conclusive proof of large-scale surveying and a new vein of archaeological knowledge? 170

- 3.1 First test of simple alignments among early Mayan sites
- 3.2 A designer's view of the Olmec frame
- 3.3 Design simulation provides an unexpected probability proof
- 3.4 Yaxchilan & Bonampak

3.5 The late Classic development of antagonistic Piedras Negras and Yaxchilan territories in context with Altar de Sacrificios

## 4. Final words 193

- 4.1 Chaco and Mesoamerica
- 4.2 Other meridians in the frame simulation
- 4.3 Ideas of "landscape pyramid" as first organizers of larger scale cultures

4.4 Summarizing hearth patterns and foci of Mayan sites: Bassie-Sweet's idea expanded

- 4.5 Implications of social organization
- 4.6 What to do with this manuscript?

#### **0.1 Introduction**

To an architect academically unfamiliar with the huge archaeological record of Mayan sites, the geometry of built form at these places is nonetheless immediately intriguing. On the one hand the complexity of design at city scales involving several hundred meters overwhelms and firmly resists any immediate intuition of unified planning. Yet within pyramids or other such obviously religious features, the evidence of carefully designed combinations of elements is unquestionable. So, from a design perspective, if the Mayans had the technical ability to formalize complex geometry of structures in plan, section and elevation--some of which individually are over a hundred meters in size--why didn't they apply similar, formalizing design processes to the urban site as a whole? Does the answer lie in research concluding that these sites began and grew incrementally—perhaps as modest villages--without any master plan to guide the placement of successive ceremonial foci? Is the location of non-ceremonial first occupation in the larger landscape therefore incidental to the later development of sacred city?

The author, an architect/social anthropologist, has studied the possibility that formalized ritual layouts used by preliterate cultures ubiquitously at small scales, could, with simple but accurate surveying techniques have been laid out at very large scales of landscape. The most transformative idea here is that small scale ritual of plazas and domestic dwelling interiors didn't morph into monumental architecture as sites and social organization evolved. The ritual layouts of shamanistic practice, to the contrary, long before monumental ceremonial sites, developed its power through association with a real, formally structured large-scale landscape (the Warao as best example in the new world, Wilbert 1993). Then, as social organization became more sedentary, these landscape frameworks may hypothetically have provided the locations where first "architecturalized" ritual settings beyond dwelling and village scales were built. If true, requisite prehistoric surveying might likely have been experienced as part of ritual process. These ideas are now at least known and cited by Ancestral Pueblo (a.k.a. Chaco et.al.) archaeologists through a limited list of articles, and a book currently under review (Doxtater 2019a, 2007, 2003, 2002). Aspects of this work detail precedents and techniques for prehistoric surveying and are not presently repeated.

The author's primary mentor on Mayan culture, and especially spatial manifestations of such, is a long-term friend and classmate from a professional program in architecture. Falken

Forshaw eventually wrote a dissertation on the layout of the Caracol at Chichen Itza as part of a PhD in geography (Forshaw 1984). On multiple occasions, while doing research on large scale prehistoric space in the U.S. Southwest, Scandinavia, or on Minoan Crete, I would visit Falken at his studio. Even though he made his living practicing architecture, his studio/library is probably one of the best repositories of information about Mayan cultural space that exists as a personal office. I learned immensely about the formal geometry and layout processes of ball courts, plazas, e-groups, pyramids, observatories, and of small objects as well; most have either archaeoastronomical or purely mathematical interpretations.

Despite gaining much from such a mentorship from a unique Mayan scholar, the present volume, however, only integrates tangentially with these scales of geometric design. At larger scales a certain amount of published analysis exists in this regard, illustrating how cosmology is reflected in some site assemblages (e.g. Mathews & Garber 2004, Ashmore 1991, Ashmore 2002), and how observation of astronomical phenomena often plays into formal features and layout (Sprajc, et. al. 2009, Almers & Rice 2006, Malmström 1978, Aveni et.al. 2003, Green 2014, Kelley & Kelley 2000). Still, however, one finds virtually no literature about how either site location and even site orientations, where they occur, might be related to any surveyed, large scale, geometrically formalized concepts of landscape.

#### 0.1.1 "Orientating Bonampak"

The only piece of discussion about possible Mayan surveying was found in a brief blog on David Stuart's web piece *Maya Decipherment*, April 30, 2009. He posted a paragraph about the possibility of the architectural site axis of Bonampak being aligned to the larger site of Yaxchilan about 24 km to the northeast. The text, accompanied by a good site drawing of Bonampak features and topography, prompted five replies. Clearly, from the discussion among these seasoned Mayanists, this topic lies outside their typical discourse. Though not a peer reviewed publication, nevertheless the blog seems to customarily provide citations of related literature. In this case the source of the map is cited, but nothing else that speaks specifically about prehistoric surveying. Most of the discussion focuses on causeways, such as between Calakmul and El Mirador, or the 100 km "road" running from Coba to Yaxuna. Little is said about precision or degree of accuracy, just the recognition that some sort of aligning technique was necessary to these constructions. Not unlike Chacoan roads, with which the author is much more familiar,

saches do run relatively straight in sections, but even within and certainly between show



considerable variation from precise alignment (that could have been relatively easily achieved by prehistoric surveying). Very briefly mentioned are extremely primitive survey techniques—from

observing smoke at the target site to using a hollowed-out tube—that might have been used to align Bonampak's site features across a visually intervening ridge on the line to Yaxchilan.

Most interesting are assumptions made about Mayan site development, in regard to overall site orientation, where it exists, and to causeways between sites. The brief blog discussion only imagines the use of surveying to either orient features at one site to a distant other, or to align a causeway between two existing sites. The idea that sites could have been aligned with each other via some large-scale surveyed landscape framework—as part of their founding and prior to the orientation of site axes or causeways—is never mentioned. This appears to follow conventional wisdom in the field that most sites are originally chosen for local, ecological reasons, and only after becoming heavily imbued with highly formalized religious features (for a recent exception in the case of very early Seibal, see Inomata, et. al. 2015).

Taking a closer look at the published map of Bonampak, figure 1 (Pallés 1986), one discovers another assumption made by the bloggers, i.e. that civil engineers and other map makers accurately orient their north arrows. When one compares the nicely detailed topographic map with a satellite image of the same area, the linear airport feature can be seen on both. Considering the Google Earth image as correctly oriented with respect to true north, one can adjust the Bonampak drawing, correcting its error of about seven degrees. Archaeoastronomers, of course, now routinely make these adjustments, before generalizing about comparative analyzes of astronomical orientations of site features at regional scales (see the similar use of Google Earth aerial in Motta & Gaspani 2014).

Pallés' map of Bonampak shows an apparent site axis very close to the actual azimuth to Yaxchilan; archaeologists comparing the site axis to a line between the two sites on a regional map or on Google Earth would see the close similarity of orientation. However, the actual orientation of Bonampak's features (plaza) misses the approximate center of Yaxchilan by over three kilometers to the west. Without any discussion of accuracy in the brief Stuart blog, one does not know whether the participants would have considered a seven-degree error still as "aligned". This can be compared to margins of error commonly used by archaeoastronomers of about two degrees (about four times the width of the sun), a distance far greater than any used when evaluating possible prehistoric technology. This can be down as accurate as 0.02 degrees for prolonging (Lekson's chapter on surveying in1999), or for trial and error straightening of long lines (Doxtater 2009). Visual acuity of the naked eye is about 0.017°.

The most accurate large-scale geometry that can be associated with the Bonampak-Yaxchilan pair is not the apparent site orientation, nor likely any yet undiscovered causeway, but a line from Tajamulco, the highest volcano in the southern region of Mesoamerica. The precise line from the center point at Yaxchilan to the highest present-day point on the rim of Tajamulco misses the center point in the Bonampak plaza by about 52 meters (error of 0.11°). The overall distance of this three-point alignment is 228.72 km. Taken from the Yaxchilan point, the azimuth to Bonampak's point in the plaza is 153.91°, and to the high point of Tajamulco, 153.80°. If the field of archaeology had come to an understanding that the Maya probably could have matched or exceeded prehistoric surveying techniques hypothesized among Chacoans, then the Stuart discussion probably wouldn't have been confined to a blog, and likely would have focused additionally on some possible sacred power integrating the two sites to each other possibly via Tajamulco. Four other three-point alignments involving the pair, of lessor degrees of accuracy, might well have also been investigated by comparing existing with random patterns and looking for possible links to material culture and even ethnography of other involved sites.

#### 0.1.2 Strategy of this work: design simulation and testing probabilities of alignments

In simulating design, the author works first from a perspective as architect, seeking to discover possibilities of large – scale "formalizing" design of an Olmec landscape. While the mentioned Warao ethnography documents surveyed lines over a hundred kilometers in the Orinoco jungle—formally defined with opposed cardinal axes (Wilbert 1993:89) --no examples exist at this scale in the vast Mesoamerican archaeological record. Furthermore, in the Warao example, rich as Wilbert's description and analysis of the culture is, we don't know how they technically laid out such accurate lines. The same is largely true in the also sizeable literature on the US Southwest Ancestral Pueblo, particularly as relates to Chaco's context in its large pilgrimage landscape. While the author's published descriptions of possible large-scale formal geometry between prominent natural features and ceremonial sites have been cited by a number of mainstream archaeologists, seldom can any disciplinary discussion be advanced. These kinds of design possibilities simply do not yet integrate discursively with things scholars presently study, even including archaeoastronomy and ethnographic accounts of modern Maya religious use of the landscape. Thus, one cannot provide an initial integrating literature, and how the following work logically flows from the work of others.

The reader is encouraged to place oneself in the mind of the designer, less the ecological and religious Mesoamericans one has researched or read about, than an individual or individuals who wish, for both esthetic and social reasons, to construct a large scale system of ritual practice-one in principle no less formal and undoubtedly more powerful than the symbolic frameworks of religious action in dwellings, public plazas and perhaps emerging purely ceremonial structures. But of course, as a simulation, the following design must be initially considered a creation of the author's mind, an uneasy combination of unfettered impulse to graphically compose with extensive ethnographic knowledge of symbolic and ritual layouts at settlement and architectural scales--always consisting of cognitive oppositional domains, orientations, thresholds, and homologues of different scales (Doxtater 1984).

Given this huge caveat--a fusion of design logic and ethnographic understanding of ritual—one wishes to discover those large-scale landscape patterns which seem to potentially involve archaeological data and interpretation. In the simulation, one should not expect any definitive conclusion in the typical sense in this "design/research" exercise. No particular pattern will be proven to be an artifact. Furthermore, it will not be known how ancient Mesoamericans could survey distances at certain accuracies even though testing clearly shows probability. Previous Chaco work attempts to integrate design simulation with somewhat independent exercises that look at probabilities that elements of a simulated large scale "frame" -- particularly alignments, 90° angles, and cardinal relationships between two points (either north-south meridians or east west lines)—are or are not most likely to be designed rather than random.

Prior to the design simulation of the prehistoric Mesoamerican map, a list of 50 earlier Mayan sites was identified. At different accuracies, numbers of three-point alignments among existing sites were compared to numbers of alignments contained in 100 sets of 50 random points each. The best results of this first exercise came from the narrowing down of existing points to seven, those Pre-Classic sites focused on by James Doyle (2012). These results seem to strongly suggest large scale surveying and design

The second comparison with random phenomena after the frame has been fully simulated divides the existing sites into: 16 natural features, 14 major ceremonial sites, 8 benchmarks (necessary survey points with no known architectural features) and 41 other Mayan sites (those from the first study but not included in the subsequent simulation). The three kinds of sites involved in the frame are combined in different ways to measure the number of three-point

alignments created between the 38 frame sites and the 41 sites not included in the simulation. Comparisions are made then with random points substituted for the 41. Results here as well indicate the presence of design and large-scale surveying, though only regarding the way threepoint alignments numerically link the 41 to the frame. These geometric connections, part designed, part random, are left for analysis in future work.

### **1.0** Simulating Frame Design in the Mesoamerican Landscape

Given the importance of landscape in both Mesoamerican ethnography and symbolic representation of such in prehistoric pyramids, art and recorded mythology, it makes design sense to look for coincidence between prominent mountain features as first elements of some larger framework on the landscape. Interested primarily in Mesoamerican calendrical systems, the geographer Malmstrom (1978) maps close to thirty mountains, mostly as pairs, but some including alignments of three or four, that coincidentally create observation alignments with solstice risings and settings. Unlike most archaeoastronomy that maps local observations between built features and rise/set points on the immediate horizon, or within other built features, Malmstrom's solitary piece, somewhat inadvertently describes what may be initial building blocks to landscape ritual "systems", far beyond more singular means of telling (ritual) time for particular groups in particular geographical places. If mountains, and particularly volcanos have always been sacred, and if formal elements among two or more were understood for their ritual timing coincidence, these formalized pieces likely would have been considered all the more sacred and religiously powerful.

The reader will observe, as the simulation unfolds, a clear shift from astronomical alignments of "observer" peaks to peaks where the sun rises at equinox, solstice or zenith and nadir passage, to more precise alignments between the topographic summits themselves as the primary, but still astronomically associated, element of religious practice. This should not be surprising, since timing ritual can easily be distinguished from the fixed topographic or architectural structure that formally frames ritual action. Furthermore, even though a pair or triad of peaks are accurately aligned (coincidentally), either astronomically or purely geometrically, it is most likely that these features existed in some larger formal context of religious practice that included other natural features such as caves and other mountains, and the settlements and internal foci where people lived.

Wilson's (1995: 52-61) ethnographic description of the religious meaning of the modern Maya landscape provides an excellent sense of the ritual complexity of their landscape, with mountains and associated caves as primary sacred elements. Mountains are conceived of as individual living gods, and villages often take their name from these animate features. Thus, immediately we have a sense of the homologue between mountain and village, and the way it structures ritual practices between the two. Wilson also mentions pairs of "brother" mountains who speak to each other across three villages below. Other framing concepts involve highest mountains being called "king", or the "Thirteen Great" highest mountains surrounding a linguistic territory. These examples of non-astronomical structure, however, are seldom actually mapped by ethnographers looking for geometrical formalities that can serve as well to strengthen the cognitive affect of ritual action, not unlike more obvious examples at smaller scales of ceremony, e.g. Gossen's (1958) classic diagrams of ritual frameworks in village churches and dwellings.

Gossen does of course recognize the kinds of landscape practice and meaning described by Wilson but does not map it (perhaps this is a different kind of ethnography requiring additional technical skills). Instead he graphically creates a generalized geometric or formalized cosmology which informs the patterns in church and house and appears to come from some native conception of sun paths in the landscape. This cosmology, as diagramed, also can be seen in the archaeology of E-Groups and their observer orientation to the power of East. In this volume on the "Olmec Frame" one will see numerous examples of generalized Mesoamerican cosmologies such as Gossen's, and ultimately these must reconcile with more complex possibly designed formalized frameworks. Again, one of the few examples of an actually mappable large-scale landscape framework is the Warao; this is a ritually real landscape structure that then symbolically informs the homologue of village large house where shamanistic ritual begins and ends—often with integrated trips out to features at formal junctures of the landscape.

The first illustration of this design exercise attempts to convey, not primarily just the locations of the forty highest mountains in Mesoamerica, but more importantly a cognitive sense of the pattern of important features in the landscape. Recent archaeology on first people in the New World now dates Paleo-Indian occupation of the Mesoamerican area to about 13,000 B.C.



Figure 2. Location of the highest or most prominent mountain features (mostly volcanos) in Mesoamerica; a pattern of lower elevation and easier communication can be seen in the superimposed arrows connecting the peaks around the highest of all, Orizaba to the NW and the cluster of volcanos around Lake Atitlan to the SE; many of these natural places were undoubtedly sacred and used rituall long before people began building monumental ceremonial sites/cities.

This means that for some 10,000 years people were actively moving in, talking about, and culturally attaching meaning to the landscape in figure 2—*long before they began building monumental ceremonial architecture*. It is not unlikely that they, like a landscape architect perhaps, might have thought of the two areas with the most and highest volcanos, the **Valley of Mexico** (something like "north" and "above") and **Atitlán** ("south" and "below") as connected by a narrower threshold between the two oceans. Trading and other reasons for moving between the two areas would logically have followed this geography and entailed shared cognitive maps-not necessarily yet any kind of formalized ritual integration.

An overlap exists between some sites as presently design simulated and some on Malmstrom's list. Again, his comprehensive geography of coincidental astronomical alignments among features works more from interests in locally used phenomena, however, mostly related to time and calendrical concepts, rather than any larger scale integration of landscape features *per se*. In contrast, a designer's/symbolic anthropologist intuition focuses not only on the latent opposition between the Valley of Mexico and Atitlán, but the highest or most prominent mountains of these two powerful areas.

## **1.1** Coincidental geometric patterns among most prominent mountains and alignments with the sun

#### 1.1.1 Cerro Gordo: "north" / "above"

\*illustrations in this exercise follow architectural drawing convention where north is always up and isn't frequently indicated on each sheet. In the present case, all aerials, plans and other representations of the horizontal dimension are correctly oriented as much as possible to true north. The graphic borders of these illustrations are accurately cardinal.

\*digital maps, here mostly ArcGIS World Topo and Bing Satellite provide a graphic background correctly oriented to true north. Custom software allows one to calculate azimuths of great circle lines between lat/long points on the ellipsoid earth surfaces described by these maps. Software provides precise great circle azimuths to five places of decimal degrees. After placing a map as base layer in an Adobe Illustrator file, one can draw on a file layer above a precise meridian (northsouth) line and rotate it to the precise azimuth provided by software calculations. Thus, in the present graphics a line drawn in relation to a precise lat/long point or points on a map or aerial can be taken as having little or no "drawing distortion". This is in effect a means of discovering quite accurate patterns in the absence of extensive field surveying on the ground.

Playing the simulated role of early or even Pre-Olmec designer, one of the first choices of framework element in the Valley of Mexico was logically the winter solstice rise alignment between the highest mountain in Mesoamerica, Orizaba, and Cerro Gordo, sitting immediately north of the later monuments and city of Teotihuacan. This is one of Malmstrom's coincidences as well, which he includes with a provisional dotted line expressing the fact seen in the profile of figure 3, that one probably cannot directly observe the rise on Orizaba from Cerro Gordo.





Figure 3. Means of observing winter solstice sunrise over Orizaba from Cerro Gordo; direct view is obstructed requiring one intermediate station point.

Illustrated as well is how a survey station point aligned between the two peaks could be positioned to transfer the Orizaba rise west to Cerro Gordo. Ritually, a signal from the station point to the summit of Cerro Gordo at Oriziba rise time could easily be symbolically understood for the relatively accurate alignment that it is. This, like all elements to be included in the design might well have been ritually significant to local or regional populations for thousands of years prior to development of the "Olmec Frame".

The case for Orizaba's spiritual power grows—beyond its modern technical consideration as highest mountain in Mesoamerica—when one now includes its rise role for nadir "passage", actually an alignment of three volcanic peaks as illustrated in figure 4. Orizaba's solstice axis to Cerro Gordo associated with the 365-day count, while its axis to Mount Tlaloc and La Malinche relates to the 260 count involving observations of zenith and nadir passages. Unlike observing sunlight entering narrow vertical architecturally designed voids when the sun is at zenith, in these latitudes, nadir passage can only be observed as a sun rise during winter (when the sun is vertically "below"). From the perspective of landscape ritual design, nadir observation may be even more important than the zenith in that nadir requires alignment with a landscape feature whereas zenith observation need only involve the vertical architectural site feature. Observing the nadir rise from Orizaba, rather than direct zenith observation, symbolically makes better



Mount Tlaloc prehistoric feature on summit



19.41226, -98.71248 74.102 km Average alignment deviation of La Malinche summit from Mount Tlaloc - Orizaba nadir rise point line is 0.056

Solstice rise from station point on alignment between Cerro Gordo and Orizaba: calculated point is -23.94, approx. 697 m north of summit (ideal NOAA declination is -23.69) La Malinche summit



Orizaba nadir rise point as observed from La Malinche summit (calculated)



19.22964, -98.03201

83.050 km

19.02305, -97.27316 (summit)

Nadir rise from La Malinche: calculated point is -14.10, approx.1100 meters south of Orizaba summit (ideal NOAA declination is -14.86; rise from Mount Tlaloc is slightly better at -14.25). Photo at right is taken from La Malinche; at left photo is reduced to scale with distance the station point on the east ridge overlooking Cerro Gordo (photo from Expedition to the Ultra Mountains of Central Mexico - Part II www.cohp.org. accessed 1-23-18).



Figure 4. Calculated alignment of Nadir rise among Mount Tlaloc, La Malinche, and Orizaba; relation to feature on summit of Mount Tlaloc; illustration of winter solstice and Nadir rises at Orizaba.



association with solstice rise meaning, also in the landscape, perhaps providing some sort of unification of the two calendrical systems via the highest mountain in the land.

In the triad of nadir observation peaks, one encounters a nice piece of archaeology in the open walled-in area on the very peak of Mount Tlaloc. The archaeoastronomer Iwaniszewski (1994) provides a nicely detailed analysis of how the varied wall azimuths time Aztec calendrical ritual, all on a twenty-day count sequence. The structure is considered to have been built in the fifteenth century A.D. The time of the nadir observation mapped in figure 4 is November 1 and February 9, which fits Iwaniszewski's extensive analysis of Aztec calendrical ritual, but is not emphasized as a simple nadir point in time.

Just how coincidentally accurate are the three peaks aligned with the rise on nadir dates as seen from Mount Tlaloc. The calculated rise point on Pico de Orizaba's south flank, when extended west misses the topographic summit of La Malinche by 77 m (at the southern edge of the collapsed crater) on its way to the enclosure on Mount Tlaloc. While the given summits of La Malinche and Orizaba do not accurately align with Mount Tlaloc, curiously enough, the long-walled corridor rising to the observation enclosure seems to align very accurately to the rise point on Orizaba. This agrees with Iwaniszewski's measurements; the varied azimuths of enclosure walls are created by design to associate with other astronomical phenomena. From the layout of the entire built setting, the nadir orientation of the corridor is clearly dominant, and one asks whether the late Aztec design recognized some more ancient precedence of the primary meaning of the association of this threesome with the nadir rise when considering the orientation and location of principal features of Teotihuacan.

Finally, up in the "north" / "above", the designer can further enhance the assumed symbolism of Pico de Orizaba by calculating its also coincidental equinox rise as seen from the second highest Mesoamerican peak Popocatepetl. As recorded in section and map in figure 5, the three Orizaba coincidences involving the three primary astronomical phenomena form an eastern side of a horizontally laid out "pyramid landscape". Cerro Gordo forms the apex of the pyramid, with Popocatepetl and Orizaba its eastern base, and the coincidental equinox pair of Toluca and Tlaloc Milpa Alta as western base. This pyramid domain does not form a coincidental isosceles triangle, nor is Mount Tlaloc coincidentally aligned with Cerro Gordo and Popocatepetl, nor does any precise meridian from Cerro Gordo run coincidentally directly south to any apparent natural or archaeological feature.





Figure 5. Cerro Gordo "pyramid landscape" equinox base lines: Toluca / Tlaloc-Milpa Alta (77.357 km apart, latitudes are off about the angular width of the sun) and Popocatpetl / Orizaba (142.893 km apart, latitudes are off about one half the angular width of the sun); photo from summit of Orizaba open web source. As design process, it wouldn't seem unlikely that very early priest/designers understood the pyramidal shape created by the coincidental relationships between pairs and triads of very prominent volcanos, all of which except perhaps for Orizaba (though by transfer) can be seen from Cerro Gordo. "Pyramid" might thus initially symbolize the both the way mountains as gods, and their associated social groups, are spatially integrated through a cosmological frame, and ritually timed by integrated astronomical phenomena.

#### 1.1.2 Lake Atitlán: "south"/ "below"

Moving to the possibly symbolically opposed other cluster of high mostly volcanic mountains, around Lake Atitlán, the designer looks for coincidental elements not dissimilar to those described in the "north" / "above", figure 6. Most readers may not be surprised that Atitlán immediately appears to play a complementary opposition role to Cerro Gordo. One begins as well with coincidental pairing of mountains aligned with winter solstice rise, as with Cerro Gordo and Pico de Orizaba. The observation of rise over the highest mountain of this southern domain, however, does not directly involve Atitlán, but Tacana and Tajamulco. The most comparable solstice rise observation from Atitlán, thinking about Cerro Gordo's role, is a somewhat distant volcano to the southeast, San Salvador. Here, not unlike Cerro Gordo, an interim station point is necessary to transfer ritual timing to the focus at Atitlán.

Given the unobstructed view from Atitlán to the Tacana – Tajamulco pair, one's design inclinations suggest a symbolic association of the coincidental solstice rise between the two and Atitlán. Most likely having knowledge of the pyramidal landscape domain of the North, particularly its powerful focus on Orizaba, the designer logically imagines that the Atitlán – San Salvador rise ideally should be Tacana- Tajamulco (Cerro Gordo – Orizaba), or more specifically that there should be a means of symbolically linking the two together in one frame. Logically the western pair, being the two highest of the southern area, can be seen as the most powerful, and ideally should link more directly to Atitlán.

Adding to Atitlán's increasing symbolism, it too, not unlike the northern pyramid landscape, can boast of a coincidental triadic nadir rise alignment, figure 7. One must first consider relatively precise alignments among topographic points, necessarily surveyed with simple instruments, separate from understandings of the two-degree range archaeoastronomers use to



Figure 6. Coincidence of winter solstice rise at Tajamulco as seen from Tacana, and at San Salvador as seen from Atitlan (this observation is much less evident due to its length and necessity for one interim station point); photo from https://steemkr.com/travel/@sunny9091/travel-memories-guatemala-part-1.





summit -14.92 (-14.85)

Figure 7. Coincidence between Nadir rise and alignment of Atitlan, Acatenango and Agua; only visible by backsighting from Acatenango.

define how the one-half degree diameter of the sun rises on a horizon. The case of this southern nadir threesome converges in ways not seen in the Mount Tlaloc – La Malinche – Orizaba discussion. First, the present-day summits of Atitlán, Acatenango, and Agua coincidentally align to an extreme. The azimuth from the Atitlán point to Acatenango is 254.78897° (the author's software uses a counterclockwise count from zero at north), and to Agua 254.79835°. Thus, Acatenango's position deviates 0.00938° from the precise line from Atitlán to Agua. Given Acatenango's 34,886 m from Atitlán, the deviation of the interim point from the total line can be calculated as about 5.7 m. Pure coincidence. This is not to say, however, that such precise results aren't conditional upon accurate placement of latitude/longitude points on digital maps or satellite photos. In the present work, volcano summit points are taken from ArcGIS World Topo mapping. There may be some small inaccuracy between these "drawn" points and locations taken directly from satellite photography.

Attempting to measure rise position much more accurately than usual in archaeoastronomy (though these scholars will need to weigh in on work in this volume), one first records that the



Figure 8. Coincidental meridian axis from Atitlan summit to center point between Toliman twin peaks; photo from Atitlan looking north over Toliman peaks and Lake Atitlan (from the Smithsonian Institution Global Volcanism Program https://volcano.si.edu/volcano.cfm?vn=342060, accessed 6/14/2018).

nadir rise at Acatenango as observed from Atitlán is well off the precise alignment of the trio. But adding coincidence again, if one plots the nadir rise point on Agua as seen from the interim point Acatenango, it is only a few meters from Agua's summit, and therefore quite accurately coincident with the non-astronomical alignment of the three peaks. If "Olmec" landscape designers knew of this coincidence between "landscape" and "astronomical" alignments, it might well have added symbolic significance to Atitlán as primary southern focal point. It follows that in this case they would have understood the different technical aspects of the two kinds of alignments.

Turning now to figure 8, and an additional symbolic/geometric role for Atitlán, one encounters something of an established skepticism about the importance of North/South or meridians in Mesoamerican archaeology, and even ethnography. This has been surprising to this author who has researched Scandinavian, Minoan, and Ancestral Pueblo ritual concepts and spatial expression of "*axes mundi*", vertical ideas of space all firmly associated with North-South (Doxtater 2019ab). In Chacoan work in the U.S. Southwest, no fewer than four large scale symbolic and ritually used meridians framed the Southern Colorado Plateau, along with many clear examples of related motifs at large sites such as Chaco, where all agree that the two great houses located due north and south of each other on opposite canyon rims, along with building orientation, reflect some *axis mundi* aspect of religion (Doxtater 2019aa). Pueblo Bonito's precise interior meridian wall provides another example at smaller scale.

The disinterest in meridian phenomena in ancient Mesoamerican is probably mostly due to the lack of strong north-south orientation in ceremonial sites and most dominant structures, and archaeoastronomical emphasis on eastern observation of rise phenomena, including the characteristic 15-17° cant of some major site axes, particularly that of Teotihuacan. Then too, ethnographers like Gossen promote this temporally related emphasis of power in the east.

Given the almost universal recognition of most powerful landscape direction as North-South in traditional cultures, it is also exceedingly difficult not to see the coincidental meridian alignment of Atitlán's summit with the center point of the Toliman summit pair as adding even *greater* symbolism than the solstice and nadir coincidences described above. While Cerro Gordo, sitting at the zenith of the northern pyramid domain, implies a vertical axis running south through the "center" of that landscape, again no coincidental "*axis mundi*" natural feature yet confirms this latent meridian.

In sum, Atitlán possesses a solstice observation to a somewhat distant San Salvador, a remarkable fusion of landscape and nadir astronomical alignments in its triadic relationship to Acatenango and Agua, and what would likely be understood as a very unique North/South meridian coincidence across many other cultures in the world. Yet it has no coincidental linkage to the Tacana-Tajamulco solstice pair, nor any coincidental equinox component in its southern landscape layout.

## **1.1.3** Atitlán X and the great diagonal, a coincidental connection between North/Above and South/Below

Several patterns have been discussed at relatively small distances essentially within the two domains "north" / "above" and "south" / "below" with their foci on Cerro Gordo and Atitlán respectively. Intuitively the design choices in the buildup of symbolic association with Atitlán follow precedents in the Cerro Gordo pyramid landscape. Most likely designer/priests knew the total geography illustrated in figure 2, and not only emulated symbolic association in both domains, but might logically have asked whether some coincidental geometry might connect the two, despite the long diagonal distance that separates them. How might they have approached the task?

Without asking how early priests technically could have surveyed a line approaching 1,000 km, might they have tried a small number of lines attempting to find some "god given" coincidence or spiritual power by which to create such an ambitious social and religious integration? It might be most symbolically logical to test an alignment between the two foci, Cerro Gordo and Atitlán. Looking for some prominent interim point coincidentally aligned, one can discover today no such feature. Software search options allows one to set the angular deviation of interim points on three-point alignments, given an extensive site list across the total landscape. From Chaco work the relatively accurate maximum deviation of 0.075° will be shown to very adequately include the most promising patterns of the present simulation. This figure is an average of the angular deviation of the interim point from each end point. In the example of Atitlán – Acatenango – Agua, the deviation from Atitlán is 0.00938° and from Agua, much closer to Acatenango, the deviation is 0.0223°. When averaged together for a more representative measure of accuracy, theirs is 0.015° (0.015840) or just about the acuity of the unaided eye of 0.017°.

A second ancient trial might logically have sought some two points coincidental with the very powerful Pico de Orizaba, receiver of solstice, nadir and equinox rises at the east base point of the Cerro Gordo pyramid landscape. Did it make formal sense to try to connect Orizaba with Atitlán, or even the highest counterpart in the South, Tajamulco? When working with features in the Atitlán area, I quite early tested an intersection point precisely due north, a prolonging of the Atitlán meridian, and a line extended precisely cardinally east from Tajamulco. From a design perspective, this point, here called "Atitlán X" formally connects the solstice Tacana – Tajamulco pair to Atitlán.

But there is nothing coincidental in this point's relation to the major natural features of the "south" domain. This is the hand of man, not god. When combined with the idea of a long diagonal linking "above" and "below" domains, however, this Atitlán X point can be discovered to be coincidental to the long axis between Cerro Gordo's and Atitlán's volcanos that receive winter solstice power, i.e. Orizaba and San Salvador, figure 9. The coincidental accuracy of this three-point line, i.e. the cardinal intersect point to the long diagonal, has an average deviation of an overly accurate 0.00086°. The line between the two end points misses the Atitlán X intersection point by about 6 m.; the line is 1,034 km in length. Again, one makes no judgement at present about what early surveyors could or could not do. The simulation more simply maps interesting design patterns, here still involving coincidence, and provides uninterpreted pattern data.

With the addition of the cardinally created Atitlán X, a certain oppositional logic appears with respect to the diagonally opposed domains. As seen in figure 9, the two pyramid halves, one east the other west are inverted and express their respective "up" and "down" roles as a kind of zenith and nadir (though these terms might well be reserved for timing phenomena). The right angle at the southern intersection point creates an implicit hypotenuse between the (domain) pyramid peak, Atitlán and the highest mountain of the south, Tajamulco. More explicit of course, but symbolically identical is Cerro Gordo's hypotenuse to Orizaba. Each half pyramid has a cardinal line as base anchored at the two highest mountains of the two domains. There may well, however, be no actual equinox observation of the intersection point in the south from the top of Tajamulco.



Figure 9. Coincidentally precise alignment between Orizaba as western vertex of a Cerro Gordo landscape pyramid, Atitlan X as the base meridian cardinally paired with Tajamulco of an inverted Atitlan landscape pyramid, and San Salvador, whose winter solstice rise relationship with Atitlan mirrors Orizaba's with Cerro Gordo.

#### **1.2** Cultural extensions of coincidental natural frame elements

#### 1.2.1 The Lake Atitlán landscape and Bassey-Sweet's ideas of Mayan Hearth

While one finds no site elaboration of the Atitlán X point from satellite imagry, about two and a half kilometers away is the early fifteenth century site of *Q'umarkaj* or Utatlán. More ethnographically, studies of these K'iche' Maya include reference to a mythological or historical founding king who marries the daughter of another king presiding over a Pre-Columbian settlement near San Lucas Tolimán, the meridian partner to Atitlán (Carmark 2001:181). Detailed site drawings in Carmark and Weeks (1981) describe four or five separate ceremonial sites as part of the Utatlán complex. Though there is discussion of some cardinal association, particularly of the northern entity, no clear formal pattern exists overall. The center of the Utatlán group is about 2.6 km from the Atitlán – Tajamulco cardinal intersection point.

Perhaps the most tantalizing piece of archaeology intersecting with the present simulation, can be found in Karen Bassie-Sweet's linkage of Mayan art, architecture and mythology with specific geographical places (2008, see also review in Toohey 2013). Most relevant to the present simulation, her introduction gives great credit to reading the Popol Vuh, a sixteenth-century manuscript written by literate Postclassic K'iche' elite of highland Guatemala. She explains the value of Popol Vuh creation mythology that influences the work of numerous archaeologists. Before getting to Bassie-Sweet's core ideas about mythologically linked real places, one must add a piece of information not provided in her introduction. The original translation is said to have been a phonetic rendering of an oral recitation performed in or around Santa Cruz del Quiché. This colonial town is located just off the map of figure 9, less than a kilometer east of Utatlán (Tedlock 1985). Thus, one of the most important sources of Mayan mythology was recorded within walking distance of the intersection point between the Atitlán meridian extension and the cardinal east from Tajamulco.

With all Popol Vuh's reference to cosmological quadripartite structure—not atypical as creations myths go—are these hints of the creation of the Atitlán X cardinal intersection point, perhaps millennia earlier. The most interesting piece of Bassie-Sweet's chapter 13 "Sacred Landscape", with respect to the Atitlán X location is her linkage of four mythic "Rivers of the World" to four actual rivers that drain highland Guatemala. These four rivers flow away from a central area "just northwest" of Atitlán to south, west, east and north respectively. From her map

on page 240, the most adjacent of tributaries of three of the four world rivers, are in the Atitlán X area, north of Atitlán and east of Tajamulco. Indigenous knowledge of coincidental proximity of headwaters location of the four rivers might certainly have been understood, both geographically and religiously, long before formalizing surveying created the precise intersection point. While certainly not creating the exact Atitlán X point, preexistent shamistic belief might have influenced the decision to look for large-scale coincidence in this area.

Bassie-Sweet's chapter 13 spends most text on the mythological associations to the trio of volcanos at Lake Atitlán (Atitlán, Toliman and San Pedro), and how this primordial Mayan "hearth" pattern is replicated at Palenque's Cross Group (she also describes other mythological links to other nearby volcanos).

"The "pib'-naah" of the Temple of the Cross is called the Six Sky place of GI. The Tablet of the Cross text refers to the 13.0.0.0.0 Period Ending at the three stones place where the three hearthstones were dedicated and goes on to describe a house dedication ceremony a year and a half later. On this date, GI is said to have descended from the sky and inaugurated his Six Sky Place, also called his northern house (Zender 2005). Volcán Tolimán is the northernmost of the three Lake Atitlán volcanos. I deduce from the text that when GI dedicated his house at the Six Sky Place, he was, in fact, dedicating his house on Volcán Tolimán. GI was a god of wind and storms. The Tz'utujil see a rainbow on Volcán Tolimán as a sign of wind, and clouds over the volcano as a sign that a norte (northern storm) is approaching."

Thinking ritually, the saddle between the two Toliman peaks could be considered not only an extremely liminal location within the peak itself, but also as a threshold between Atitlán and Atitlán X, thus perhaps the emphasis of northerly direction described by Bassie-Sweet.

The article preceding editor Timothy Pugh's concluding overview of "Maya Sacred Landscapes at Conquest" is an ethnographic piece by Robert Carlsen called the "Footpath of the Dawn, Footpath of the Sun: Maya Worldview at Lake Atitlán" (2009). Focused on the Maya town of Santiago Atitlán on the east shore nestled between Tolimán and Atitlán on the east and San Pedro on the west, Carlsen describes rituals and routes that integrate the town and church focus with sacred points on the mountains. Stanzione (2003: 240-244) documents ritually related



Figure 10. Evidence of prehistoric surveying in the positioning and orientation of Mayan temple (under Santiago Atitlan church) aligned with the Tolimant Center Pt. and the summit of San Pedro (photo by Alfred P Maudslay 1881, Archivo Digital Ethnografico Atitlan www. archivoatitlan.org). observations of key sun rises and sets through the year. The locations of observations from a mound near the Santiago Atitlán are not technically mapped in an archaeoastronomical sense, leaving a clear impression that, while ritually structured, the observed points on the horizons of the three mountains create no formalized spatial frame as such. Yet it seems evident from the work of Carlsen and Stanzione that observations of the path of the sun play a powerful role in the ritual they describe. It follows that when I emailed the figure 10 images of the accurate three-point alignment between San Pedro, the church, and the Toliman center point, Carlsen called the line "approximate", reflecting, it seems, the reality that the actual ritual path and observation location in the landscape is not formally laid out.

Understandably not recognized by either ethnographers or archaeoastronomers, is that formalized means of locating ceremonial sites or structures may involve purposes and processes different from the observation of timing alignments *per se*. In the present case, Carlsen tells me that the church of Santiago Atitlán was built over a prehistoric Mayan temple (n.d.), meaning that the location was already aligned with the two volcano points at the time the church was constructed. This technical feat measures as a 9,669 m three-point alignment with an average deviation of about 0.073°. At this relatively short distance, the precise line between the two volcano points actually hits the church, about 6 m off its center. This precision, despite the half a millennium overlay of Catholic belief and practice, is today still recognized as a "symbolic line that runs down the middle of the floor in the church" and that "a hole in front of the churches' altar is thought to be the very center of the world".

One does not know if some architectural element of the underlying Mayan temple also communicated its accurate alignment with the two volcanos. Clearly some simple surveying process was necessary to position the temple, and perhaps to orient its architectural axis as well. This is not as technically difficult at it might seem. Climbing the 1,600 meters from Santiago Atitlán to volcano tops for ritual purposes is still being practiced today and doing so to position a ceremonial site below would be part and parcel to their religious experience. With a signal party, using fire or mirrors on the opposite volcano top, San Pedro, as well as below at lake side, the survey party at the Toliman center pt. needed to site vertically down from the San Pedro signal, communicating with the crew below when their position aligned. The vertical angle from Toliman to the potential temple area below is about 15°.

Modern surveyors would simply set their plumbed transit, and then rotate the scope the 15° down to the location below. This can easily be done as well with two tall tripods, each with a plumb bob (see appendix in Doxtater 2019a). At a distance about 6 meters apart, the natural visual acuity of the eye can discern alignment between the two cords. Again, using signal crews on San Pedro and below, one sights from a short distance in front of one tripod to the vertical cord of the second aimed toward the signal on San Pedro. The 15° angle down to the potential site area translates to about a meter and a half down from horizontal on the second tripod cord, easily obtained on a relatively flat surface between the two tripods. Plumb lines were unquestionably widely used in Mayan temple construction, particularly where long walls or terraces required alignment. Once the position of the Santiago Atitlán temple was established, the orientation of the building axis (perhaps emulated in the church) could be achieved by a reverse sighting through tripods up to one of the volcano points.

Two things are paramount in the present example, first is that at the azimuth of about 242° looking east from San Pedro to Toliman appears *not* to be an astronomical observation alignment. It orients almost 28° south of cardinal east, while the maximum sun rise angle at this latitude is about 23°. Secondly, and most important, is that its accuracy provides an excellent example of Mayan ceremonial sites being carefully surveyed to align or otherwise integrate with geometric patterns--"frames"-- of prominent natural features.

Returning to the larger scale implications of the prolonged Atitlán vertical, the Toliman center point included, one can document the meridian relationship between the late Utatlan complex and the knob called Cerro de Oro on the southern shore of Lake Atitlán, see again figure 10. A precise vertical from the natural Cerro de Oro point misses the Utatlan complex point illustrated in figure 9 by about 92 m, at 39.533 km. No literature about Cerro de Oro surfaces when doing an academic search. On the web, one finds promoters of local tourism describing a still used Maya altar, hieroglyphs and legends of tunnels leading up to Toliman volcano. All one can firmly report is that the late Utatlan complex, associated with the *Popol Vuh* tradition sits quite accurately as a meridian climax to this Cerro de Oro feature, not unlike a possibly much earlier *axis mundi* precedent from Atitlán/Toliman culminating at Atitlán X. But if modern Mayans still ritually climb to the tops of Bassie-Sweets' three hearth mountains, as well as others, why wouldn't the founders of Utatlan, if interested in meridian alignment, have

employed the necessary technical expertise and done likewise—perhaps rediscovering the ancient meaning of the Atitlán X intersection point?

#### 1.2.2. Chocolá's integration with the Toliman center point and San Pedro

One now returns to the much more ancient Mesoamerican landscape and the site of Chocolá. Given present primary interest in processes of site location, such as the temple under the church in Santiago Atitlán, and site orientations, at Chocolá, we find an added overlap with studies of astronomical observations and Mayan structuring of time. Was the location and orientation of Chocolá determined by the way features of the eastern horizon create somewhat coincidentally multiple unique rise points from this particular place? Or was its location determined from some surveyed ritual frame among prominent natural features *per se*. Or both?

Working at Chocolá, Green (2014), an independent researcher well regarded among archaeoastronomers, records rise points for the equinox, zenith and nadir passages, and the midpoints between each of these 20-day intervals as the sun cycles through its 260 day calendar. Two additional points on the horizon are identified, a 13-day Marker (*Trecena*, 13 days after zenith passage and 3x13 days before summer solstice), and Winter Solstice. Of these seven rise points, only the two Nadir/Equinox midpoints and the *Trecena* marker occur at a mountain peak. Particularly prominent in Green's images of rises is zenith passage associated with a cleft on the northeast horizon of local mountains. No horizon feature marks the equinox rise. Taken as a whole, it would seem that some number of features on the horizon coincidental point work from the Chocolá site, while others do not. From the perspective of major coincidental associations in "north" and "south" pyramid domains, the three prominent rise phenomena of winter solstice, nadir passage and equinox do not seem to be that important at Chocolá, placing greater emphasis on the zenith, midpoints and 13-day marker.

Green is particularly interested in Chocolá because of discourse about a special zenith passage latitude as related to Maya calendrical systems and site features (also discussed in Malmstrom), about 14.6° at which Chocolá sits (center point in figure 9 is 14.62035°). Perhaps this makes the Chocolá's observation of the zenith rise from the cleft a candidate for influencing site selection. Yet again, zenith passages can be observed by the sun entering



2005

Chocala





Figure 11. Simulated positioning of Chocala via equinox line east to the Toliman Center Pt. and a zenith rise point from San Pedro (ceremonial site to scale with Toliman aerial).

Station pt. required ?

15

Tolimar

ж<sup>1</sup> ж vertical chambers at noon and need not be marked by the summer rise on the horizon.

Through many personal conversations Hal Green has taught me a great deal about Mayan archaeoastronomy. And although the present goal is to develop ideas about largely non-astronomical landscape framing of ritual, at Chocolá some sort of combination of the two kinds of aligning might be at work at least in locating the site. Figure 11 above illustrates two lines from Chocolá's center which both have astronomical meaning and prolong over station points on ridges to two of the three Atitlán "hearthstones". The most important line may be a cardinal axis due east from the site center which runs about 170 m south of the center of the northern crater of the twin Toliman peaks. This is some 245 m north of the Toliman center point used in the positioning of the temple/church at Santiago Atitlán. Of course, Chocolá is likely much, much earlier and perhaps considered the northern twin with its view north over Lake Atitlán, toward Atitlán X, as symbolically most significant. Chocolá is about 25.738 km from the Toliman point.

The question then for Hal Green is whether some equinox observation from the northern Toliman crater, or Toliman center point might have been prolonged west across the featureless ridge position observed from Chocolá? Or alternatively, was this line more fundamentally a cardinal ritual element, working perpendicularly with the Atitlán meridian—perhaps with no associated equinox observation? Chocalá is after all, by far the largest and closest Mesoamerican site to Atitlán.

As for the second possible site locating line, Green's persuasive observation of zenith passage from Chocalá can also be extended to one of the hearthstone trio, San Pedro, figure 12. The sun rise cleft is actually two ridges one behind the other. With a little trial and error, one can locate a point on each ridge, both of which align accurately to the Chocolá center and San Pedro. The resulting four-point alignment is quite a good fit for the zenith rise over San Pedro, not unlike the Cerro Gordo – Orizaba relationship where the symbolic effect of rise observation hypothetically transferred via a station point down to the ceremonial site (without fieldwork it isn't known if one or both station points are needed in the Chocolá case). Thus, it is possible that only the zenith line from San Pedro, and that (non-astronomical?) cardinal from Tolimán were necessary to locate the site, all other astronomical alignments mapped by Green being coincidental.









Figure 12. Projecting a zenith rise from San Pedro down to potential Chocola site requiring two station points on separate ridges (above); two distant largescale patterns among prominent peaks as possible reasons for Chocola's site orientation (below).

Left undefined, however, is the orientation of the clear site axis of Chocolá, measuring close to 20° (counterclockwise from north). Given the way the site is generally perpendicular to either astronomical or ritually cardinal lines of power coming from the east, one tends to seek some accurate 90° relationship. But the 20° cant, on the opposite side of north as we will see shortly at Izapa, and later at Teotihuacan, doesn't fit as accurate perpendicular to any of the lines discussed, particularly zenith San Pedro and cardinal Tolimán N.

Here the design simulation introduces an additional dimension to framing process. It is possible that in addition to alignments with natural features that locate sites, a site orientation azimuth can come from some distance and be largely independent of site experience *per se* (this is not the case with Santiago Atitlán where a locating line was used to orient the temple/church and plaza). Independent "azimuths" provide an additional means of invoking power from formal landscape features, perhaps for political as well as symbolic reasons. In practice this means that ancient surveyors need to be able to measure and record an azimuth of formal features at large scales—generally between two points--then reproducing that orientation as part of the layout of a previously positioned site.

As seen in figure 12, two possibilities of formal patterns between most prominent distant natural features can be found that closely match the approximate 20° orientation of Chocolá. The possibility in the southern Atitlán domain rests on the azimuth from Tajamulco to Tzontehuitz, a key mountain on an east-west construct to be introduced shortly. This angle, if recorded, can be emulated at Chocolá, once located. Good symbolic reason to connect Atitlán area mountains with the Tzontehuitz related frame construct will be discussed for multiple sites. Additionally, for Chocolá, its cardinal relationship east to Tolimán is a homologue to the eastwest component from Tajamulco to Atitlán X. By association, some feature, particularly pyramids, at the northern part of Chocolá's axis might express Tzontehuitz (and all that it will be shown to mean); a feature at the southern end could relate to Tajamulco, thereby bringing the power of these distant features into ceremonial play on the site.

A second possibility of independent source of site orientation could also be the 20° site perpendicular pattern between Popocatepetl and La Malinche, pivitol as it seems to be in the nadir component of the Cerro Gordo pyramid landscape. Not unlike the Tajamulco – Atitlán X homologue with Chocolá – Tolimán, is the cardinal Popocatepetl - Orizaba line. In this case the site axis emphasis is a perpendicular, rather than a direct emulation of one azimuth. Such is

problematic for a couple of reasons. First it seems somewhat less than logical given all the "real" alignments toward the east; and second because no features at the site center, perpendicular to the east, appear to strongly express this possibility. Both Izapa and Teotihuacan, however, may provide examples where both site axis and a perpendicular are formally laid out.

#### 1.2.3 Izapa: linking Tacana-Tajamulco with Atitlán and Atitlán X

From Izapa, Malmstrom recorded the unimpeded view of the summer solstice rise over Tajamulco (1978). This is a clear astronomical line which logically could have helped create site location. In calculating the rise azimuths from three points on Izapa's long axis, over a kilometer, the most accurate point is from an approximate center of the northern group at the far apex of the site. However, given the 2° range of deviation generally used by archaeoastronomers, all points along the total axis could have been used in the solstice rise observation over Tajamulco. The calculated azimuth from the southern end of the site axis is 26.51° (off 1.7° from the ideal of 24.81° from NOAA), and from the northern end 25.06° (off 0.24°). Obviously, the northern observation point is much more accurate. Using the approximate center point of the northern group illustrated in figure 13, the sun will be seen to rise about 70 meters from the edge of the 150-meter diameter rim of Tajamulco. The volcano is only 32.532 km from the north Izapa point.

Did early landscape designers understand the better observation accuracy of the north end of the site axis? Adding complexity to the issue is the fact that the point in the north group can be adjusted slightly to form a precise bisect ray mimicking that from Tacana to Tajamulco as seen in figure 11. The 25.06° observation is calculated from this precise point, and there may well be some "perfect" point in the north group where both observation and bisect are even more accurate. In any event one can find a strong coordination between astronomical and landscape alignments for the north group of the Izapa axis.

The bisect center line is also understandable, unifying Tacana and Izapa via Tajamulco, as prolongation of the cardinal line east from Tajamulco that helped create Atitlán X. One could even imagine some fundamental participation of Izapa in the creation of this intersection point on the Atitlán meridian, perhaps even prior to the discovery of the long line alignment coincidence
of Atitlán X with Orizaba and San Salvador. In this vein, would this be sufficient symbolic connection, in terms of Izapan ritual, to integrate the power of Tacana/Tajamulco and Atitlán



Atitlan

to the Izapa location? Furthermore, why was the northern apex of the site axis chosen for the solstice observation/bisect? What about the orientation of the site axis, and the meaning of the focus of the site toward the southern end of the axis?

From a designer's perspective, while the north point can clearly be a powerful first element in site location and orientation, it doesn't set up any direct site pattern between Tacana/ Tajamulco and Atitlán itself. This can be accomplished with a 90° angle directly between Izapa, Tacana (Tajamulco) and Atitlán. As seen in figure 13, the precise right angle occurs somewhere close the southern end of the Izapa site axis. Recognizing that surveying lines to Tacana, Tajamulco and Atitlán from the Izapa area is a relatively easy technical process, given excellent visibility and short distances, surveyors could have created a curved line running somewhat diagonally west-east, along which all points would be accurately 90° to Tacana and Atitlán. One assumes that this would have been the second move after establishing the solstice line from Tajamulco—without having yet established any north point or site axis. These two lines intersect a kilometer or so west of Izapa, and would have created one all-powerful point, an obvious center for the site.

Why didn't they do this? Why the duality between upper and lower parts of the site along a long very linear axis? Is this a precedent for the layout of Teotihuacan? The reason here lies in the design idea that ceremonial sites not only integrated power from somewhat distant volcanos, sometimes overlaid with astronomical phenomena, but that symbolically these sites were seen to emulate as much as possible the actual experience of observation from a "threshold" volcano like Tacana—a liminal opening to the power of Tajamulco. Thus, an additional design element, in addition to the bisect and right angle, would be for the site to accurately *face* Tajamulco, i.e. as an accurate perpendicular to the Tacana – Tajamulco line. To do this in the context of the bisect and right angle, requires the technical ability to record and transfer the Tacana – Tajamulco aximuth.

Here is how one can do this in design simulation. First was the solstice line, then the arc of uniform 90° right angles between Tacana and Atitlán, and then one can out a correctly oriented Tacana – Tajamulco perpendicular and move it by trial and error until it connected both bisect and right-angle lines. The aximuth from Tacana to Tajamulco is 245.97036°, and its perpendicular is 155.97036°, or about 24.02964° east of north. As best as can be determined

from existing Izapa maps, its axis, cardinally corrected from satellite images of the exposed north group, is about 24°, plus or minus a degree.

Thus, looking at the site in this perspective, some feature in the north group might well have symbolized not Tajamulco, but "Tacana"—its equivalence established by the bisect. Then given the idea of threshold or observer peak, and the perpendicular to the focus peak, some feature to the east of the axis at the overall site focus would be symbolically "Tajamulco". The expression of these two locations created by the axis and its orientation are unified by the southern base of the axis linking the threshold peak Tacana to the meridian base Atitlán.

What does the process of Izapa's positioning and orientating of site axis share with Chocolá? Both use seemingly accurate astronomical alignments to provide one line or positioning element: (summer) zenith rise at Chocolá and summer solstice rise at Izapa, though these are from different locations on the linear sites, i.e. site center and north group respectively. Then, both processes involve cardinal relations to the Atitlán meridian, first via an easterly line from Chocolá to the north twin peak of Tolimán, and the west-east line from Tajamulco to Atitlán X associates with Izapa through its bisect with Tacana. Both are equal "observers" of this cardinal. This meaning may have been most expressed in the north group. The southern end of the site also needed its own cardinal positioning element, here the 90° lines to Tacana and Atitlán. Izapa's site axis, the perpendicular to Tacana-Tajamulco, participates with the line elements at north and south ends of the site area.

At Chocolá, the best zenith rise observation emanating from San Pedro connects to the center of the long axial site, and therefore fuses with the cardinal from Tolimán. Both lines create the center, apparently without the necessary component of site axis orientation as at Izapa, suggesting that Chocolá's orientation was free to pivot around the established center point, for additional symbolic effect. Of the two options diagramed in figure 12, the "observer" perpendicular from Popopetcatl to La Malinche seems similar to perpendicular observer experiences at Izapa—Tacana – Tajamulco--also imported from a distance. If designers could replicate an azimuth orientation from a pair of volcanos in the southern area, why not from the north, even though at a greater distance? Furthermore, Chocolá exhibits major "zenith" meaning as seen in its (summer) rise and La Malinche plays a strong threshold role in winter nadir symbolism up north, suggesting that some sort of zenith-nadir opposition could be at play via Chocolá' site axis.

### **1.2.4** La Venta as first defined landscape domain of an Olmec Frame: a larger scale coincidental equinox base line and related meridian

This exercise makes no claim on the author's part to chronologically sequence formal landscape patterns according to any well researched archaeology. All patterns, however, appear to be "early", either pre-Olmec, Olmec, or Preclassic. A very ancient Izapa was described more in relation to the Atitlán complex, including Tacana-Tajamulco, than to Chocolá in any temporal sense. The discussion about the long line from Orizaba to San Salvador was included earlier because of its coincidental relationship to Atitlán X. One now returns to this feature and the integration that this largest of scales suggests.

At the heart of some Olmec integration of the "above"/"north" with the "below"/"south", lies the discovery of two sets of cardinal or equinox related mountains, separated by a void in the middle or "*medio*" region of Mesoamerica. Coincidence here is not limited to the two sets of equinox alignments, but the way the two pairs and their void replicate the pattern forming the base of the Cerro Gordo pyramid landscape (figure 5), suggesting perhaps, some more ancient ritual understanding of the "above" setting. The *medio* construct with Cerro de Aguila - ZempoaltepetI to west, and Tzontehuitz – Victoria Peak to the east, creates an implicit "gap" connector that intersects with the Orizaba – San Salvador diagonal. As illustrated in figure 14, this point serves as a logical base for a meridian (*axis mundi*) for the La Venta site. Disclaimers about dating aside, for the moment, it seems that the apex location of a La Venta pyramid domain may have been chosen sometime before its dominant architectural pyramid and site orientation were built. Reasoning here will be explained shortly.

The diagram below the large map of figure 14 examines a range of accuracy for a meridian stretching 126.509 km up to La Venta. Precise calculations were first made to determine the intersection between the coincidental Orizaba – Atitlán X - San Salvador diagonal and the connecting line between Zempoaltepec and Tzontehuitz. The diagram shows a range of survey error within  $0.075^{\circ}$  that might have occurred for each of these coincidental lines. While the location of the La Venta meridian is off about 371 meters east of the precise intersection point, an error of only about  $0.025^{\circ}$  in the survey of the much longer and more difficult "great"





Figure 14. Positioning of La Venta and its landscape pyramid: intersection of Orizaba great diagonal with *medio* connector between Cerro del Aguila -Zempoaltepetl and Tzontehuitz - Victoria Peak; meridian north with equal angles from meridian point to Cerro del Aguila (west vertex) and new "benchmark" San Salvador *Medio* on meridian from San Salvador(east).

diagonal from Orizaba to San Salvador would produce a highly accurate vertical positioning of La Venta.

Once the meridian was surveyed, the second step would be to determine a good design point on this *axis mundi* to fix site location. Seeking to integrate some greater west-east dimension of the Olmec landscape pyramid, design logically can begin with Cerro del Aguila to the west extreme, and then Victoria Peak (listed by Malmström 1978) at the opposite end of the *medio* pattern. Geometrically, however, Victoria Peak is not a possibility, since equal angles from a La Venta meridian point between it and Cerro del Aguila intersect do not occur on land. The logical alternative is to create a meridian north from San Salvador, marking its cardinal intersection point (San Salvador Medio) as new east end of the La Venta landscape pyramid. Laying out lines from each of the two base end points would require some trial and error work by sets of crews on both sides—remembering that these early interacting groups could have been investing most of their ceremonial resources into landscape "framing" rather than architecture. With an image in mind of a pyramid shaped landscape domain, not unlike that of Cerro Gordo perhaps, survey crews could continue the positioning process by laying out two lines reaching the previously established meridian; each would then move to meet at a common point. Finally, again by trial and error, the connected "rays" of the new landscape pyramid would either move in unison south or north on the meridian until reaching the magic point where their angles with respect to cardinal west-east became equal (close to 74.9935°). The accuracy of this process to establish the La Venta site point on its vertical suggests an equal dexterity in creating other meridians such as that from San Salvador volcano.

Thinking about both figures 12 and 14, the reader can judge the importance of Tzontehuitz in its role as base to the La Venta pyramid domain. The line from the most powerful volcano in the south, Tajamulco, to the closest point of the La Venta pyramid domain base, Tzontehuitz, has an azimuth similar to Chocolá's site axis. An "observer" relationship exists as well at Chocolá, but only in relation to west-east cardinal, possibly equinox lines. The cant of the Chocalá axis in relation to the cardinal line to theTolimán north point replicates aspects of the same geometry at Tajamulco, where the line to Tzontehuitz can be taken as "site axis" in the same canted relationship east to Atitlán X. One or both of these design alternatives could have been coincidental and unknown to Olmec designers, particularly since neither is necessary to the process of site location. If known and used to orient the site axis, both would involve measuring and recording azimuths of frame features independent of surveyed lines from natural features directly running to the site.

### **1.2.5** San Lorenzo as meridian apex: a second great coincidental diagonal and new *medio* point

When searching early on in this simulation for some largest scale coincidental connection between "above" and "below" domains, it wasn't the line from Orizaba to San Salvador that came to the fore—it needs the Atitlán /Tajamulco intersection point—but a line from Cerro Gordo at the peak of its landscape pyramid down to Tacana. The coincidental interim point is the threshold peak of La Malinche. Using the high point of La Malinche early on, the average deviation of this 877.812 km line is about 0.08687°, or just over the 0.075° measure for survey error presently used. As can be seen in figure 15, however, the precise line runs only about 130 meters north of the center of La Malinche's extant west crater rim (its eastern half is collapsed). Using the center of the rim, rather than the slightly higher point just south and not on the rim (used in the 0.087° calculation) creates a more accurate coincidental three-point alignment; the line from Cerro Gordo to Tacana passes about 81 meters north of the old crater center. Symbolically this line from the "north" landscape pyramid apex connects solstice timing (via Orizaba) with the nadir observer (La Malinche) down to solstice timing (Tacana).

Also early in this simulation, it was assumed that a San Lorenzo meridian was positioned earlier than that at La Venta, primarily because of the intersection of the most unique coincidental "above"/" below" great diagonal Cerro Gordo – Tacana line with the connecting *medio* line from Zempoaltepetl to Tzontehuitz, figure 15. No good site plan appears in the literature for San Lorenzo, leaving only a presently estimated center point of the modest butte to be used in measurements. The meridian south from this point misses the precise intersection of the two large-scale coincidental lines by about 1,100 meters to the east. Yet from the diagram of figure 15, the reader can see that San Lorenzo's meridian falls within the area defined by 0.075° survey error for either line. The line from "San Lorenzo Medio" to San Lorenzo is about 77.763 km. Given the lack of site map for San Lorenzo, one cannot evaluate site orientation.

The major reason why La Venta's location—but not yet its architectural pyramid or site axis—was created first is its greater scale and simplicity in its landscape pyramid pattern with base points at Cerro de Aguila and San Salvador Medio. The laying out of San Lorenzo's meridian obviously mimics the larger La Venta vertical axis. To create the meridian apex, and San Lorenzo site itself, designers might well have looked first to some similar western ray from Cerro de Aguila, running it up at a trial and error angle to the meridian. But how does the designer know that lines from neither Tzontehuitz, nor Victoria Peak, both on the *medio* base line could hit the San Lorenzo meridian at equal angles to the Cerro del Aguila western ray?

Thinking more fundamentally about the coincidental founding of the growing framework, designers can consider the way in which the two long diagonal axes connect, as it were, in the northern domain--via Cerro de Gordo's links to Orizaba and La Malinche. Symbolically logical



Figure 15. Positioning of San Lorenzo and its landscape pyramid: intersection of Cerro Gordo great diagonal with *medio* connector; meridian north with equal angles to Cerro del Aguila (west) and new benchmark Atitlan Medio (east) created by perpendicular through Atitlan X to Tacana - San Salvador line.

would be some pattern connecting the southern ends of the two lines, Tacana and San Salvador. A key part of this thinking sees Atitlán X as critical to any connection between diagonals. It perhaps had previously been understood to link the Orizaba – San Salvador line with at least Tajamulco, and more indirectly to Tacana.

It took a while in the simulation to discover what happens when a direct line between Tacana and San Salvador is surveyed first, and then a precise perpendicular at a point on this line is constructed that runs accurately through Atitlán X, continuing north to create an eastern "Atitlán Medio" point on the "great" *medio*. This is a much more symbolically powerful east base point for a San Lorenzo landscape pyramid. Lines can now be laid out from the new (east) Atitlán Medio point and (west) base point at Cerro de Aguila up to a trial and error position on the San Lorenzo meridian. Then the meeting point where the two lines create equal angles can determine the location of one of the first ceremonial sites eventually with monumental features. It is not impossible, perhaps ignoring the geometry of the La Venta landscape pattern for the moment, that the two angles at the San Lorenzo apex are simply coincidentally off about 0.027° (as a bisect). But from a design perspective the logical layouts of La Venta and San Lorenzo seem to be cut from the same mold. Yes, the creation of the Atitlán Medio point is more complex but the reader will soon understand considerable additional meaning this "benchmark" provides to locating and laying out several additional sites.

# **1.3** Revision of La Venta frame via unifying Atitlán Medio: homologues of pyramid and hearth landscapes/maps as urban design

## **1.3.1** Unification of the two great diagonals: La Venta, Piedras Negras, (and Monte Alban?)

When this design simulation next sought additional sites to possibly integrate into the large-scale Olmec Frame, Monte Alban seemed interesting because of its proximity to Cerro de Aguila, the common west base point for both La Venta and San Lorenzo. Using spatial ritual logic, if some western site was built in relation to that part of the two pyramid domains, might there be some oppositional eastern site? Yet while Monte Alban architecturally seems to be an axial site, perhaps not unrelated to Chocalá and Izapa, the eastern site closest to Atitlán Medio is either Yaxchilan or Piedras Negras, both seemingly influenced by different layout planning. Since Piedras Negras seems larger and more complex (earlier too?) than Yaxchilan, its location as an opposite seemed more promising. Given the complexity of San Lorenzo's simulation and its key dependence on the unifying the two great diagonals via the Atitlán Medio point, finding a frame connection to Piedras Negras became the first move. An initial line from the (preexisting?) La Venta point to Atitlán Medio was laid out as in figure 16. By trial and error then, Piedras Negras could have been located at the point where the curved path of two lines from San Lorenzo Medio and Atitlán X, always intersecting at 90°, crosses La Venta – Atitlán Medio. Thinking then about the possible western dualistic site of Monte Alban, La Venta's meridian to La Venta Medio should also play a role in establishing a geometrically logical, perhaps even symmetrical, location for this western base point of the La Venta landscape pyramid. Part of an oppositional logic here would balance the base line from Piedras Negras to the vertical base of San Lorenzo, with a base from the Monte Alban location to the vertical base of La Venta—a neat integration of the two west-east sites with both San Lorenzo and La Venta meridian base points at the center. In the present simulation, however, experimenting with the La Venta Medio point *does not* produce a Monte Alban location with any accurate oppositional geometry.

One satisfyinig design element finally emerged. The La Venta site orientation of about 3° was imagined as having been laid out in relation to the location of the two paired sites. In this vein, if one calculates the accurate location of a new La Venta "meridian" running south to the San Lorenzo Medio – Piedras Negras line, this point has an azimuth of 2.88604° or very close to La Venta's site axis. From this new vertical base point, "La Venta Medio 2", a line west could be surveyed along with a ray from La Venta. After an intersection of the two lines is established, then this point can be adjusted by trial and error to find a point creating an angle equal to that from Piedras Negras,

Although the distances from the pair sites to La Venta are remarkably close to being equal— 312.389 km and 312.711 km—it seems doubtful that they were ever chained off or measured linearly. More definitive perhaps, was the measurement of the two angles—21.62326° and 21.61208°. Both the hill location of Monte Alban, and the river location of Piedras Negras would appear to be incidental to the large-scale symmetry integrating the two sites via La Venta.

The design of Monte Alban's site axis, about 3.5° in the opposite direction from La Venta's is not readily understandable. Like Izapa and Chocolá perhaps, some perpendicular to its long







Figure 16. Revised La Venta landscape pyramid with equal angles and leg distances to Monte Alban and Piedras Negras; right angle between Atitlan X and new La Venta base, "*Medio 2*", with vertex at Piedras Negras; new line to La Venta similar to its site axis. linear axis could have aligned either to some distant feature from the site itself, or possibly mimicked the alignment of a pair of features not directly linked to the site. At an azimuth of 267.42930° perpendicular from Monte Alban, lies the cardinal mountain Tzontehuitz. This could be an oppositional link between Alban as associated with the western cardinal point of Cerro de Aguila (base with Zempoaltepetl), and the western cardinal point of Tzontehuitz (base with Atitlán Medio, San Salvador Medio and Victoria Peak). No approximately 3.5° (perpendicular) azimuth between some independent pair of mountains, such as up in the Cerro Gordo domain, is evident.

At the much larger and more complex Piedras Negras, one sees no immediately apparent site axis, even though more formally dominant axes appear at Chocolá, Izapa, La Venta and Monte Alban. Some uncertainty of as-built drawings undoubtedly exists for many of sites of the present simulation, particularly at Piedras Negras where nothing is visible from satellite cameras, and where the primary site map, detailed as it is, was drawn in 1930s (Satterthwaite et.al. 2005). In a recent remapping dissertation, mention is made of previously recorded dimensions being off as much as 20 meters; nothing is said about the orientations of major architectural elements (Nelson 2005). Thus, while the large-scale geometry being simulated with present technology may be off only a few tenths of arc seconds, this entails a much greater comparative accuracy than geometric patterns measured from most published site plans. Given the size of Piedras Negras and its total cover from satellite imagry, establishing a precise calculation point is difficult. The point used in large-scale site location lies on the precise La Venta – Atitlán Medio line. It is the northwest Ball Court, determined with email help from Zach Nelson.

At Piedras Negras simulation began to use azimuth lines of the Olmec Frame in the design of urban layout. The reader needs to clearly understand the relative accuracy of this process. Placing the correctly oriented site map in a base layer in Adobe Illustrator, a layer above is used to test azimuth lines. In the upper layer a true cardinal north-south line is drawn, then rotated to the selected azimuth from the frame list. *With its orientation fixed*, this line can moved around on the site to see if it seems to work in the positioning of principal features. When a line is "rotated" in Illustrator the ends of it cannot be dragged to a new orientation, as is the case when a line is simply drawn between two points. One can lengthen or shorten rotated lines while maintaining the original orientation. The designer cannot





Figure 17. Meridian axis connecting north and south plazas at Piedras Negras, homologue map of original La Venta landscape pyramid with apex at monumental stair as threshold on meridian; north Ball Court axis as perpendicular to Orizaba great diagonal with Atitlan X and San Salvador; triple axes grid using azimuth from Piedras Negras to San Salvador, with a perpendicular involving south Ball Court. fudge these lines by moving one end to more accurately align with a feature; one must move the entire line in its fixed orientation. All azimuth lines shown in illustrations are numerically fixed.

Formal aspects of the Piedras Negras plan of figure 17 express a west-east opposition as primary concept of the overall site. Four prominent structures, the largest at the north, form a meridian alignment that passes through the center of the grand stair feature connecting the two domains. This stair point forms the apex of a horizontally laid out pyramid shape that is an accurate homologue using large-scale azimuths to map or express La Venta's locating landscape pyramid, i.e. its meridian from the Orizaba-Atitlán X-San Salvador line and side "rays" to Cerro del Aguila and Piedras Negras – Atitlán Medio (replacing the original east base point of San Salvador Medio).

The eastern ray of this central site meridian and related map appears to originate (as a symbolic surrogate for La Venta?) from the highest part of the acropolis, and a second azimuth from the high point, replicating the western ray of the landscape pyramid map (Cerro del Aguila – La Venta) seems to be important in the positioning of K-5 at the top of the meridian. *It is symbolically logical for not only the apex of the La Venta map at the center of Piedras Negras but the apex of the site meridian at K-5 to be formed by the apex creating azimuth of the large scale La Venta landscape frame. Once the central stair point and meridian apexes are created, then the Ball Court axis can be laid out from K-5; this is the perpendicular azimuth to the great diagonal Orizaba-Atitlán X-San Salvador line that creates La Venta's meridian base point, La Venta Medio. The Ball Court axis terminates at N-1, positioned by a cardinal west from the central stair point. The opposite point on this cardinal, O-12, is created by the La Venta-Piedras Negras Negras – Atitlán Medio line from the acropolis high point, curiously enough the K-5 to O-12 line is the mathematical horizontal reflection of the Ball Court axis from K-5.* 

The design caveat here is that despite a possible later day adjustment of La Venta's base to La Venta Medio 2, key to the positioning of Piedras Negras, the map being reproduced on the site's meridian/stair focal point is that of the initial La Venta landscape pyramid without any associated built sites, perhaps even at La Venta itself. Furthermore, while the two pyramid ray azimuths correctly model those of the aboriginal La Venta frame, the cardinal base line of the Piedras Negras homologue is a simple west-east cardinal, symbolically simplifying the fact that the base pairs of the La Venta landscape pyramid, while both being cardinal, are not on the same latitude (just as in the Cerro Gordo landscape pyramid).

Given the cultural significance of Ball Courts, and their formal dualism in the Piedras Negras complex of features, what second line fixes the location of the Ball Court in the West Group Plaza? A possible alignment runs from the acropolis high point through the prominent J-4 feature to the center of the Ball Court. What, then, positions J-4? In terms of azimuths recorded from elements of the early Olmec Frame, J-4 maps the 90° Piedras Negras point to San Lorenzo Medio and Atitlán X that helps locate the site originally, see again figure 16. Adding technical complexity to J-4's "perpendicular" meaning, is the apparent fact that the line from its apex point to the central stair point is also perpendicular to the Ball Court axis from K-5 itself.

Without yet understanding the total positioning of J-4's dualistic partner, J-3, both features at the front of the acropolis are termini for two of three parallel azimuths invoking the large-scale relationship of Piedras Negras to San Salvador. J-4's line runs down to the second of Piedras Negras Ball Courts in the eastern domain. J-3, for its part helps line up R-5 on the meridian. The western Ball Court and La Venta landscape pyramid west point, N-1 seems to form a middle axis to the two J-4 and J-3 lines. This line may climax with J-29 to the northwest, R-16 on the meridian, and R-10. The line between the center of the eastern Ball Court and R-5 seems to be a perpendicular to Piedras-Negras – San Salvador azimuths.



Figure 18. Relation between Piedras Negras high point and stair feature running to threshold point on site meridian and on to feature O-12; this is the azimuth of the eastern ray of the La Venta map, La Venta - Piedras Negras -Atitlan *Medio* (sketch from Satterthwaite 2005: 156).

If the reader will shift now to the second Piedras Negras plan, figure 19, the positioning of J-3 can be more fully explained. Designers can use the highly significant azimuth in the founding of San Lorenzo, i.e. that from Atitlán X – Atitlán Medio, also the basis for the positioning of Piedras Negras, to associate the two prominent features at the front of the acropolis, J-3 and J-4. Again, this line is perpendicular to the Tacana – San Salvador line that links the termini of the two great diagonals from Cerro Gordo and Orizaba. From figure 19, this 90° relationship can be used as an organizing grid for six major features, including the eastern Ball Court where it turns down to include the "South Group". The positioning of J-4, O-12 and R-16 in this grid can be accomplished while integrating the other lines to these three points already described. As an architect, one has a growing intuition that, not unlike contemporary design process, numerous alternatives were tested in some small-scale modeling or even drawing medium before final solutions emerged.

Regarding the Ball Court orientations, one can note here that both west and east places for the sacred games are founded by azimuths involving the great "Olmec" diagonals. For the west Ball Court, a perpendicular to the La Venta diagonal, Orizaba-Atitlán X-San Salvador, and for the east Ball Court, the connector that links this diagonal with San Lorenzo's, i.e. Tacana – San Salvador and its perpendicular Atitlán X-Atitlán Medio. It is also possible that the grid of the second plan of figure 19 involving the location of Atitlán related points (Tacana, San Salvador, and Atitlán X) associates this southeast direction with the location of Piedras Negras' "southeast" Ball Court.

The Ball Court in the northwest associates more with Orizaba in that region of the greater landscape. It is not directly linked to the grid-like diagonals that run down from J-3, J-29, and J-4 whose azimuths replicate Piedras-Negras – San Salvador. Yet the N-1 feature very much connects the "northwestern" Ball Court axis with the center diagonal. The diagonal from J-4 down to the "southeastern" Ball Court seems to integrate the two grid systems. While it possesses a strong relationship to the Orizaba orientations of the "northwestern" Ball Court, and an azimuth connecting it to N-1 (Atitlán X-Piedras Negras and its 90° to San Lorenzo Medio used in the site location) and the 90° at the "southeastern" Ball Court, it also participates in the Atitlán related grid, and a second 90° angle at the "southeastern" Ball Court. Aspects of this integration of the two grids are also expressed in the position of J-3, though it hasn't J-4's linkage to the "northwest" Ball Court alignments.



Figure 19. Grid expressing the perpendicular between Tacana - San Salvador and Atitlan X - Atitlan Medio that created the revised La Venta east ray on which Piedras Negras was located (above); azimuths in first "hearth" shaped domain defining the acropolis (below left), which

when rotated 180°creates a largely complete map of the actual landscape with its internal focus on Atitlan X (below right).





Also illustrated in figure 19, is the somewhat independent right-angle relationship between J-3, O-13 and the "southeastern" Ball Court. The J-3 to O-13 azimuth replicates the line from Piedras Negras to Palenque to the northwest. The way this line misses the importantly integrated and perhaps "aboriginal" N-1 point, together with its odd canted, though 90° relation to the Ball Court, suggests the creation of the O-13 point at a later time perhaps involving the establishment of Palenque.

The triangular diagram between J-3, K-5 running through the "northwest" Ball Court, and J-29, with an interior focus on J-4, shown in figure 19 appears to be a second kind of homologue map, where an actual large-scale landscape domain is reproduced as urban design pattern. At Piedras Negras, the first map lays out the revised landscape pyramid with La Venta as apex, Cerro del Aguila as west base point and Atitlán Medio as east base point. This appears to be a founding symbolism integrated with the sites' meridian. The second map at Piedras-Negras with its acropolis focus is created by four highly critical points on the early Olmec Frame: Tacana and San Salvador, and the perpendicular to this connector of the two great diagonals, Atitlán X and Atitlán Medio.

The lower diagrams of figure 19 show the geometric relationship of the Piedras Negras map to the actual geographical area created by the four points. Curiously enough, the map on site is rotated accurately 180° placing the "Atitlán Medio" apex in an inverted position at the bottom. Similar rotations exist at other sites and will be discussed in the conclusion. While the Atitlán Medio point and the two pyramid rays from it are reproduced, a variation occurs in the base. The inverted site base is the Tacana – Atitlán X azimuth, while the actual landscape domain base is the longer line from Tacana to San Salvador. This is strange, given the recognition of this latter line in one of Piedras Negras' grids. A Tacana line directly to Atitlán X is not prominently part of the frame at this stage of possible evolution, even though, as will be seen, it carries serious weight in the locating and urban design of Copán.

J-4's special position in the triangle conforms to the azimuth and context of the Atitlán X-Atitlán Medio line, but again the lengths of the conceptually corresponding lines are different. Most significantly, J-4 appears to play the role of Atitlán X, not only because of its association with the Atitlán X-Atitlán Medio azimuth, but because of the way the azimuth San-Salvador to Atitlán X "points" to this location on the Piedras Negras homologue. Atitlán X and J-4's

perpendicular relation to Tacana-San Salvador is expressed by a second "pointing" azimuth. J-4 is again the grid "climax" with J-3 and O-12.

When first simulating Piedras Negras, the acropolis triangle as map was not thought of as particularly expressive of an actual place in the larger landscape that might, following the lead of Bassie-Sweet, symbolize the Mayan Hearth concept. Continuing work on other major sites, however, soon changed this perception. The simulation of Piedras Negras was a revelation, with a much fuller understanding of the way recorded azimuths can not only originally position sites, but more symbolically important perhaps, create on site homologues which might logically be used to frame ritual practice.



Figure 20. Alignments of monuments and doorways at Piedras Negras as drawn by Hartung 1984:224; two labeled lines correspond in orientation to azimuths in present work.

Before leaving this complex, engaging design simulation, one may ask why no site expression of the 90.55279° azimuth between the large-scale geometric pair, Monte Alban and Piedras Negras exists, or for that matter the seemingly important 91.87357° base line from Piedras Negras through the La Venta Medio 2 point (perp) to San Lorenzo Medio? Could knowledgeable archaeologists, once engaged in this new scale of Mesoamerican formal design, speculate about how at the time Piedras Negras was located, Monte Alban, San Lorenzo Medio and La Venta Medio 2 were prominent in the symbolic thinking of "Olmec" designers. Later, however, particularly after an expansion of the frame and locations of major sites like El Mirador, Tikal, Takalik Abaj, and Kaminaljuyu, lines participating in these locations became more politically

important, particularly those dependent on Atitlán X and its offspring. In all of this does the power of the two San Lorenzo meridian points become less influential, though still venerated, in comparison to the way the apex site of La Venta participates prominently not only at Piedras Negras, but in subsequent eastward evolution. It is also probably true that large scale site location dependent upon participation of multiple groups from a region may inherently be less susceptible to a politics of symbolic expression than the orientation and alignment of site architecture.



Figure 20. Alignments of monuments and doorways at Piedras Negras as drawn by Hartung 1984:224; two labeled lines correspond in orientation to azimuths in present work.

At Piedras Negras one encounters the work Horst Hartung, though engineer and city planner, primarily thought of as a pioneering archaeoastronomer of Mayan sites. Yet his 1984 piece looks at design formalities among site features *independent* of astronomical observations. Most interesting to the present simulation of how large-scale surveyed lines among prominent natural features—either part of site location or as remote homlogues—overlaps with Hartung's mapping of stela and altar features at Piedras Negras. Two of his three feature alignments appear to have similar azimuths to large scale lines as here labeled over his drawing of figure 20. One is the reoccurring Tacana – San Salvador azimuth, perpendicular to Atitlán X – Atitlán Medio, and the other replicates the line between Piedras Negras and Palenque. For the most part the stela tell histories of particular rulers in temporal contexts. Why, one immediately asks, would histories at a relatively late classic date of the 600's A.D., want to symbolically associate, not only with other rulers, but with the much earlier hypothetical Olmec Frame that might have created

original site location? Are sequences of Mayan time and later kings, somehow integrated with a more ancient formalized landscape?

Hartung (1984), also looks at other geometric patterns among site and architectural features, i.e. cardinals, right angles and isosceles triangles, particularly this latter pattern as laid out in the South Group Port (his pg. 232) in the relationship between R-4, R-5, and R-10. These azimuths do not match any of the frame components used elsewhere on the site. One of the reasons why Hartung does not really analyze the entire site, mapped earlier, might be that by the time of his fieldwork, much of the site had once again been overtaken by jungle. Apparently, he preferred to use his own site data rather than rely on the maps of others, a habit undoubtedly developed by necessity in studying astronomical alignments with site features.

#### 1.3.2 Palenque's site positioning and hearth identites with Piedras Negras

Palenque's location lies approximately north (off about a full degree) from the southern terminus of the great Cerro Gordo diagonal, Tacana, a volcano peak of growing importance regarding site layouts thus far discussed, and particularly as part of the "hearth" map at Piedras Negras. A Palenque landscape pyramid can be most precisely simulated, however by a symbolic "meridian" to Izapa, highly integrated with Tacana as it possibly might have been. Designers can first choose the two base points of the prospective landscape domain: the original La Venta Medio 1 meridian base, and the San Lorenzo related Atitlán Medio point prominent in the positioning and site layout of Piedras Negras about 90 km the the southeast of the eventual Palenque point (its central tower is presently used). The site positioning process can begin by running opposing lines out from these two base points, figure 21. The angles from west and east base points up to the new Palenque symbolically should be equal. Once these two lines meet at a trial and error apex point, a bisect line could have been prolonged to the south. One can imagine three separate survey crews, with requisite numbers spread at visible intervals along each line. Communication can easily occur among all part of the lines. Logically the bisect axis would be prolonged down to either Tacana, or alternatively Izapa. At each of these positions, adjustments in the location of the Palenque point would be made.

A Palenque point can be found that forms a landscape pyramid apex with equal angles to La Venta Medio 1 and Atitlán Medio (with Tzontehuitz). The bisect of the apex angle runs very





Figure 21. Palenque landscape pyramid with "meridian" axis to Izapa, equal angles to La Venta Medio 1 and Atitlan Medio; major site axis La Venta - Palenque with perpendicular involving the Ball Court and the Templo del Sol; possible map of Palenque's landscape pyramid with apex at palace high point.

accurately down to the southern point of the Izapa site axis. Not unlike the revised La Venta "meridian" possibly created to equally frame the relationship between Monte Alban and Piedras Negras, the Palenque "vertical" is also not true, being off at the azimuth of 357.13001°, about the same variation of the second La Venta axis, but in the opposite direction (not unlike Monte Alban's).

Given the layout prominence of azimuths at Piedras Negras to La Venta, the first accurate azimuth line to be simulated on an Illustrator layer above the correctly rotated site plan of Palenque, is logically as well one to La Venta. The La Venta – Palenque line, perhaps directly surveyed once the site is located, seems to generally organize the overall site. More accurately, however, is the similar orientation of Temple XI's plan and the parallel relationship of north features of the Palace. This main site axis, again invoking La Venta, appears to form a limited grid, with a perpendicular creating the Ball Court axis that runs to the Temple del Sol. Another grid element, parallel to the main site axis may organize El Grupo Norte.

Not unlike Piedras Negras, a grid of the perpendicular relationship between Tacana – San Salvador and Atitlán X – Atitlán Medio is also in play. Beginning at the Ball Court, the grid goes to and turns at Temple X, running down to and pivioting at the Templo de las Inscripciones, crossing over to the Templo de la Cruz, with another perpendicular to this leg stretching down to Templo XX.

A third grid of sorts may express the Palenque – Atitlán Medio line that participates in the original locating of the site. Two perpendicular features are initially suggestive here: parallel features on the south side of the Palace, and a line running from a palace point (tower?) up to the Templo del Conde. Deviating from the 90° constraint, a line from the Palace "pivot" point then replicates the other ray of Palenque's original landscape pyramid, i.e. Palenque – La Venta Medio 1, terminating at the singular pyramid shown (not named as part of the Palenque core). This connection pattern then reproduces the northern Palenque – Atitlán Medio line now running across to Templo XX. Continuing with this symbolic expression of the original site positioning layout in the larger landscape, the pattern finally returns up to the pivot point in the Palace, perhaps considered the high point of the site core. Replacing the southern Palenque-Atitlán Medio line with the implicit line formed by south palace features, one has a map created with accurately recorded azimuths of the original landscape pyramid seen in the large-scale diagram of figure 21. This appears to be an equivalent to Piedras Negras's Cerro del Aguila – La Venta –

Atitlán Medio homologue with its apex on stair center on the site meridian. Palenque's line symbolizing its relationship to Izapa (s) is its "meridian" in this respect. There is, however, an accurate meridian expressed in the relationship between the Ball Court and the Templo de la Cruz.

Templo XI may play an integrating role in unifying features on the north and south sides of the Palenque – La Venta site axis. It radiates two lines, a San Lorenzo – La Venta azimuth to the north aligning Templo X and Templo del Conde, and an Atitlán Medio – San Salvador line connecting the Templo de las Inscripciones and Templo XX.

Moving to the enlarged scale drawing of figure 22, it first shows how the overall site was correctly oriented by coordinating satellite features, here the Templo de las Inscripciones, with geometry of a drawn site map. First of all, few if any of the azimuths in either figure 21 or 22 are also astronomical alignments. It is true that archaeoastronomers have carefully studied the way important sun rises work with particular architectural features. The best example here may be the discussed winter solstice alignment between the Templo de las Inscripciones and the Templo de la Cruz, though it is difficult to know exactly which features on the tops of these two temples were used. This alignment of course is close to, if not identical to the coincidental solstice relationship between Tacana and Tajamulco.

The azimuth from the northern top threshold of the Templo de la Inscripciones to the southern top threshold of the Templo de la Cruz has already here been identified as Tacana-San Salvador with a perpendicular of Atitlán X – Atitlán Medio running down through the Templo del Sol and on to Templo XX. In figure 22, one can diagram a triangle with Tacana-San Salvador as its north base and Templo XX as apex. Understanding the two other sides of the triangle as the azimuths of Atitlán Medio-San Salvador to the west and Tacana-Atitlán Medio to the east, one discovers virtually the identical Mayan Hearth homologue found at the core of Piedras Negras. The Palenque map is also inverted, i.e. rotated 180° and accurate in terms of its azimuths. The only difference between the two hearth maps is Palenque's more precise modeling of the inverted base, here the full Tacana-San Salvador line, compared to Piedras Negras Tacana – Atitlán X.

Symbolically more pronounced than J-4 at Piedras Negras, perhaps, is the meaning of Palenque's interior hearth focus, the Templo del Sol. According to the complete hearth map of



Figure 22. Palenque hearth map with internal focus on the Templo del Sol; map is virtually identical to Piedras Negras' including its 180 orientation from the actual landscape (below right); variation occurs in the hearth bases, Tacana - San Salvador at Palenque and Tacana - Atitlan X at Piedras Negras (Palenque plan from Barnhart 1958).

Palenque, the Templo del Sol is Atitlán X, again the place where *Popol Vuh* was recorded. In addition to this very clear map definition, one of the diagonal azimuths crossing through the Templo del Sol connecting the XV feature to the palace tower is that from Palenque to Atitlán X. Its opposite diagonal aligning from the Templo de la Cruz, does not associate with Atitlán X, and remains undetermined. The final alignment to the triadic focus of the Templo de la Cruz connects with the Templo de la Cruz Foliada. This azimuth from Tacana to La Venta Medio 1 does not otherwise occur at either Palenque or Piedras Negras. Does the Cruz Foliada express the meridian of what is appearing to be the most powerful pattern in the Olmec Frame, i.e. the La Venta pyramid domain? Furthermore, the symbolic tie between Tacana and La Venta, Medio 1 base, also links the two great diagonals.

Looking now at the possible Orizaba – Atitlán X - San Salvador azimuth that runs across the lower portion of the triangular map, the Atitlán X role of the Templo del Sol can be seen to symbolically connect with the line that forms the top of hearth construct, Tacana – San Salvador, with its perpendicular down to the Templo del Sol. The power of Atitlán X resides in its integrative role assimilating the coincidentally natural Cerro Gordo and Orizaba diagonals, which may have founded San Lorenzo and La Venta.

# **1.4** The coincidental alignment of El Chiflón cascades with La Venta and Atitlán X: hearth homologues at El Mirador and Tikal

#### 1.4.1 La Danta / El Mirador and the site prominance of an evolved Mayan Hearth

The location of the La Danta pyramid point and related El Mirador is as strongly integrated with La Venta and San Lorenzo preceedents as any designer might predict. A line from Orizaba mapped in figure 23 runs to the La Venta pyramid landscape apex, the singular onsite pyramid point itself, and then continues down to the great *Medio* line. For the third time, following La Venta and San Lorenzo, a meridian from a *Medio* intersection point works to partially position an important early site, specifically the largest eventual El Mirador feature, La Danta, also one of the largest and highest pyramids in the world. Then, the latitude of La Danta, 17.75155°, is close enough to San Lorenzo's less accurately defined of 17.72922° to logically suggest it as the second cardinal firmly locating the site on the meridian from "Danta Medio". Included in figure



Figure 23. Position of La Danta pyramid and El Mirador as the intersection of a meridian from the point where Orizaba - La Venta hits the *Medio* line (benchmark Danta Medio), and a cardinal east from San Lorenzo.



23 is again a diagram illustrating the relative accuracy of meridian location with respect to the calculated diagonal-*medio* intersection point.

Turning to a simulation of the El Mirador site itself, after Piedras Negras and Palenque, the urban designer has two precedents in mind, first a homologue or map that reproduces the large-scale landscape involved in positioning the site, and second a possible Mayan Hearth, also as map of a larger actual landscape domain. Again, the first essential step to the mapping illustrated in figure 24 is the accurate orientation of site to the true cardinal directions, this before rotated





Figure 24. Major site axis and 90° grid created from the La Venta -Danta azimuth; new hearth map correctly models large - scale pattern with inverted apex at EI Chiflon cascades; line from San Lorenzo to Danta Medio is also accurate as expressed running through hearth focus in site design. Olmec Frame azimuths can be tested on an upper Illustrator layout. Site orientation was easy in the El Mirador case because of work by a team of archaeologists and archaeoastronomers (Sprajc et. al. 2009) whose efforts also depend upon correct orientation of built features.

The presently used site map for El Mirador is at quite a large scale, and ideally some greater close up drawing would provide a more exacting determination of the fit between azimuth lines and principal features. While the azimuth accuracies are extremely precise having been determined from such large distances, the drawn architectural site map is decidedly less so, given the complexity of this work in the field, financial resources, and perhaps technical ability of the surveyor. Thus, again, the apparent design patterns presently illustrated must be taken as an exploratory survey. To match the site map accuracy with precise large-scale alignment accuracy would of course require young legs and a decent grant for onsite field work.

Once the site had been located—the Danta point perhaps prior to any massive pyramid there—designers might well have considered expressing two, and even three primary azimuths. The most symbolically powerful would surely have been the line from Orizaba, with all its pyramidal and astronomical coincidence, through the La Venta apex point to the intersection with the Medio line that located Danta's meridian. The second most important line would be the direct azimuth from the Danta point to La Venta. When the Orizaba line is "transported" to the Danta point, it forms, together with La Venta – Danta, an arc sector radiating west that seems to symmetrically define four major features at El Mirador's center.

Given this arc, its bisect fittingly defines the central axis from Danta pyramid's peak, through a smaller "sighting" pyramid and running to the feature archaeologists call the "Central Acropolis". One calculates the azimuth of this bisect, 77.90252, and rotates this angle from a cardinal line in the upper layer of Illustrator. It works very accurately as an alignment of the central features mentioned, considering again the map and graphic limitations of 8 ½ x11 format. The reader will notice, however, this central line is labeled differently on the site drawing of figure 24. It was only discovered subsequently when looking at some possible actual map of a large pyramid landscape, that the azimuth from the San Lorenzo point to Danta Medio is largely indistinguishable from the precise bisect, again given the limitations of map accuracy and graphic presentation. The line from Danta Medio to San Lorenzo is 78.31422, about 0.40° from the bisect figure given above. At the distance of about 1,400 meters from the Central Acropolis to Danta's peak, the two azimuths vary about 10 meters, a difference which cannot be seen when

comparing the two rotated Illustrator lines on this site plan. Using unaided visual acuity, Mesoamerican designers might well have been able to achieve accuracy close to 0.017° (at both large and small scales), or in terms of the El Mirador axis, something less than one half of a meter.

As a design pattern, the three lines of the principal axis sector seem to clearly define the major triadic form with the central axis from Danta focusing on the center of the acropolis. Much has been written about the many triadic patterns of features at many, but not all, Mesoamerican sites. In a recent overview, Szymánski (2014) analyzes a large number of smaller scale "Triadics", always three pyramid like features on a common platform. Given that El Mirador has a few dozen such platforms, including the La Danta complex, it seems reasonable to think of the largest scale triad drawn in figure 24, as not unrelated to the symbolism discussed by Szymánski. Among all the triadics at El Mirador, besides La Danta, he places emphasis on Structure 34 and its two smaller side buildings 33 and 35. This is the triadic on the south flank of Tigre pyramid. From the present simulation, one can clearly see this triadic as the terminus to the central El Mirador axis from Danta, a possible homologue of San Lorenzo – Danta Medio.

Detailed in Szymánski, is the fact that small scale platform triadics orient to all directions, despite assertions that they map the southern portion of the Orion constellation which does not rotate as it moves through the night sky. If so, he says, why wouldn't all the triadics have this same orientation? His overview includes earlier ideas about triadics as replications of cosmic "hearths" as a primordial partitioning of the universe and emergence of first land, after Schele and Freidel (and Bassie-Sweet previously in this volume). Domestic Mayan hearths today are still defined by three stones.

In the case of the larger central triangle at El Mirador's site core, thinking about either *site locational* or *hearth* maps, what large scale lines might have been used to symbolically and graphically found this feature? The base of the triangle at the top is already defined as parallel to La Venta – Danta, part of the symmetrical rectangle enclosing the largest scale central triad. Here the designer recalls the inverted bases of the Mayan Hearths at Piedras Negras and Palenque. As for the two rays of the triangle, the only azimuths among previously described *points* in the Olmec frame —though not lines with azimuths--seemed somewhat coincidentally to converge on the Izapa North. The design logic seems somewhat consistent. The lines that run from Izapa create two points not only both on the great *Medio* line, but they are the two that

define the eastern half of the original La Venta landscape pyramid, i.e. La Venta Medio and San Salvador Medio. Independent of the location of the inverted triangle apex, two internal rays from the two major features on the west and east of the inverted triangle base (La Venta – Danta) to the center work well as rotated azimuths of Tacana – San Salvador (so important at Piedras Negras and Palenque) from the west, and La Venta Medio – Danta from the east, a line that actually runs to El Mirador.

At this point in the simulation, one understood that La Venta Medio 1 – La Danta, and the top of the triangle, La Venta – Danta might form an actual landscape hearth domain, were it not for the disassociation of the two rays from the *medio* line to Izapa. The calculated intersection point of the two acropolis related azimuths from the west and east points of the base (La Venta – Danta) occurs about 40 km southwest of Palenque. Ideally, in terms of a Mayan Hearth, the two side angles wouldn't terminate on the *Medio* (from Izapa), but at La Venta and Danta themselves. The layout of El Mirador's core would then be an accurate reproduction of the larger scale domain. To discover such an ideal new inverted apex, one needs only find a point that replicates the site azimuths, i.e. close to those focusing on Izapa. Checking this possible area in Google Earth, one sees many photos along a ravine about 2.5 km east of the calculated intersection. Unbeknownst as a natural site to the simulation process previously, the Cascadas El Chiflón is a series of five waterfalls and a major ecotourism destination.

While the calculated El Chiflón point works relatively accurately as the hearth apex for El Mirador, it was not until working with a growing importance of this location at subsequent sites, particularly Tikal and Copán, that one realized that the uppermost origin of the El Chiflón cascades is quite accurately aligned with La Venta and Atitlán X, figure 25. As noted in this illustration, the precise line from the top of the La Venta pyramid to the Atitlán X benchmark runs about 121 meters above the center of the uppermost pool of the cascades; the line is 455.397 km. It is thus possible that at El Mirador the two hearth rays to Izapa are purely coincidental to the issue, or not understood by priest/designers. Instead, they may well have originally sought a western hearth ray down from La Venta, perhaps even running to Atitlán X as a means of integrating a variation of Mayan Hearth with others emphasizing Atitlán X. Discovery of the



Figure 25. El Chiflon cascades, the uppermost pool which is coincidentally and very accurately aligned as an interim point with La Venta - Atitlan X; at Atitlan X, the line runs to Chisalin, the upper or northernmost of Utatlan complex, the vicinity where the Popol Vuh was recorded.



alignment of the cascades with the two most important sites of the frame might well have carried enormous symbolic weight to framing ritual.

A search of historical and archaeological literature finds no reference to the sites' use in this regard, nor does Bassie-Sweet mention the site in her discussion of a geographical place that was the original Mayan "hearth". The azimuths, however, work quite well for an actual triangular map that matches the central triadic layout of El Mirador. Chiflón to La Venta is 41.57030 (41.28059 La Venta Medio – Izapa), and Chiflón to Danta is 304.76355 (304.51660 Izapa – San Salvador Medio). Note that although there is a rough alignment between the triangle center intersection point, Chiflón, and Izapa—which symbolically associate the two pairs of triangle sides--this does not appear to be an accurately surveyed construct. Furthermore, the perpendicular from the La Venta – Danta top is at a different angle than the approximate line from triangle center down to Izapa. Like other possible "benchmarks" in this simulation, the El Mirador landscape map center point near Palenque is here conjectural and remains archaeologically or ethnographically undocumented.

Szymánski concludes that the primary symbolism of triadics (again small-scale platform phenomena) lies in *meaning more ancient than that of associated rulers*. Part of this spatially imagible mythology sees the Maize God "depicted in a dugout canoe floating among the watery Underworld. Paddler Gods navigate the vessel helping the Maize God to get to the surface world" (2014:150), the classic version of which comes from *Popol Vuh*. As an act of resurrection, this "happens through a crack on a turtle shell. The turtle has been identified as the world, and the crack as a cave that links the Underworld with the surface" (ibid 151). In the *Popol Vuh*, the discovery of this Mayan paradisiacal place of resurrection called Flower Mountain has associations with "splitting" or "cleft" and has "long been linked with the birthplace of maize and the Maize God himself across Mesoamerica at least from Olmec times. Early Maize God depictions from La Venta and elsewhere show the distinctive cleft feature..." (ibid 151). In terms of the landscape hearth domain possibly expressed in the El Mirador site layout, can one imagine its (inverted) apex at the Chiflón cascades as mythological cleft? And did the Flower Mountain paradise actually exist as the intersection point at the center of the triadic landscape shape?

Extremely interesting from this designer's perspective, is the way the La Venta – El Chiflón – Atitlán X line solves the lingering mystery of Utatlan's location. As seen in figure 25, the

location of the Utatlan complex serves as the base to this "great" hearth diagonal, flanked on either side by very powerful azimuths, the Atitlán meridian to the west, and the original Olmec great diagonal Orizaba – Atitlán X – San Salvador to the east. Is this coincidence or design that this location at the base of the La Venta – Atitlán X, with the mediating cascades water feature in between is the very place where the *Popol Vuh* was recorded? This might well raise important theoretical questions about the temporal relationships between Olmec Frame and recorded mythology. Even though the Utatlan complex might have been accurately positioned in relation to perhaps the most important alignment in the Olmec Frame, the location might well have been ritually significant long before the appearance of its ceremonial architecture. It is not impossible that the oral *Popol Vuh* myth coalesced in this location during many centuries between the last major evolution of the frame, and the climax of "glyph culture" at ceremonial sites.



Figure 26. Superimposition of Olmec Frame patterns over Sprajc et. al. (2009) map of astronomically significant alignments at El Mirador; lack of correspondance suggests independence of ritual space (landscape related frame) and ritual time (astronomical rises).

Before leaving El Mirador in this evolution of early landscape framing, the archaeoastronomy work of Šprajc et. al. (2009) provides a good opportunity to strengthen the distinction between the role of geometry in ritual as "space" and as "time". Figure 26 superimposes presently simulated symbolic map aspects of El Mirador over their conclusions

about possible multiple alignments of site features with astronomical phenomena, generally towards rises in the east. Of the four superimposed lines from Danta that formally define El Mirador's major elements, only the central axis comes close to one of the astronomically significant lines on the publication map. Šprajc, et. al.'s measurement of the azimuth from Monos to 1A 5-1 is part of the 12° group corresponding to known astronomical alignment preferences across Mesoamerica. Their work does not associate this "time" with the Danta-El Mirador central axis as presently defined, perhaps reflecting the degree and a half difference between their Monos azimuth of 258.2334°, and that of the central axis and San Lorenzo – Danta Medio of 259.76112°. The Šprajc team clearly recognizes that other factors besides astronomy may lay behind formal geometries in sites such as El Mirador:

"The fact that several buildings of El Mirador do not face in directions we have assumed to have been astronomically functional agrees with analogies from central Mexico and southeastern Campeche, which allow us to conclude that the placement of the main façade access to a building does not indicate the direction in which its astronomical orientation was functional, but was rather dictated by the symbolism and ritual associated with a particular structure, as well as by general factors of urban planning" (2009:93)

This quote focuses on building orientation, leaving the reader to assume that buildings were *positioned* on site primarily for astronomical reasons. Present work suggests that building (and site) location are not primarily the result of the need to mark ritual time through astronomical observation, but of a need to integrate large-scale formalized social space as the primary basis for ritual. One could even go so far to say that using features of buildings and landscape horizon to mark ritual time are secondary, even widely assumed presently to be primary determinants.

#### 1.4.2 Tikal's Emulation of the Atitlán X Meridian and addition of a new Hearth

Tikal's largest feature, Temple IV, lies only about 65 km from El Mirador's largest, Danta. At El Mirador, the location of this ultimately huge architectural feature was determined by two cardinal lines, one the meridian from the point on the Medio where Orizaba – La Venta intersects, and two, a direct cardinal east from San Lorenzo, figure 23. Not dissimilarly in figure 27, the Tikal location point (IV), involves both kinds of lines, illustrating again the importance of cardinal meridians and *medios* in founding sites. It involves the same Orizaba – La Venta –

Danta Medio line, using the intersection point ("Atitlán Zenith") with a meridian prolongation from Atitlán and Atialan X to mimic the Danta east cardinal from San Lorenzo, but here to Tikal. Tikal's major meridian to emulate Danta's axis to Danta Medio, creates an additional natural feature in the evolving Olmec Frame. The meridian from the volcano Santa Ana runs extremely precisely to the Temple IV point (actually positioned at the base of the pyramid in front).

The only built site point participating in the Tikal location is La Venta, though again its location is determined wholly by natural landscape points, or cardinal extensions thereof. The intersection of the two cardinal extensions that position Tikal also create two additional large-scale patterns that emerge in the design simulation. If one prolongs a logical meridian south from the apex of the "Above" domain, Cerro Gordo to an intersection with a prolonged cardinal west from Cerro del Aguila, the angle from this point to La Venta 12.20° is close to that from Tikal to La Venta 12.31° (using *Medio* cardinals). If understood, though still perhaps a coincidental byproduct of sorts, this relationship might signal some final frame concept that formally sets up the Tikal meridian with the Santa Ana volcano as the eastern partner to a western Cerro Gordo meridian. La Venta, of course, remains resolute in its position at the center apex of the reformed frame.

A more interesting, partially coincidental, pattern working very accurately with the new Tikal point is also shown in figure 27. Here the vertex of a 90° angle lying on the line between the new Atitlán Zenith point (cardinal east to Tikal) and Santa Ana, has rays running to San Lorenzo and Tikal. While more will be said of this point "East X" below, much symbolism is immediately apparent. It links the top and bottom of Tikal's two positioning meridians and connects strongly with Danta through the 90° line to San Lorenzo.

Tikal's locating design process builds from El Mirador/Danta immediately in two ways. It borrows spiritual power from Orizaba – La Venta – Danta Medio, redirecting it cardinally east, and in perhaps not unrelated symbolism, further diminishes Danta's meridian with the greater scale and flanking the two Tikal meridians to Atitlán and Santa Ana. Once Tikal's enormous site plan is oriented to true north using satellite images, figure 28, the designer can first observe that the two locating cardinal lines, if accurately surveyed, do not both focus on the Temple IV point, only the meridian from Santa Ana. The cardinal east from Atitlán Zenith points instead best to the group at the northernmost part of Tikal called "Complex P".


Figure 27. Positioning of Tikal Temple IV point at intersection of meridian from Santa Ana volcano, and cardinal east from new benchmark where the Atitlan meridian hits La Venta - Danta Medio, "Atitlan Zenith"; possible discovery at this time of coincidental 90° angle from a point on the Atitlan Zenith - Santa Ana line, whose rays run from the vertex, "East X", to San Lorenzo and the Tikal point.



As one can see from the topography of Tikal, some adjustment in this regard might well have been made to lay out an envisioned primarily symbolic urban complex. The actual intersection of the two founding cardinal lines occurs to the northwest and at an elevation too low with respect to other key site elements perhaps wanting prominence in designer's minds. Here the simulation can suggest an an actual layout sequence, referring again to figure 28? Given the difficulty of an intersection point between the Santa Ana meridian and the cardinal from Atitlán Zenith, one can begin with the most prominent point in the ultimate site, i.e. Temple IV. The next most important azimuth, beyond the meridian on which the temple was later built, logically can be the major west-east site axis, the azimuth from Temple IV to La Venta, identical in concept to the La Venta – Danta azimuth as inverted hearth base and grid at El Mirador. From the first Temple IV site point this azimuth can be extended across the potential site. Second and third azimuths from this point then logically define the arc that encompasses the site geometry, i.e. the west ray emulating an emerging El Mirador – like hearth triangle, the all-important La Venta – El Chiflón – Atitlán X, and a northward azimuth linking Tikal to the Atitlán Medio point so prominent at Piedras Negras and Palenque. Though three lines at this stage radiate out from the Temple IX point, no intersecting lines yet terminate these lines with important features.

The next step is a bit more difficult to simulate. One possibility, however, comes from a clue provided by the azimuth between the northernmost and southeasternmost features eventually built at Tikal, i.e. from Complex P to the Temple of Inscriptions. This line might be the azimuth from Atitlán Zenith to the base of the Tikal meridian, Santa Ana. Referring to figure 27, this is the line on which the vertex of the right angle with San Lorenzo and Tikal coincidentally form the "East X" point. Thus, the Atitlán Zenith – Santa Ana azimuth at Tikal becomes the hypotenuse of an ideal right angle where the two legs are the East X – Tikal and East X – San Lorenzo azimuths, *reflected* along the latter orientation. Because of its geometric complexity, the East X point appears to be Tikal's most innovated addition to the frame. As such, this eastern right triangle in the site plan might have been a designed pattern superimposed, as it were, over the first three lines radiating eastward from the Temple IX point.

Missing in this right-angle pattern, perhaps designed and modeled first, are lines from its vertexes to a common center. In the right angle's revised posture, the azimuth from its southwest vertex could have been envisioned as completing the third side of the hearth, i.e. the azimuth El Chiflón – Tikal, again echoing the pattern at El Mirador. As for the lines from the other two vertexes, the azimuth of one needs to coincidentally match an existing line in the frame record. Logically, a meridian from the north vertex seems most symbolically powerful, this given the meridian at Piedras Negras, and Tikal's new meridian move to Santa Ana.



This leaves the eastern repetition of La Venta-El Chiflón-Atitlán X, its paramount importance in the frame notwithstanding, as coincidental? In any event, the right angle pattern, now with its center determined by three internal axes, could have been superimposed, by trial and error such that three of its points intersected with the three radiating lines from the Temple IX point: 1) the right angle itself on the hearth inverted apex at *Mundo Perdido*, 2) the center of the right angle on the major La Venta – Tikal axis creating the Ball Court location, and 3) the northern vertex of the right angle on the Atitlán Medio – Tikal line, positioning Complex P.

Clearly from the simulation thus far, *Mundo Perdido*, as inverted hearth apex not unlike the three others unveiled at Piedras Negras, Palenque, and El Mirador, is a site point of considerable symbolic importance. The other point of rivaling design significance would be the North Acropolis as perhaps interior focus of the hearth reproduction. Following the other three sites, the azimuth from hearth apex or *Mundo Perdido* to a central point of the North Acropolis is that of Atitlán X – East X. Because of the small scale of feature elements on the large Tikal site map, it is difficult to comfortably simulate relationships between building orientations and the azimuths that organize their locations. The line from the center axis of the North Acropolis, the termination of Atitlán X – East X from Mundo Perdio, might replicate the azimuth East X – Danta, a new line in the frame record. This however, would require some serious coincidence, given the possible completion of the major aspects of site layout at this time.

Also difficult to presently simulate, though eventually essential, is the relationship of Temple IV's orientation to the major west-east site axis, as well as that of the North Acropolis perpendicular. Perhaps influenced by the spread of axes from Danta to the hearth core of El Mirador, one suspects that two additional axes, besides that directly to La Venta from the Temple IV location, might be in play here. Framing the central direct La Venta axis to the north is the reproduced major azimuth Orizaba – La Venta – Atitlán Zenith –Danta Medio, from which Tikal's original positioning cardinal was designed (Atitlán Zenith intersection point). Then flanking Tikal's La Venta axis to the south, is the San Lorenzo – Atitlán Zenith aximuth. This would also be a new azimuth in the evolving frame record, perhaps reflecting the importance of both points to the creation of Tikal. The three lines seem to define the Temple IV base, though some inaccuracy exists in the relation to the symmetrical center axis of the pyramid.

As at other sites, though less extensive than Piedras Negras, the simulation finds two limited grids organizing other features in the site. The first has perpendicular relationships with the San

Lorenzo – Atitlán Zenith line just mentioned and may involve the primary axis of Munto Perdio. The second works with the central La Venta axis and seems to define a domain around the Ball Court, perhaps meeting the San Lorenzo – Atitlán X grid at *Mundo Perdido*. But again, the simulation is quite limited in accuracy because one cannot accurately "zoom" back and and forth between site and feature design scales.

The dualistic opposition of the two most monumental features at El Mirador and Tikal, one west and the other east, respectively, may be understandable in relation to San Lorenzo. Danta faces the cardinal line from San Lorenzo that may have positioned the site, together with its meridian. At Tikal, while the site might have reversed the basic orientation because of better site topography east of the Santa Ana meridian, designers may have created a purely symbolic meridian well east of the actual one, i.e. the meridian from Complex P to the Ball Court in the inverted East X right triangle. Complex P can associate in part with Danta, located of course to the north of Tikal. In this way the meridian relationship of the site center point to Complex P emulates Danta's meridian with Danta Medio. If IV's eventual axis and orientation were to be accurately perpendicular to the Ball Court – Complex P meridian, then Temple IV and Danta would, by 90° logic face each other—befitting the relation of Tikal's and Danta's positioning merdians seen in figure 27.



Figure 29. Preclassic features of Mundo Perdio complex at Tikal (Laporte and Fialko 1995); inverted hearth apex point of azimuths works best near center of linear feature.

Limited accuracy between scales notwithstanding, the location of the inverted apex point of the hearth domain at Tikal appears to lie somewhere close to the midpoint of the linear feature directly east of the observer's platform of the *Mundo Perdido* compound. Laporte and Fialko's (1995) drawing here reproduced as figure 29, provides a perspective of the first late preclassic structures, though they break architectural convention by orienting the plan portion to the west rather than north. Said to be the largest Preclassic ceremonial complex at Tikal, the setting is primarily thought of in terms of its E-group meanings. From Laporte and Fialko's drawings, however, these astronomical observations from a western point to the rising sun to the east might have been a later addition to a location already powerful for other reasons. No articulation exists, i.e. markers for rise times, on the linear "horizon" feature—at least as determined by Laporte and Fialko's discovery process. Is it possible to also see the original feature, and even together with aspects the articulation that occurs along it over time as an expression of the waterfall sequence at El Chiflón?

Summarized in figure 30 is the design possibility that four triangles on the site may via their azimuths express actual landscape areas in the Olmec Frame. The primary integrating points are the Ball Court at the base of the site meridian, and Mundo Perdio whose location serves as inverted apex of two of the domains that appear to be Mayan Hearths. Can one assume that such patterns would likely involve integration among different Mesoamerican populations, based on shared symbolic practices? Would it follow then that Tikal's contribution to the Olmec Frame, while fundamentally integrative, also was seriously expansive at a large scale?

It is almost as if hearth "A" in figure 30 sought to emulate El Mirador's singular domain between La Venta, El Chiflón, and itself. In Tikal's "A" hearth, the new focus simply replaces the old? Perhaps the largest driver of additional triangular domains—at site and larger landscape scales—might have been the absence of Atitlán X in hearth "A" even though its western leg aligns accurately down to this point. From this strictly design simulation perspective, given the importance of Atitlán X and Atitlán Medio to Piedras Negras and Palenque, Tikal's ambitious site designers might well have decided to include azimuths symbolically vital to those sites. But what element might logically create a new eastern leg from Atitlán X? Ideally such a point should lie on the diagonal azimuth unifying Tikal's two cardinal site positioners, i.e. Atitlán Zenith (east line to Tikal) – Santa Ana (north line to Tikal. A point on the lower part of this





diagonal might serve as the eastern point of a new variation of hearth with Atitlán X as inverted apex.

The new hearth landscape with East X as its eastern point for the first time uses the La Venta – El Chiflón – Atitlán X as western ray but moves the inverted apex to Atitlán X itself. Given the way the western rays of two hearth landscapes, A and C in figure 30, constitute the major La Venta – Atitlán X axis, the homologue of Tikal's site plan logically superimposes the two, essentially sliding the two together along this major axis. The eastern ray of the new southern hearth is that from Atitlán X to East X, running in Tikal's plan from *Mundo Perdido* to the North Acropolis.



Figure 31. Tikal's North Acropolis as prime mediator of landscape maps and their azimuths expressed in site design (drawing from H. S. Loten 2007, fig. 49).

The large-scale surveying and design inquiry that uncovered the coincidence of East X could have also revealed two sets of frame azimuths, which when added to the record may have been recognized to be quite parallel. The first of these is the way the new inverted hearth base El Chiflón – East X mimics the important La Venta line that creates the Atitlán Zenith point used as a cardinal running east to position Tikal. These azimuths vary by about 0.20°, quite inaccurate in terms of large-scale surveying, but perhaps quite close when using recorded azimuths to lay out ceremonial sites. Given the possible symbolic equivalence, it is not impossible that the superimposition of the new hearth C, involves a different inverted base, i.e. Orizaba – La Venta – Atitlán Zenith – Danta Medio (equivalent to El Chiflón – East X). This would explain the axis

that flanks Tikal's central La Venta – Tikal axis to its north. Ideally, drawing scale limitations not withstanding here, this upper central axis to Temple IV, should relate (perpendicularly?) to the North Acropolis whose position appears to depend upon the Atitlán X – East X azimuth from *Mundo Perdido*.

The second pair of parallel azimuths then possibly added in the frame record, is that of the new East X – Tikal and Atitlán X – Atitlán Medio (about  $0.15^{\circ}$  off), highly valued in the layouts of Piedras Negras and Palenque. This as it turns out can be a critical equivalence in creating the integrated Tikal layout. It allows the designer to rotate the East X right triangle 180° along its San Lorenzo – East X axis. In doing so, the now west leg of the triangle becomes Atitlán X – Atitlán Medio, and can be part of landscape domain B, both in actual map and as reproduced in the Tikal layout. It may well have been symbolically and socially vital that domains laid out at site scales have actual correspondence to real landscape. In the case of triangle B, it not only can now be integrated with other triangles, but actually maps landscape reality.

It is also possible for such manipulation to enhance the symbolic power of integrated design layout, all the while making real the correspondence between site and landscape. By rotating the East X right angle, and recognizing the identity with Atitlán X – Atitlán Medio, designers are also expressing the way the positioning site of Atitlán Zenith relates to the new hearth with its inverted apex at Atitlán X. If the rotated triangle B is laid out in the landscape, its relationship to the new hearth C is the Atitlán meridian itself, running of course through Atitlán X. While it does not seem to be possible to realize this landscape reality in the process of superimposing the B right angle over hearths A & C, this meridian symbolism might well have been associated with the meridian of B, from Ball Court to Complex P.

Note: This is an unusual design move where a rotated actual landscape pattern, when reproduced as a ceremonial site element, reverts to a different actual landscape pattern. Such a move is made possible by an azimuthal equivalence such as between East X – Tikal and Atitlán X– Atitlán Medio.

Given the integration of these multiple maps into a unified site design at Tikal, one finally asks about some map reality associated with the site area created by IV, *Mundo Perdido*, and Complex P. The Atitlán Medio – Tikal azimuth was early on simulated to be one of the three first lines to radiate eastward from the Temple IV point. This, with the symbolic equivalence of

Atitlán X – Atitlán Medio (East X – Tikal), seems to suggest association of this northwest area of Tikal's layout with Piedras Negras and Palenque sited in that direction. But is this a map of an actual landscape? The comparatively small size triangle "D" in figure 30, with its apex at Tikal itself, can be a real place. Its base would logically be the extension of the line from La Venta to Atitlán Medio that helped position Piedras Negras. This azimuth of 251.38347 when positioned on Tikal's central axes, runs about a degree north of the Orizaba – La Venta – Atitlán Zenith – Danta Medio line mentioned. Much about the likely multiple central axes remains to be simulated with larger scale, correctly oriented, more detailed site drawings.

The rotated right triangle B and small pattern D, when mapped on the real landscape, each create one new benchmark point, the right angle itself in B, and the point where the extension of La Venta – Atitlán Medio hits the East X – Tikal line in D. While typically not exhibiting prehistoric built form in their satellite images, these points have not been presently tested for other possible significance as Olmec Frame benchmarks. Intuitivly, they seem to represent a kind of point secondary to more primary frame patterns. If designers modeled their ideas during the site planning process, as they certainly must have, they might have created patterns such as with B and D by knowing the major azimuths and related benchmarks—and where they are in the real landscape. If new "secondary" benchmark point was necessary to complete some design component, then it could be added to the site layout, without invalidating the effective map relationship to the primary symbolic landscape.

### 1.5 Copán as southern hearth: linkage to Atitlán X, Tikal and Calakmul

### 1.5.1 Copán's location as unifier of the great diagonals

Tikal was positioned by two or possibly three frame elements: the Santa Ana volcano meridian, the cardinal east from Atitlán Zenith (on the Orizaba- La Venta – Danta Medio line), and the East X coincidental point formed at the intersection between at the 90° vertex from San Lorenzo. Despite multiple dimensions of coincidence involved, this clearly integrated evolution of the Olmec Frame may well have denied any direct ceremonial role for Tikal in symbolically unifying the eastern ends of the two great diagonals from the Cerro Gordo landscape pyramid, Tacana and San Salvador.

As primarily design simulation, one dares not wade too deeply into discourse about most ancient origins of the Copán site location, whether as one of three very early settlement areas, or the first kings in either 160A.D. or 426A.D. (Schele and Freidel 1990:307). From a strictly site engineering perspective, however, given the obvious technical expertise of the Mayans, it seems unusual to have positioned a prospectively great ceremonial center so close to the river. It has been rerouted in modern times to avoid any further collapse of the acropolis east wall and related features. Following the logic of the Olmec initiated landscape frame, one can simulate a set of related design decisions that might well have fixed Copán's location for symbolic reasons, despite the dangerous proximity to the river.

Copán does what Tikal did not. Primary azimuths of its site design, figure 32, suggest homologues of large-scale surveyed lines from the highest point on the site, acropolis Temple16, to both diagonal termini, Tacana and San Salvador. The first unification feature is Tacana itself. It both receives the three-point alignment from Cerro Gordo through La Malinche and aligns east with Atitlán X via the terminus of this line at Copán (recall that this is the inverted base line of the Piedras Negras hearth). It might well be that both Temple 16 and Temple 26 symbolically oriented to Atitlán X and Tacana. The azimuth south between these two prominent site features reproduces the large-scale azimuth from Copán to San Salvador. This line, however, would not have been a second surveyed artifact that worked with the Tacana – Atitlán X line to fix the site location.

Also reflecting the inability of Tikal to provide a great eastern ceremonial site that terminated the Olmec Frame, a 90° angle could have been laid out beginning with the meridian base of Tikal's east cardinal from Atitlán Zenith, i.e. Atitlán itself. Then running a symbolic connecting line to the base of Tikal's own meridian at Santa Ana, the right angle could have been struck up to fix the Copán point. When this azimuth is moved around on the correctly oriented Copán site plan, it appears to mimic the large-scale pattern where Temple 26 (Hieroglypic Stairs) expresses Copán, and Temple 16 San Salvador. In this case Copán's SW anchor point may have served as symbolically Santa Ana, lying as it does also as the south terminus of Copán's primary meridian expression. The line from this point to Temple 26 may nicely position the NE corner of West Court.

Recalling the role of a possible surveyed line from Tacana to San Salvador and its perpendicular through Atitlán X up to Atitlán Medio, which appears to have been an earlier









Figure 32. Positioning of Copan via an extension of Tacana - Atitlan X line and eastern ray of right angle from Atitlan with Santa Ana volcano as vertex; site plan expression of Tacana - Atitlan X azimuth to Temple 16 and possible as alignment of hieroglyphic stairs, alignment of Temple 16 and Temple 26 as azimuth to San Salvador including grid elements, alignment azimuth to Tikal and Calakmul from north feature in Great Plaza through Ball Court to Temple 16, meridian expression from north feature through central feature of Great Plaza and features in West Court, azimuths of west exterior walls of the site; aerial of Atitlan X area showing relationship to the Tacana - Copan azimuth. unification of the great diagonals particularly in the landscape expressions of San Lorenzo, Piedras Negras and Palenque, what does the related (post?) Tikal role of Copán suggest in this regard? Perhaps the Santa Ana – Copán azimuth might have been considered a homologue to Atitlán X – Atitlán Medio 333.09274 (which already pairs up with East X – Tikal 332.96035). The azimuth from Santa Ana to Copán 334.21054, however, is much less "identical". Since the Atitlán X-Atitlán Medio azimuth is *not* used prominently in the Copán site layout, particularly compared to Piedras Negras and Palenque, it might be that one needs to understand over a full degree variation of the Santa Ana – Copán line to be distinct. The rotated azimuth used in the Copán site simulation is Santa Ana – Copán.

Once any site was positioned in relation to the extended Olmec Frame, could it have been used ritually for some years either with or without hearth related layout of the site and construction of major architectural features? The simulating designer is thus far impressed by how positioning frame azimuths and (other) hearth azimuths work well together, seemingly to defy any clear distinction about symbolism at a time of site positioning and at that during times of maximal build out. A logical early feature at Copán is a point for Temple 16, perhaps paired up with one for Temple 26 on the San Salvador axis. Given the homologue pattern of the azimuth from Copán to Tikal's meridian base, Santa Ana, the next line to be laid out might have been from Temple 26 down to a site benchmark at its SW corner. From here then, Copán's site meridian can now be laid out running north (eventually positioning the symmetrical feature 4 in the Great Plaza as well as the "climax" feature farthest north in the great urban space.

These three lines set up the ritual sequence beginning with the cardinally oriented Temple 11, then moving along a secondary meridian through the West Court, making the turn around Temple 16 and up to the culmination of the San Salvador axis at Temple 22 (its eventual position as least). The axis appears to be perpendicular as illustrated in figure 32. Could this sequence have begun at the foot of the Hieroglyphic Stairs which may also have oriented out to Tacana-Atitlán X, then moved through the site meridian element of Temple 11, expressing the second positioning large-scale line, the vertex of the 90° pattern Copán forms with Santa Ana and Atitlán? Temple 16, then returns the ritual focus to the meaning of Atitlán X, a prominent inverted vertex element of hearth maps elsewhere. The 180° ambulation around Temple 16 perhaps symbolically transported participants to another world as expressed by Temple 22 in its eventual representation of San Salvador, the volcano base of the greatest of the great diagonals,

the coincidental line Orizaba-Atitlán X- San Salvador, creator of La Venta's meridian. While Temple 22 is held by archaeologists, e.g. (von Schwerin 2011) to be especially symbolic of the role of sacred mountains in Mayan religion, its texts do not appear to specifically define related meaning of the ritual sequence, particularly including understood azimuths and their landscape focal points. The meaning of Temple 22 will be considered in greater detail in a separate text section tangentially considering Mayan astronomical maps and myth.

How ritual associated with Copán's singular and centrally located Ball Court related to the meaning of the acropolis sequence is less immediately clear. Did these events relate more to socio-political alliances than the fundamental Olmec originated landscape religion, *per se*? It seems apparent that the north climax point that terminates the meridian and the Great Plaza itself was determined in part by the azimuth of the large-scale alignment from Calakmul to Copán that runs close to Tikal's primary expression of hearth apex, *Mundo Perdido*. This azimuth nicely aligns the Great Plaza north point, the center of the Ball Court, and the apex of Temple 16, Copán's highest point. If Copán's internal site meridian expressed Tikal's large-scale meridian to Santa Ana, this symbolism may have been made more explicit by its intersection with the azimuth that actually and very accurately runs to Tikal (and Calakmul).

Copán's acropolis and Great Plaza may have been framed by defining features on southern and western sides, recognizing again that its eastern edge was destroyed by the river. The southwest benchmark, base of Copán's meridian, may have been aligned via the azimuth Tajamulco-Copán to feature 29, which also might have served as the terminus of the San Salvador axis (parallel to that between Temple 16 and Temple 26) from Temple 22. On the western side of the site, the major orientation of walls is apparently the same azimuth as the orientation of the Ball Court (at least in its latest iteration). The azimuth from Calakmul to Santa Ana seems to serve both.

#### **1.5.2** An Extreme of Hearth Map Expression

If part of Temple 16's visual prominence and location related to large scale lines that fixed Copán's position--perhaps among multivocal others related to Atitlán X as inverted hearth apex-then does this pyramid also replicate an actual hearth related landscape location? If the design simulator begins with Temple 16 as hearth apex, seen in figure 33, the Atitlán X – East X azimuth of the map as hearth has to be envisioned as part of the positioning of the SW site

benchmark and base to the site meridian (could it have preceded the meridian?). Because of the river damage we have no complementary SE site benchmark which may have been involved in positioning the the second hearth azimuth (La Venta – El Chiflón – Atitlán X).

This western hearth line, however, needs also to use Temple 16 as apex. Moving north it runs through the center of Temple 11 and terminates at Temple 7 across from the Hieroglyphic Stairs. A parallel Atitlán X – East X azimuth from Temple 26 intersects with this western map azimuth to Temple 11's location. As for a second line to mark Temple 7's location, a San Lorenzo – Calakmul azimuth from Temple 26 may fit the bill.



Temple 7's map expression as "El Chiflón" now provides the point from which the azimuth to East X can be laid out to intersect with some missing feature on the north east area of the East Court. Such a El Chiflón – East X as inverted hearth base, again is most likely embedded in Tikal's integrated hearth, specifically as it relates to the aspects of the major site axis from

Temple IV to the Ball Court, and the azimuth identity of El Chiflón – East X and the Orizaba – La Venta – Atitlán Zenith – Danta Medio line.

At Copán, this inverted hearth base azimuth crosses the bottom center point of the monumental north stairs of Temple 11 and the entrance to Temple 22 perhaps as ritual climax in the East Court. While the two possible SE and NE benchmark points are missing, the angle created between these two points by the hearth map projection thus far appears to parallel the San Salvador East Court axis. From drawings at the present scale, the San Salvador axis seems perpendicular to the line from Temple 16 (and perhaps 26) to Atitlán X and Tacana. As azimuths, however, this is not so; they are close to a degree and a half off 90°.

Even though the southern line of Copán, the Tajamulco – Copán azimuth – does not replicate the inverted hearth base azimuth where Temple 16 is apex, the hearth pattern and its azimuths may have continued northward on the site. Consider the La Venta – El Chiflón – Atitlán X line from the NE ("East X") map corner in the East Court. It runs through the summit of Temple 26 up to Temple 1 and beyond to the extreme NW point of the Copán complex. The opposite hearth azimuth, Atitlán X – East X runs from Temple 7 up to an extreme NE site point which also intersects with an Atitlán – Copán azimuth from the cardinal Temple 4 in the center of the Great Plaza. The El Chiflón – East X line (identical with Orizaba – La Venta – Atitlán Zenith – Danta Medio) azimuth connects the two extreme site points of the Great Plaza and appears parallel to exterior wall features on both sides. Finally, Atitlán X – East X is repeated one last time running from the north terminus point of the site meridian down to the lower feature of the cardinal triadic platform on the NW corner of the Great Plaza.

The middle pattern between the larger northern and southern identical "Tikal" created pyramid landscape pattern, though inverted, is identical. *Note that this hearth when inverted is not also a map of an actual landscape pattern, like the Tikal example*. Simulating this repetition of hearth maps as Copán's defining "grid", the designer logically seeks an azimuth that connects the two inverted apexes of the upper and lower maps; such a line would undoubtedly be considered highly symbolic. This axis looks to be the azimuth that aligns Calakmul and Tikal to Copán. Although this line to Copán's Temple 16 runs through the center of the Ball Court, the apex of the northern hearth map occurs just north of the Ball Court in the space created by the Altar L structure.

From a design perspective, it seems likely that the site meridian which terminates the grid at northern and southern extremes of the site was part and parcel to the layout of hearth maps. What then, does one make of the more symmetrical triangle that two of hearth grid azimuths create along with a third line from the northern feature of the triadic platform down through Temple 7 (Danta Medio – Copán), this apparently creating the second line to fix the focus of Temple 13 on the Tacana – Atitlán X line to Temple 16. Did the three lines to the center of this triangle position Temple 4 at the center of the Great Plaza, i.e. La Venta – Copán, Atitlán - Copán, and East X – Calakmul?

The Temple 4 feature in the center of the triangle is not that dissimilar to the hearth related pattern at El Mirador, Piedras Negras and Palenque. While these latter two have internal axes involving Atitlán X, associating this meaning perhaps with a center of the "hearth", neither El Mirador nor Copán carries such symbolism. What is Temple 4 at Copán, cardinally oriented and positioned on the site meridian? Is it somehow conceived of as a center to the reformed Tikal originated hearth map that makes the Copán grid? It clearly does not geometrically integrate well as a center point for the northern map, lying some meters off the key line connecting the two map vertices (Calakmul – Tikal – Copán). It is true, however, that at Tikal, the center site focus might have been created by the intersection of Danta – East X and Atitlán X – East X azimuths. Somewhat related, perhaps, is the symbolism of the East X – Calakmul azimuth from Temple 7 to the Copán's Great Plaza center feature, Temple 4. Temple 7's map location carries symbolism on the first level of El Chiflón and deeper perhaps of Orizaba or La Venta, given the azimuth equivalence of the lines. Given the late construction of the great plaza and its "forest of kings", the location of Temple 4 seems highly integrated into stela location.

### 1.5.3 Do stela/altar locations associate with azimuth patterns?

The background of the present researcher provides no expertize in interpreting glyphs and stella meaning in general. While Newsome's (1998) work on Copán stela provides good introductory facts on what must be amazing pieces of sculpture if seen firsthand, much of this article clearly requires far greater knowledge of the Mayan record of art and language and cannot here be commented on. What one can say from Newsome is that very early on the Olmec erected stela; some had no artwork; some were out in the landscape while most were installed at ceremonial

sites. And interestingly after over a thousand years, their function became dramatically more symbolically and politically important, particularly by the last ruler of Copán in the 700's A.D.

As briefly mentioned in the present simulation of Piedras Negras, some of Hartung's alignments of stela may coincide with prominent azimuths at that site. Assuming for the moment that some stela azmuth alignments at Piedras Negras relate symbolically to their artistic content, this would mean that in spite of some antiquity of the Olmec Frame, later rulers in Classic periods still had possession of an azimuth "calendar" – or knew the particular azimuth





Calakmul.



Figure 34. Highly accurate alignment between Tacana, Stela 10 about 5 km west of Copan and the Ball Court; accurate alignments of Stela 10 to El Palmar and Danta; positions of Stela 5 & 6 (west) and Stela 12 (east) together with the Ball Court might define lines to principal points at Tikal running up to





history of their site and used this knowledge to support their stella declarations. All the azimuths thus far described at Copán might, with the eyes of a stela expert, provide a novel new layer of meaning, particularly regarding late rulers.

Before looking more closely at obvious overlaps in the Copán site plan itself, one can begin with questions about stela 10 located over four kilometers west and nicely identified by photo attachments in Google Earth, figure 34. Stela 10 aligns very accurately as an interim point on the line from Tacana to Copán's Ball Court; the benchmark point Atitlán X is accurately on this line. While one should not necessarily take this kind of extreme accuracy (0.002°) as a typical level of Mayan technical abilities, nevertheless, even a less accurate line would come close to the Ball Court at the core of the Copán site. But why would perhaps a late Copán ruler (depending on the dating of stela 10) reemphasize this highly symbolic line, not only locating stela 10 to the west but perhaps shifting the alignment symbolism from Temple 16 which appears in its architectural and urban orientation to reflect this original line that locates the site? Furthermore, the perpendicular to the axis of the latest remodel of the Ball Court—the azimuth from the volcano Santa Ana to Calakmul, figure 32—does not work for the stela 10 line in question from the Ball Court.

More explanative might be some additional more vertical line to fix the location of stela 10. The latitude/longitude of this stela provides an accurate southern terminus of a line from Danta through the Preclassic site of El Palmar, just 15 km west of Tikal. El Palmar sits extremely accurately on the cardinal west-east line from Atitlán Zenith that helped position Tikal. The stela 10 location thus connects El Mirador with Tikal via El Palmar. Danta, El Palmar andTikal have geometric cardinal relationships to the great duality of the frame, i.e. the two parallel lines of the hearth in Orizaba- La Venta- Zenith Atitlán-Danta Medio and El Chiflón – East X. Could the location of stela 10 have served as a ritual start point for processions to the Copán center? Could a Danta – El Palmar- Copán related stela 10 have expressed a later day politically motivated but nonetheless religiously integrated relationship between these two major ceremonial foci? Logically, following the design simulation thus far, El Palmar's longitudinal location on the Atitlán Zenith – Tikal cardinal would not have been fixed by a line to a point four kilometers from Copán's center. Having presumably been determined by some more logical reference to

the frame, El Palmar's location and line from Danta could have hit the Tacana – Atitlan X -Copán line anywhere, a point made tangible by the stela.

Muddying the water here for expert investigators will be the apparent fact that several of the stela at Copán have been moved from one location to another. Was the stela carved prior to being moved? Did both creation and change in location take place in Classic Copán? What can be somewhat better determined within the present context are locations. In 1902, Gordon published a short piece on the "bundle" characteristics of certain Copán stela, both of which had been moved from their original location. Stela Y had been used as a base for stela 4 in the great plaza, but stela X—both of whom are of paramount importance for Newsome's (2003) study of bundles—became the base for stela 5 over a kilometer to the west of the ceremonial center itself. Newsome concludes that both X and Y were originally located at the climatic north platform of the Great Plaza as illustrated in figure 35. Stela 5 and apparently 6 as well are located only a few meters from each other as indicated in the Fash map used by Newsome (2003:4). Unlike stela 10, and 12 as well some distance from the center to the east, the 5 & 6 combo cannot be precisely located as features in Google Earth. Stela 5 was reported by Gorden as broken and fallen, having served as pedestal for stela X, moved later to this location.

In looking at design possibilities integrating large scale patterns among the tentatively located 5/6 pair and 12, no pattern like 10 could be found. These two sites, together with some point in the ceremonial complex itself, seemed to suggest a related triad, somewhat different from the more distant singularity of stela 10. Coming to the design mind concerning triads, is of course some sort of hearth symbolism. According to the simulation, once Copán was positioned by it two originating surveys, i.e. Tacana – Atitlán X and the 90° pattern between Atitlán and Tikal's meridian base Santa Ana, it participated with Tikal to create the integration with Calakmul. Logically this alignment from Calakmul to Copán's center would associate with the apex point of the layered hearth at Tikal, Mundo Perdio.

Looking more closely at this line, using the earliest Temple I at Calakmul, instead of Temple II (see illustration 37), sharpens the accuracy of this association, running only twenty some meters from the linear plaform focus of Mundo Perdio. But what about the other two hearth points of Tikal's reproductions? The alignment between Calakmul's Temple I and Copán's stela 12 runs only a few meters from the meridian base point (adjacent to Ball Court) on the main west-east La Venta-Tikal site axis. Now considering the third point of Tikal's hearth, Temple

IV, the logical design association is complete. Again, considering the (small?) error that might exist in the 5/6 latitude-longitude point, it may be quite accurate as well. The line from Temple I at Calakmul to the presently used 5/6 point misses the front base of this largest pyramid at Tikal by about 110 m (the overall distance of the line is 367.795 km). Curiously enough, the later and larger Temple II at Calakmul creates a line to the Copán 5/6 point that runs across the approximate mid-point of the front stairs of the Temple IV structure. One needs to better locate stela 5/6. Together with the primary Calakmul line to Tikal's hearth apex that originates at Copán's Ball Court, these two additional lines very much appear to project the map pattern as laid out in Tikal's site plan down to Copán.

Given Copán's possible representation of Tikal's landscape pyramid/hearth (pattern "A), now including this "projection", how are these three points geometrically related? Taking the two most clearly located points, the Ball Court and Stela 12, one checks the connecting azimuth. At 254.44350, about a degree and a half from the inverted base of the Copán hearth, the "identical" lines of Orizaba- La Venta-Atitlán Zenith- Danta Medio (252.95859) and El Chiflón – East X (252.73186). But given the probable precise accuracies of Mayan surveying, this likely wouldn't have been "close enough" for symbolic work. More interesting, and perhaps ultimately conclusive, is the fact that a line from the tentative 5/6 location to stela 12, hits the Copán ball court, a more likely intentional move. For the record, the two west and east azimuths of the Copán hearth were tested from 5/6 and 12 respectively (including using the El Chiflón – Tikal azimuth also expressed at Tikal). Did they intersect with an extension of the Calakmul – Mundo Perdio – Copán Ball Court south of the Copán site? They seem clearly not to, nor to this writer's knowledge is there a recorded stela in this location south of Rio Copán.

Newsome (2003) says that Altar X was moved to the location of Stela 5 (as its pedestal) during remodeling of the Great Plaza by a particular ruler, where, along with Altar Y and associations with adjacent Stela 17 it may have been originally located as shown in figure 35. Newsome's primary interest lies in earlier "fire" and "sun" meaning of these "bundle" stones (X and Y along with Altar A' and CPN53) as they relate to the founding of the kingdom, dynastic leadership and migrations of legendary ancestors as they acquire ritual bundles. Such was the symbolic means of defining a group's claims to ancestral lands and a class of supernaturals associated with the Mayan domestic hearth. The reoccurring name Ox Witik means "Three Roots" and is a toponym for some important though undetermined location in the Copán Valley.



Figure 35. Locations of Stela and Altars in relation to azimuths

Thus, according to Newsome, these altar inscriptions recorded events occurring in the distant

past. She concludes that such rituals are often overlooked, while in practice they renewed human uses of and claims to land. Inalienable rights of territorial exploitation figure so prominently in the *Popol Vuh* and many other accounts of migration (2003:52). Altars X and Y suggest a deeper historical meaning and even the conception of Copán's dynastic beginnings as contemporary stela are superimposed over altars that refer to founding of the Kingdom.

If one now considers the possibility of a designed framework as part of these beginnings, and particularly the way maps of landscape hearths are reproduced in the layout of ceremonial cities, then how could Mayan designers casually move a stone with such important symbolism, as Altar X, to serve as a pedestal for a new stela (5) out "off the grid" so to speak, even though associated with an elite residential area? Returning to the central line from Temple 16 up through *Mundo Perdido* and on to Calakmul, as shown in figure 35, it runs on the Copán site itself through the center of the late version of Ball Court up quite accurately through the point that Newsome believes was the original location of Altars X and Y. Were these stones originally located to align with the "foundational" survey that connected Copán to Tikal and Calakmul—this immediately after Copán's site had been fixed by lines emanating from Tacana and the Santa Ana/Atitlán right angle?

The movement of Altar X from this paramount location on the line to Tikal's *Mundo Perdido* hearth apex may have been a demotion of sorts but could have been ameliorated by the surveying of the possible west and east Tikal map points from Calakmul, i.e. Stela 5 and Stela 12. Altar X's reuse on the west point of Stela 5 may have continued to carry strong symbolism of early foundation. Could elite residences owe their location to this frame meaning? Similarly, the association of the fourth of Newsome's bundles, CPN 53 reused at Stela 6, may have invoked not dissimilar symbolism.

The reuse of Altar A' and Altar Y within the formalized layout of Copán itself, may also carry related meanings vis-à-vis azimuth patterns seen in figure 35. Altar Y was cached under Stela 4 which may have been conceptually aligned with Copán's meridian, running from the X & Y position down through feature 4 and on to a possible southwest benchmark platform. Along with Stela 4, four additional stela are located on this meridian. Newsome mentions cardinal geometry in aspects of founding symbolism, though such meaning is ubiquitous in virtually any Native American culture. The roles of meridians in the founding of the Olmec initiated landscape, location of important early sites, and particularly in the site layout of Piedras Negras

and Tikal, all may have provided symbolic weight to the original and moved location of Altar Y. Most specifically again, Copán's location itself may have been founded by its relation to Tikal's meridian base, the volcano Santa Ana.

What then of Altar A's relocation as part of the Hieroglyphic Stair? The central Calakmul line through Tikal's hearth apex seems to align with Stela M--a monument to ruler 15 who completed the stair (Fash & Fasquelle 2005) --standing just in front of the celebrated art feature that records the founded dynasty of rulers at Copán. Running farther south toward Temple 16, the Calakmul line comes close to Altar Z, on the "bridge" between powerful temples 11 (west) and 22 (east) (Schele/Freidel 1990:324). The alignment of Temple 26 and the Hieroglyphic Stairs appears from drawings at this scale to be slightly different than its partner Temple 16 on the azimuth south to the volcano San Salvador. While Temple 16's alignment seems a good fit with the Tacana- Atitlán X azimuth – again the way it integrates the western terminus of the great diagonal from Cerro Gordo, Tacana, and the eastern terminus of the Orizaba diagonal via Atitlán X and San Salvador --- it is not clear where the great stairs of Temple 26 point. They face west and seem off center from any clear axis to the much smaller feature Temple 7 across the courtyard. Nevertheless, a San Lorenzo-Calakmul azimuth does seem to connect the Stela M in front of the stair to at least one of the four stela in front of Temple 7.

Looking more closely at the possibly original acropolis hearth grid shown here first in figure 33, one could interpret Temple 7 as a kind of "La Venta" association, perhaps saying something about ultimately where the founding dynasty expressed in the stairs received its authority. While at the smaller scale of hearth on the actual landscape, its NW point is El Chiflón—the water sequence of falls as stairs perhaps—at the larger scale it is La Venta by virtue of the Atitlán X-El Chiflón-La Venta line. Again, the La Venta / El Chiflón association is given further depth by the homologue between the two inverted bases of the two hearth scales: El Chiflón – East X, and (Orizaba) La Venta – Atitlán Zenith – Danta Medio.

If Temple 7 is La Venta in this regard, then the hearth apex (inverted) at Temple 16 seems to associate most strongly with Atitlán X, reinforcing the temple's orientation to that all-important frame and myth point and on to Tacana. Then in terms of the smaller scale landscape map, the apparent center point of the dominating Temple 11 as entrance to the acropolis from the North, could have been more symbolically specific as El Chiflón in its position on the west hearth ray between 7 and 16. Shele/ Friedel (1990:325) describe Temple 11 as a "magnificent cosmic

statement" of a great ruler, "one of the most unusual and intriguing temples ever built in the Precolumbian Maya world". With its Witz Monster as mouth to north entrance, huge giants at the northern corners holding up images of the Cosmic Monster, and "symbolic replication of the arch of heaven and planetary beings who moved through that path on their supernatural journeys", is this powerful site threshold the image of portal to the underworld at El Chiflón?

Once in the otherworld, perhaps, the acropolis procession moves down and around Atitlán X, then culminating via the San Salvador volcano axis and three East Court features to Temple 22 with its demonstrative mountain imagry (von Schwerin 2011). Temple 22 in its position on the hearth base may have a symbolic relationship to both the southern hearth and the inverted middle hearth. Entering from the south in a reversed orientation from Temple 11, Temple 22 is described in even more ultimate cosmic terms in Friedel, et.al. (1993). They feel the temple may portray astronomical hearth like triangular structure of the stars with the ecliptic running at an angle west and east, and the Milky Way moving to create a near vertical *axis mundi*, with Orion as apex. The question is whether this hearth seen in the sky integrates at all with the hearth maps of Copán, and in particular to Temple 22? Present work returns to this issue in a following section that specifically addresses possible isomorphism between landscape and sky maps, including a close-up of the layout of Temple 22.

Given the transformative meaning of the likely ritual experience from Temple 11 to Temple 22, the primary threshold exists as Temple 16. As the first Copán hearth apex, based on a possibly long-lived set of frame related practices, it is not impossible that an altar feature at this location speaks of actual ancient frame practices. While discussed in archaeological literature in the context of political and territorial ownership of the ruling dynansty, the meaning of Altar Q's location may also reveal a deepter layer of meaning, *a la* Newsome. In a piece for PBS NOVA 2001, David Stuart describes the meaning of Altar Q:

"The inscription on the top of Altar Q really tells the story about Yax K'uk Mo' and how he came to Copán. It begins with a reference to a day in the early 400s, when it says that he took the emblems of office at a place that we think is connected somehow to Teotihuacan or with Central Mexico somewhere. Three days later, it says, he comes from that place. He leaves that very spot. And then the inscription goes on to say something really remarkable. A hundred and fifty-three days after he leaves, apparently Central Mexico, he rests his legs. And then it says he is a West Lord, and that's a title that he has throughout the Copán inscriptions throughout history. And then finally, the last two glyphs of the passage read "Hu'li Uxwitikî," "he arrived at Copán." So there's no question in my mind that K'Inich Yax K'uk Mo' became a king at a very far away spot in Central Mexico and brought those emblems of office back here to Copán to found the dynasty."



Figure 36. Altar Q, most likely oriented to Copan's Temple 16's axis to Atitlan X and Tacana; depicts the founding of the dynasty in the early 400s by a king coming from somewhere in the west.

Aside from the fact that Stuart comments on the square shape of Altar Q as being a cosmogram expression of cardinal directions, the actual orientation might well be aligned with that of Temple 16 and the azimuth to Atitlán X and Tacana with all their frame associations. If so, then the altar doesn't simply face West and the realm of the dead in Maya cosmology (as seen particularly in Gossen's 1958 ethnography), but much more precisely to the ultimate Mayan hearth apex as the fusion of great diagonals and *axis mundi*, Atitlán X, again the place where *Popol Vuh* was recorded. Again, the limited Mayan background of this researcher must resist asking questions that cannot be even minimally discussed herein. But one question will certainly be front and center in the minds of any Mayan archaeologist considering the fundamental paradox of this work, i.e. how could ceremonial urban centers like Copán be dynastically

founded at sites located and even ritually laid out according to an Olmec Frame of much greater antiquity?

## **1.5.4** Calakmul as northern terminus of the Olmec Frame: alignment with Tikal and Copán

The precise great circle line from Copán's Ball Court to Calakmul's (first) Temple I, again runs about 22 m west of the East Platform in Tikal's *Mundo Perdido*. The overall distance of this line is 358.227 km and its average deviation is 0.009°. As shown previously the East Platform feature worked best as a primary focal point as Tikal's hearth apex. In design simulation, the line from Tikal and Copán up to the Calakmul area would have logically been laid out first, then the cardinal east from La Venta – emulating Tikal's cardinal east from Atitlán Zenith – was prolonged to intersect, fixing the Calakmul site location. Leaving an archeological discourse of the dating of Calakmul and Copán (or Tikal and El Mirador for that matter) to more informed others, from a purely design logic, the northern pole of the Tikal – Copán - Calakmul line was positioned last.

The application of azimuth lines to Temple I on the correctly oriented site map of Calakmul, figure 37, does not seem to express the Calakmul-Tikal-Copán axis, somewhat surprising given apparent importance of this azimuth in Copán's layout. Furthermore, unlike most Mayan sites thus far investigated, the possible earliest iteration of Calakmul has no expression of a meridian, though the cardinal west to La Venta may have been associated with the positioning of either Temple VI or Temple IV of the E-Group, together perhaps with building orientations in the eastern part of the site. As one might predict, however, the principal azimuth of Tikal, i.e. La Venta – Tikal, does appear to be a component to an early Calakmul scheme. It seems to determine the orientation of Temple I and the alignment of Temple XIII and Temple VII, conditioning building orientations in the western part of the site. What does the strong presence of La Venta – Tikal at both Calakmul and Tikal – but not at Copán on the far southern end of this axis– suggest in terms of sequence and political association?

Did the possible early scheme at Calakmul map a landscape hearth domain as at other evaluated sites? At the time Calakmul was located and ritually laid out, the hearth landscape seems to have evolved to focus on the three points so intricately repeated at Copán (El Chiflón,



Figure 37. Positioning of Calakmul by threepoint alignment with Tikal and Copan, and cardinal east from La Venta (above); possible hearth with inverted apex at Pyramid I using conventional west azimuth La Venta - El Chiflon - Atitlan X, east double azimuth Atitlan X - Atitlan Medio and East X - Tikal, and La Venta - Tikal as inverted base, internal lines express elements of East X creation; possible site grid based on La Venta - Tikal (below).



Atitlán X, and East X (Copán) or Tikal. Key to this evolution, was the discovery that the La Venta – El Chiflón line in fact coincidentally runs down to Atitlán X. While this powerful symbolic alignment most likely was understood in the multiple use of the El Chiflón – Atitlán X azimuth at Copán, so too might this meaning be expressed as a western hearth element of Temple I as apex at Calakmul. The eastern ray of this hearth map appears to be the important azimuth prominent at both Piedras Negras and Palenque, i.e. that from Atitlán X to Atitlán Medio (identical to the line from East X to Tikal). The focal feature at the east hearth vertex, however, is less than clear. Together the western and eastern rays of an early Calakmul hearth such as this include elements of three hearth variations at the original El Mirador and Tikal, Piedras Negras and Palenque, and Copán.

The azimuth from Calakmul's Temple I as hearth apex up to the east platform of the E-Group (Temple VII) does not mimic Tikal's "internal" axes from Atitlán X homologue points. Nor does it accurately participate geographically in the tentative first Calakmul hearth map. Yet its symbolism is quite interesting. Here is an azimuth that not only connects the ends of the two cardinal lines that created Tikal's location—Atitlán Zenith and Santa Ana -- but aligns with the San Lorenzo – Tikal 90 that created the ultimate east hearth point, East X. Moving this azimuth west at Calakmul to run from Temple I up to Temple VII may have created no great symbolic dissonance given the fact the northern end of the meridian at Atitlán Zenith was of course intimately related to Atitlán X (and Atitlán) on its southern terminus.

Before discussing how the massive Temple II integrates into the emerging site system, one must mention anomalies in drawing accuracy of plans at Calakmul. On different published plans, at different scales, one finds considerable variation in the location of key elements, particularly mapping the spatial relationship of the E-group to features more distant from this focus. In the second plan analysis of figure 38, I have adjusted the position of Temple II to best fit the larger scale plan of the central area. The orientations of all published plans used are corrected by satellite imagery. Particularly obvious is the fact that the E-Group axis between Temple IV and Temple VI is not an equinox east-west as labeled in Folan's et.al. 1995 article. Thus, azimuth patterns here laid out at Calakmul are particularly in need of better onsite dimensional data.

As a design simulation, the most important addition to the Calakmul urban plan might have been Temple VII, north of the E-Group. Variations in the published plans notwithstanding, two



Figure 38. Build out of Calakmul site design, locating Pyramid II on meridian from Temple VI to Chiik Nahb Complex and west hearth azimuth from Pyramid I; positioning of Ball Court on La Venta - Calakmul (cardinal) running to Temple VII; bracketing of Pyramid II by Atitlan X - Calakmul (west) and Calakmul -Tikal - Copan (east) intersecting at Temple VII; Ball Court, Pyramid II, and E-group's orientation part of La Venta - Tikal grid.



lines might have located this feature: the La Venta – Tikal azimuth from XIII east, and the Atitlán X – Calakmul azimuth running from Temple VI of the E-Group up to intersect the La Venta – Tikal line from XIII. From the VII point, the major azimuth Calakmul – Tikal – Copán might have been struck south passing through the east E-Group point, creating a southerly arc in which to locate the grand pyramid as Temple II. Its location within this arc might have been determined by a meridian down from E-Group Temple VI, which eventually continued north to the center of the Chiik Nahb Complex, thus connecting the two largest features of Calakmul on a north-south line mediated, as it were, by E-Group Temple VI.

The axis of the great temple, clearly on the La Venta – Tikal grid appears to run up to the north E-Group element VII. This azimuth may be the same as that from Calakmul to San Salvador. Given the vagaries of dimension in present plans, however, this might well turn out to be a 90° line to the La Venta – Tikal grid, as appears to be the case with the orientation of the Ball Court, whose vertical location may be a cardinal west from Temple VII. Looking ahead at the large-scale plan of the E-Group area, figure 41, the reader will see that the axis between its Temples VI and IV also appears to be part of the La Venta – Tikal grid.

### 1.5.5 Calakmul's great pyramid as hearth waterfalls?

In terms of hearth maps, figure 39 suggests two variations, both of which might have expessed their (inverted) apexes at bottom and top of the great pyramid's north facing stairs. The two both map geographically with the apexes as the El Chiflón cascades. More will be said later about the Mayan mythology of paddler gods which might well have been associated with this natural feature. The first and perhaps "earlier" hearth map with its apex at the pyramid stair base uses the west ray from Pyramid I, again the La Venta – El Chiflón – Atitlán X azimuth. The eastern ray is the azimuth from El Chiflón to Tikal (again the focal feature at this vertex is less than clear). Then given the grid La Venta – Tikal northern line of the hearth, one has the original Tikal hearth seen in figures 28 and 30. The interior central axis of this hearth might be the azimuth from East X to Calakmul, which doesn't, however, geographically map with the three hearth azimuths.

The second hearth seeming to use the peak of the great pyramid as its apex duplicates the La Venta – El Chiflón – Atitlán X line of Pyramid I, but in its new position runs up to the Ball Court serving as the "La Venta-like" western vertex point of the hearth. The eastern ray of this second



Figure 39. Possibility of superimposed dual hearths integrating patterns from El Mirador and Tikal; inverted apexes at bottom and top of stairs of Pyramid II; west vertices aligned to La Venta - Tikal site grid, east vertices may form Atitlan X - Calakmul azimuth to Pyramid I.



hearth is the azimuth from El Chiflón to Danta Medio (the vertex feature here seems a bit clearer). Together with the inverted base line as the all-important Orizaba – La Venta – Atitlán Zenith – Danta Medio azimuth, a somewhat altered but geographically accurate hearth map is created. The interior focus of the hearth may have been the VI feature of the E-Group, now the intersect of the meridian from the great pyramid with the Orizaba – La Venta – Atitlán Zenith -- Danta Medio line. This second hearth comes close to replicating the hearth in both El Mirador's plan and expressed greater landscape. Here at Calakmul, the eastern hearth vertex point is essentially pivoted down to Danta Medio, the originating point for Danta and El Mirador.



Figure 40. Calakmul's Pyramid II as possible expression of the El Chiflon cascades and dual inverted hearth maps in site design.

Did the two hearth patterns of El Mirador and Tikal, with their apexes at base and top of the great stairs of Pyrmid II at Calakmul, symbolically link, above all else, the meaning of El Chiflón cascades with the also cascading stairs of the massive pyramid as sensed in figure 40? Furthermore, the axis of the structure runs to the E - Group. Did the ritual movement from the great pyramid to the E-Group core and Temple VII symbolize the paddler gods conveying the First Father in the sky canoe? (Freidel, et.al. 1993;97).

The largest scale plan of Calakmul's center, figure 41, serves as best measure of the accuracy of azimuth positioning, leaving its drawing relationship to surrounding features on the greater site yet to be better measured. As noted in the illustration, the Ball Court location was

Copan - Tikal - Calakmul N Ball Court not included in Folan et.al. plan 1995 located here La Venta - Tikal by three azimuths - W alakmu Venta Medio Orizaba - La Vența

not included in Folan, et. al.'s 1995 drawing and is here added and located by three azimuths working with central features.



Figure 41. Enlargement of site map by Folan et. al. (1995) to illustrate best accuracy of possible azimuth emulation simulated in largest scale site drawings.

Most interesting perhaps, beyond the linkage between the stair cascade and Calakmul's E-Group Temple IV, and far from being simply an astronomical time keeper (and clearly not involving equinoxes), is the way it serves to integrate azimuth meaning involving major site features on its periphery. Above all, the primary axis of the group from Temple VI to Temple IV mimics the site grid created by the azimuth La Venta -- Tikal, setting up a tripartite sequence of parallel axes from the great pyramid's orientation in the south, through the E-Group and up to Temple VII. The central feature of the platform appears to be defined by two powerful azimuths, the cardinal to La Venta and the Orizaba – La Venta – Atitlán Zenith – Danta Medio line, the site grid La Venta – Tikal azimuth centered between the two. The possible azimuths that locate the northern and southern features of the platform might have been created by two azimuths new to the frame record. It makes sense for Calakmul to express the azimuth from its original site point to La Venta Medio, the meridian that helped position La Venta. The azimuth to the southern platform feature, that from La Venta to East X, seems somewhat less convincing even though East X may be expressed in at least two other lines in Calakmul's urban plan. Finally, do any of the azimuths running east from Temple VI to the platform *also* have astronomical significance, providing an additionally integrating element of time to the E-Group's spatial or ritual role at the center of the city?

Turning to the strong north-south relationship between the great pyramid and Temple VII – running through the "void" of the E-Group—one finds a replication of the primary north-south axis between pyramids at Calakmul's opposite on the Tikal axis, Copán. Returning to figure 32, the axis at Copán from Temple 26 to Temple 16 is the azimuth from Copán to San Salvador volcano, base of the great diagonals (Orizaba – La Venta Medio – Atitlán X – San Salvador). This azimuth is reproduced quite accurately at the core of Calakmul.

While the Calakmul – Tikal – Copán azimuth might have framed the arc on the east for building the great pyramid, the possibly earlier focus line of the Pyramid I hearth up to the center of the E-Group east platform appears to have been continued accurately up to Temple VII and even to the small pyramid at the center of the Chiik Nahb Complex. Thus, the two azimuths Calakmul – Atitlán X (Temple VI) and Atitlán Zenith – East X- Santa Ana (Temple IV and Pyramid I), together with the north-south replication of Copán's axis to San Salvador provide the primary structure of the city core. Looking at the core from the great pyramid, its meridian up to Temple VI (and Chiik Nahb) and its San Salvador – Copán line up to Temple VII, appear to the integrate the two hearth apexes. A following section on sky maps will suggest additional symbolic emphasis on at least two of these Calakmul elements, i.e. the unifying La Venta – El Chiflón – Atitlán X line and a meridian.

# **1.6** The Architecturalization of Teotihuacan: its offspring and the absence of Mayan hearth maps

### 1.6.1 Origins of Teotihuacan's orientation

Design logic clearly shows that the site location and perhaps building of La Venta's volcano shaped pyramid structure occurred before all the sites thus far simulated, including Teotihuacan. Yet even if it can be proven that early Mesoamericans could accurately survey and record large scale azimuths, establishing a temporal sequence for the major ceremonial sites that followed may be difficult if not impossible. It is likely that the original meaning of the Olmec Frame, if something like it axtually existed, had primarily to do with ritual practices integrating social groups in a world still largely without monumental architecture, essentially a "non-discursive" kind of cultural expression (Doxtater 1984). Is it possible that many of the sites here simulated were used ritually for some time before dynastic kings built and rebuilt what may originally have been modest markers of azimuth patterns; these reproduced at site scale the aboriginal practices of groups coming together to design and survey symbolic domains in the shared landscape.

More than two thousand years ago, the possibly mature expanded Olmec Frame was being monumentalized by Mayan rulers. Prior to this point, perhaps, the Cerro Gordo landscape pyramid domain, figure 5, had long been a powerful, but yet unbuilt ritual focus, again a "North" and "Above" opposed to Atitlán as "South" and "Below"—with La Venta as supreme mediator based on the *Medio*. It is not impossible that people in the Mexico Valley region came together at a largely natural place near the present Teotihuacan, in full view of Cerro Gordo to the north. Their lack of impulse to build, despite the area's powerful spiritual location, may have related to working social integration of groups, lack of theocratic control by rulers, and not unrelated ecologies.

When these people did make their move –from a design simulation perspective -- it may have been to primarily establish a highly planned Teotihuacan as a spatially opposed urban, ceremonial focus at large scale to politically integrate with all that the Mayans associated with Atitlán X, and the related hearth variations thereof. Consider again the two great Olmec


diagonals that determined the meridians for La Venta and San Lorenzo, figure 15. One now can



Figure 42. Positioning of Moon Pyramid via Atitlan X - La Malinche and bisect meridian from Tlaloc MA and Popocatepetl; azimuth from La Malinche center point to Orizaba summit as origin for Teotihuacan orientation.



map a third diagonal which in effect not only unifies the Olmec pair, but firmly links the Atitlán region to the architecturalizing Teotihuacan site. As seen in figure 42, the precise line from Atitlán X passes very close to the center of the volcanic rim of La Malinche (its eastern side collapsed) and runs to Teotihuacan's Moon Pyramid—the apparent feature that fixed the specific site location. La Malinche, we will recall served as the "sighting" feature for the long line from

Cerro Gordo down to Tacana. By connecting directly to Atitlán X, the Teotihuacan line links both great Olmec diagonals, the other of course being Orizaba – La Venta Medio – Atitlán X – San Salvador.

But the new diagonal does not completely fix the site location. The natural, coincidental Cerro Gordo landscape pyramid could have had a meridian running south from its apex, in true Olmec tradition, but not monumentally marked. To position the Moon Pyramid, designers could have found by trial and error the point on the new great diagonal where a precise bisect construct to the two inner base volcanos, Tlaloc MA and Popocatepetl, creates a meridian. With this second act, a new soon to be monumental apex point homologizes Cerro Gordo.

How then, was the all-powerful site axis oriented from the Moon position, and subsequently Sun Pyramid located? The following is an alternative to the presently persuasive archaeo-astronomical explanation. Simply put, the great axis is an azimuth derived from precise land surveying, not observation of a nadir sunrise. It is not primarily the power of the sun that infuses Teotihuacan, but that of Orizaba as the greatest of all mountains. The Moon pyramid's new third great diagonal strongly connects Teotihuacan with La Malinche which plays the threshold role in the (San Lorenzo) diagonal with Cerro Gordo and Tacana. From a design perspective it is symbolically necessary to associate with the first (La Venta) great diagonal originating from the other powerful feature of the Cerro Gordo pyramid domain, Orizaba, running down to Atitlán X and San Salvador. The meaning of the Teotihuacan site orientation derives from the symbolic fusion of the three great diagonals. The azimuth of the Teotihuacan axis is the very accurate perpendicular of the azimuth from the center of the La Malinche volcano to the high point on Orizaba (105.38°).

Once the La Malinche – Orizaba perpendicular was laid out from the Moon point, a parallel line was surveyed down from Cerro Gordo, figure 43. The point where the Cerro Gordo parallel intersects the Moon Meridian is the location of the Sun Pyramid, its orientation parallel to both major site axis and line from Cerro Gordo. Recalling Cerro Gordo's summer solstice relationship with Orizaba, this symbolism is now transferred to the Sun Pyramid, together with the power of the nadir rise over Orizaba as observed from La Malinche (see again figure 3 & 4).

Clearly, the symbolism of solstice and nadir rise times are important to Teotihuacan religion, but the location of the complex with respect to elements of the evolved Olmec Frame –Cerro Gordo, La Malinche, Orizaba, the four pyramid base volcanos, Atitlán X--is more fundamentally



important from a ritual perspective of social integration at the Mesoamerican scale. Aside from this fundamental social anthropology, the actual archaeoastronomical explanation presently accepted, may be less technically correct. Sprajc (2000) works from then recent archaeological

evidence that the cave under the Pyramid of the Sun, which had been thought to be the reason for the location of the site and its largest feature, was manmade, presumably after the founding of the site. Alternatively, he concludes that the Pyramid of the Sun's position (not dissimilarly the point that fixed everything on the urban site) was located in an area of about 100 meters diameter where it is only possible for four alignments to converge. First is a projection of the pyramid's north-south axis to Cerro Gordo, second and third are the observations of Nadir rise and set on the two opposed horizons, and fourth is the observation of a Quarter Day rise over Cerro Colorado visible on the horizon off to the north of east.



Figure 44. Calculated nadir rise point on eastern horizon seen from Sun Pyramid, varies about one degree from La Malinche - Orizaba azimuth and perpendicularTeotihuacan site axis; no significant natural horizon feature at rise point.

If one begins with the site axis, not the Sun Pyramid, however, its perpendicular azimuth measures about 105.44°. This is very close to Sprajc's figure of 105.47° for the Sun Pyramid axis that corresponds to the Nadir rise and set observations, as well as the perpendicular line up

to Cerro Gordo. When one calculates the rise azimuth of Nadir on the horizon to the east of the Sun Pyramid, as shown in figure 44, the angle is off the pyramid axis by over a full degree. This inaccuracy is not explained, perhaps so because of the usual 2° variation assumed by many archaeoastronomers in their observation numbers. This possible range of error may be also applied to the Quarter Day observation of the modest Cerro Colorado hill. One is left with no site drawing of how possible variations in observation azimuths could have produced a relatively accurate intersection area of about 100 meters diameter.

An Olmec Frame perspective does not argue that priests did not observe these three features from the top of the Sun Pyramid, rather that the precise site axis and pyramid orientation did not derive primarily from these azimuths. It was most probably a transfer of azimuth, seen frequently in Mayan urban design, here the precise azimuth from the center of the volcanic cone of La Malinche – very close to the alignment (105.38°) from Moon Pyramid to Atitlán X – to the high point of Orizaba. Interestingly, if the reader will return to figure 4, the azimuth of the Nadir observational feature on the very top of Mount Tlaloc, from its alignment with the high point of La Malinche and a rise point of the summit of Orizaba to the south, is about 105.53°, also very close to the Teotihuacan site and pyramid axes. Since this line parallels quite accurately the line from the center of La Malinche's west volcanic crater rim to Orizaba's high point, the Teotihuacan "transfer" could have been from either, or both. But it likely was not from any direct observation of the featureless horizons to the east and west of the Teotihuacan site.

Also transferred was the perpendicular to the La Malinche – Orizaba axis, projected down from Orizaba's solistice observation point, Cerro Gordo. As for the Quarter Day observation of the rise at Cerro Colorado from the top of the Sun Pyramid, without more precise measurement of this azimuth — from the point where the sun's crown first appears—one cannot include or exclude this alignment as part of some original positioning of the Sun Pyramid. Within a 2° range of accuracy, how great is the possibility of coincidence? Again, one of the problems with Mesoamerican archaeoastronomers, is their dismissal of the importance of meridians. As mentioned previously, this is perhaps because of the long-standing assumptions about the importance of 17° off-cardinal site orientation phenomena. Sprajac is largely mute about the meridian axis from the Moon Pyramid to the Sun Pyramid. At the scale of the "North/Above" landscape pyramid domain, this axis which created the bisect to the two inner volcanos of the landscape pyramid base, was essential in fixing the Sun Pyramid's location on the La Malinche –

Orizaba (Nadir) perpendicular from Cerro Gordo. As seen in the Olmec Frame, meridians are highly important founding elements in the positioning and urban layouts of sites. Here at Teotihuacan the meridian between Moon and Sun may well have been as symbolic as the main site and pyramid axes, particularly in the way all major features of the Cerro Gordo landscape pyramid are being interwoven into the developed Olmec Frame. In summary, the Teotihuacan layout does the following:

 Projects the pivotal La Malinche volcano center point up to the Moon Pyramid position at a new landscape pyramid apex emulating Cerro Gordo. The third great diagonal Moon – La Malinche center pt. – Atitlán X is precise.

2. The intersection of the meridian bisect created by the two inner base volcanos of the Cerro Gordo pyramid domain and the line from Atitlán X – La Malinche ct. creates the Moon position. The Teotihuacan site axis is the perpendicular of La Malinche ct. – Orizaba laid out south from the Moon Pyramid.

3. Orizaba's solstice role with Cerro Gordo is projected down from its summit parallel to the Moon site axis, intersecting with Moon's meridian to create Sun Pyramid's position. The use of the precise La Malinche – Orizaba perpendicular from Cerro Gordo strongly suggests that the Moon Pyramid symbolizes La Malinche, and the Sun Pyramid expresses Orizaba in all their frame associations.

4. This layout fuses Teotihuacan site features with the Olmec Frame in multiple ways, particularly involving the now three great diagonals and Atitlán X. Both Nadir and Solstice times are integrated into the large-scale ritual layout.

5. There appears to be no Mayan-like hearth as site map or focus, in deference perhaps to the ancient meaning of the Cerro Gordo/Moon Pyramid landscape pyramid domain. Yet the meridian bisect to Moon Pyramid – and the related formal urban core – might be considered an internal element to the focus of the encompassing triangular shaped domain, just as those internal, focusing elements of Mayan hearth maps.

# **1.6.2** Takalik Abaj and Kaminaljuyu as base vertex points for a landscape pyramid domain with Atitlán X as apex

From a symbolic design perspective, if one wished to create an opposite socio-political landscape pyramid domain to pair up with Teotihuacan, now defining the focus of an ancient Cerro Gordo

pattern, it most logically would have its apex at the most powerful spiritual point in the "south" and "below", i.e. Atitlán X. Figure 45 describes the two virtually identical apex angles between Cerro Gordo and Atitlán X with respect to its landscape pyramid base as the cardinal west-east line between Takalik Abaj and Kaminaljuyu. This begs the question, however, of why the azimuth Cerro Gordo – La Malinche – Tacana was used instead of the new diagonal Moon Pyramid-La Malinche Ct.-Atitlán X which works quite precisely to establish a point at Kaminaljuyu in the plaza of the site focus, shown in the following figure 46. The precise line



Figure 45. Positioning of Kaminaljuyu on extension of Moon Pyramid - La Malinche - Atitlan X line; apex of landscape pyramid at Atitlan X, location of Takalik Abaj on western ray at an angle equal to apex of earlier Cerro Gordo landscape pyramid; Takalik Abaj and Kaminaljuyu are cardinally aligned on some probable symbolic latitude point.

from Moon Pyramid through Atitlán X (accurately via La Malinche as described in figure 42) misses the Kaminaljuyu center by about 19m, and misses Atitlán X by 17 m; the line is 1,045.311 km. The apex angle from Cerro Gordo to Toluca and La Malinche is within about 0.673° of creating a coinincidental equilateral triangle, where the vertical bisect is off about this angle. This may be why Teotihuacan based designers chose it to emulate in laying out the opposite southern pyramid landscape, rather than use the Moon – La Malinche – Atitlán X line (which in part determines the location of Kaminaljuyu). Thus, close to the exact apex angle (off about 0.05°) of the Cerro Gordo pyramid domain was struck from Atitlán X to create the western ray to a prospective Takalik Abaj.

The base line of this southern pyramid domain is logically the east-west cardinal line between the two new sites in the Atitlán area; illustrated in figure 46 is the accuracy of a midpoint latitude between the two site foci. In simulating design, what logically locates this common 14.63230 – 14.63808 latitude of Takalik Abaj and Kaminaljuyu? Running about 215 m south of the Santiago Atitlán Church (and former Prechristian temple) the southern landscape pyramid base lies roughly between the San Pedro peak and Toliman Midpoint to which the church/temple was aligned. The 14.63500 latitude lies about 1 <sup>3</sup>/<sub>4</sub> km north of the common latitude of Chocala's center and Toliman twins midpoint.

Is it possible that the major Mayan points like Atitlán, Izapa, Chocola, San Pedro, and the Toliman midpoint were all too highly integrated into non-Teotihuacano ritual and therefor couldn't be used for a new southern base? Instead, perhaps, the Mesoamerican 260-day interval between solar zenith passages that occurs uniquely at the latitude of 14.72° (Green 2014) may have been the rationale for the Takalik Abaj – Kaminaljuyu base—off only about 0.09°. The actual 14.72° latitude runs through the length of Lake Atitlán itself and the close azimuth base between the two city sites is up high enough on Toliman's north flank to provide a best view of the lake.

The site maps of Takalik Abaj and Kaminaljuyu are not of a scale or detail to permit the dgree of design simulation seen in the major sites thus far. What one can possibly discern, however, are general site axes, perhaps not unlike those of the "non-hearth" sites Izapa, Chocola, Alban, La Venta, and Teotihuacan. While Mayan "hearth" sites seem more complex than "axis" sites, these too seem to integrate with frame elements. First, the side and base azimuths of the Atitlán X landscape pyramid do not seem to be reflected in the orientations of axes at the two



Figure 46. Possible orientations of site axes perpendiculars of Takalik Abaj and Kaminaljuyu to opposite termini of two great diagonals to Tacana and San Salvador; perpendicular to this line runs through Atitlan X up to Atitlan Medio; common midpoint latitude indicated on site plans.





sites.Given the strong integration with Atitlán X via the pyramid domain, what else might Takalik Abaj and Kaminaljuyu reproduce? Much of the site and layout symbolism simulated thus far unifies the two great original diagonals from the two most powerful points in the "North" / "Above" pyramid domain, Cerro Gordo (to Tacana via La Malinche) and Orizaba (to San Salvador via Atitlán X). Teotihuacan's Moon Pyramid to Kaminaljuyu azimuth, via La Malinche and Atitlán X, introduces a third great diagonal. In terms of umification, Atitlán X's benchmark location collects spiritual power from both Orizaba and Moon Pyramid, but not from the other great diagonal from Cerro Gordo (except to a lessor degree by La Malinche's participation in this and the Moon line).

Recall that San Lorenzo's positioning and landscape pyramid integrated the second diagonal Cerro Gordo – La Malinche – Tacana to La Venta's Orizaba diagonal in part by creating the Atitlán X – Atitlán Medio azimuth, this based on a perpendicular to the azimuth between the two ends of the diagonals, Tacana and San Salvador. This symbolism is extensive at both Piedras Negras and Palenque, and one of Copán's major ritual roles involves azimuths to these two volcanos. Thus, turning to figure 46, it is not illogical that the new Teotihuacan initiated Atitlán X landscape pyramid, might too seek such integration, perhaps to justify the addition of a third great diagonal to the frame.

True to the oppositional character of ritual space, the axis of the easternmost vertex, Kaminaljuyu, points to the opposite great diagonal terminus, Tacana, while the azimuth of the axis of Takalik Abaj expresses San Salvador. While much more precision will be possible with better site maps in the future, perhaps, the logic seems clear. The two landscape pyramid base vertexes oppositionally symbolize an equinox unity between the two original great diagonals. And while the pyramid apex of Atitlán X participates in the two first diagonals – both on an alignment and as part of the perpendicular up to Atitlán Medio -- its position on the third diagonal and more politically perhaps as the hierarchical central element in the pyramid may have expressed not only the power of Teotihuacan in relation to Takalik Abaj and Kaminaljuyu, but a kind of counter balance with Mayan Hearth aspects of the Olmec Frame.

# 1.7 Azimuths as calendar and relation to sky maps

## 1.7.1 How could Olmec Frame elements be recorded?

Most prehistoric cultures created a form of calendar which formalized their inhabited landscapes. Particularly as the sun moved in its yearly course from south to north, directions of solstice rise and setting points on the horizon became primary structural points, often with a north-south meridian at the center, with a perpendicular east-west cardinal related to the equinoxes. These mental maps of "cosmos" were symbolically woven into ritual, myth, and art. Within the geographic scale of any particular cultural group, a latitude related structure or "frame" could in effect be transported to any location, whether dwelling or ceremonial site in landscape, to make effective religious practice. As social organization became more complex, primarily in terms of scale and cultural sub-groups, the need may have evolved to generalize such patterns to make such things symbolically understandable, i.e. integrate, across wider landscapes and organization.



Figure 47. Azimuth elements of an "Olmec Frame"; complexity of geometric pattern as a whole not understood as part of design simulation.

#### 1. Chocalá

Chocalá – San Pedro Chocalá – Toliman Center Pt. Tzontehuitz – Tajamulco

#### 2. Izapa

Tacana – Tajamulco Izapa – Tajamulco Izapa – Atitlán Tajamulco – Atitlán X Atitlán X – Atitlán

#### 3. La Venta

Orizaba–Atitlán X -San Salvador Cerro del Aguila – Zempoaltepetl Tzontehuitz–Sal Salvador Medio Zempoaltepetl – Tzontehuitz La Venta Medio – La Venta La Venta – Cerro del Aguila San Salvador – San Salvador Medio La Venta – San Salvador Medio La Venta – Piedras Negras – Atitlán Medio Monte Alban – La Venta La Venta – La Venta

#### 4. San Lorenzo

Cerro Gordo – La Malinche – Tacana Cerro del Aguila – Zempoaltepetl Tzontehuitz – Sal Salvador Medio Zempoaltepetl – Tzontehuitz San Lorenzo Medio – San Lorenzo Cerro del Aguila – San Lorenzo Tacana – San Salvador Atitlán X – Atitlán Medio San Lorenzo – Atitlán Medio

#### 5. Danta (El Mirador)

Orizaba – La Venta – Danta Medio Tzontehuitz – Danta Medio – San Salvador Medio Danta Medio – Danta San Lorenzo – Danta La Venta – Danta (5) Orizaba – La Venta – Danta Medio San Lorenzo – Danta Medio (2) La Venta Medio – Izapa N (La Venta–El Chiflon–Atitlán X) Izapa N – San Salvador (El Chiflon – Danta) Tacana – San Salvador (2) La Venta Medio – Danta (2)

#### 6. Monte Alban

Monte Alban – La Venta Monte Alban – Tzontehuitz

#### 7. Piedras Negras

La Venta – Piedras Negras – Atitlán Medio (2) San Lorenzo Medio – La Venta Medio – Piedras Negras (2) Atitlán X – Piedras Negras San Lorenzo Medio – Atitlán X Piedras Negras – San Salvador (4) Cerro del Agulia – La Venta (2) Orizaba – Atitlán X – San Salvador Tacana – Atitlán X Atitlán Medio – San Salvador Atitlán X – Atitlán Medio (3) Tacana – Atitlán Medio Tacana – San Salvador (3) Palenque – Piedras Negras

#### 8. Palenque

La Venta Medio – Palenque (2) Palenque – Atitlán Medio (3) Palenque – Izapa La Venta – Palenque (3) Tacana – San Salvador (2) Atitlán X – Atitlán Medio (2) Atitlán Medio – San Salvador Tacana – Atitlán Medio Palenque – Danta Palenque – Atitlán X La Venta Medio – Tacana

#### <u>9. Tikal</u>

Cerro Gordo Medio – La Venta La Venta – Tikal (4) Atitlán X – Atitlán Zenith Atitlán Zenith - Tikal Santa Ana – Tikal San Lorenzo – East X (2) East X - Tikal (Atitlán X - Atitlán Medio) (2) Atitlán Zenith – Santa Ana (2) El Chiflon – Tikal (2) Atitlán Medio – Tikal La Venta - Chiflon - Atitlán X (2) Orizaba – La Venta – Atitlán Zenith San Lorenzo – Atitlán Zenith Atitlán X – East X East X – Danta

#### 10. Copan

Tacana – Atitlán X – Copan (2) Calakmul – Tikal – Copan Atitlán – Santa Ana Santa Ana – Copan (2) San Salvador – Copan (3) Orizaba – La Venta – Atitlán Zenith –Danta Medio (El Chiflon – East X) (2) La Venta – El Chiflon – Atitlán X (2) Atitlán X – East X (4) Atitlán X – Atitlán Medio (East X – Tikal) San Lorenzo – Calakmul Danta Medio – Copan East X – Calakmul Atitlán – Copan La Venta – Copan

#### 11. Calakmul

La Venta – Calakmul (2) Calakmul - Tikal - Copan (2) La Venta – Tikal (3) San Lorenzo – East X La Venta – El Chiflon – Atitlán X Atitlán Zenith – East X – Santa Ana Atitlán X – Atitlán Medio (East X – Tikal) San Salvador - Copan Atitlán X – Calakmul Atitlán X – Santa Ana Orizaba - La Venta - Atitlán Zenith Danta Medio El Chiflon – Danta Medio La Venta Medio – Calakmul La Venta – East X

#### 12. Teotihuacan

Toluca – Tlaloc MA Popocatepetl – Orizaba Tlaloc/ Popocatepetl Bisect – Moon Pyramid Moon Pyramid – La Malinche – Atitlán X La Malinche – Orizaba (perp) Cerro Gordo – Sun Pyramid (parallel) Tlaloc/ Popocatepetl Bisect – Sun Pyramid

### 13. Takalik Abaj

Toluca – Cerro Gordo Cerro Gordo – La Malinche – Tacana Moon Pyramid – La Malinche – Atitlán X Atitlán – Atitlán X Tajamulco – Atitlán X Takalik Abaj – Atitlán X Takalik Abaj – San Salvador

#### 14. Kaminaljuyu

Toluca – Cerro Gordo Cerro Gordo – La Malinche – Tacana Moon Pyramid – La Malinche – Atitlán X – Kaminaljuyu Tacana - Kaminaljuyu

Figure 48. List of layout azimuths at major sites.

In most literature on the Pre- and Post- Columbian Maya, simple quadrant structures are held to be the source concept of cosmic symbolism in their religion. In terms of the present design simulation one can see a critical flaw in this assumption of continuity between "frames" that can be moved around essentially at will, dependent primarily upon Mayan myth and occasionally expressed in site planning and architecture. The key here is that, as shown in the early part of this book, early symbolic frames were often fixed to unique natural features in the particular landscape, especially its volcanos. Thus, although one might observe many religious foci within the lived area of a particular group – whose use of frame structure is extremely difficult to map ethnographically -- all might well be anchored to specifically known natural features.

It doesn't make design or cognitive sense that Mayan designers understood the complex graphic pattern created by a map of frame azimuths as in figure 47. And even though designers from a particular site would know the list of azimuths used to position the site and lay out their principal features, no particular designer would understand the way all azimuths are used at all sites, as listed in figure 48. Designers certainly will have good sense of which frame sites are most spiritually powerful and thus used more prominently and often, as in figure 49.

46 La Venta	12 Palenque	8 Santa Ana	4 Zempoaltepetl
38 Atitlán X	11 La Venta Medio	6 Tzontehuitz	4 Moon Pyramid
23 San Salvador	11 San Lorenzo	6 Cerro de Aguila	3 San Lorenzo Medio
21 Atitlán Medio	11 Danta	6 Cerro Gordo	2 Chocalá
19 Tacana	10 Orizaba	6 La Malinche	2 Takalik Abaj
19 Tikal	10 Danta Medio	5 Atitlán	2 Kaminaljuyu
18 East X	10 Piedras Negras	5 Izapa	2 La Venta Medio/2
14 Copan	10 Atitlán Zenith	5 San Salvador Medio	1 Monte Alban
12 El Chiflon	9 Calakmul	4 Tajamulco	1 San Pedro

Figure 49. Use of frame points in simulated site location and layout.

Yet the question remains as to how the developing frame is best conceptualized, or ethnographically what happens to the ancient effect of fixing frames in the known natural landscape. If one records azimuths as a kind of calendar, figure 50, do the orientations relate as well to simple quadrant spatio-temporal concepts found at the heart of all traditional religions? Note that each of the azimuths in this illustration can be read from either direction, 180°. Most line represent the angular relationship between two points, while some are three-point alignments (see most inclusive list of figure 69).



Figure 50. Representation of frame azimuths as a "wheel"; relation to principal astronomical sun rise directions; each azimuth line runs through center across the total wheel diameter.

Certain of the directions of the "azimuth wheel" coincide with the universal structural directions provided by zenith/nadir, equinox, and solstice rises. Yet the frame components are clearly attached to fixed features in the landscape. How is this different from the way ancient smaller scale societies fixed their simple cosmic structures of space and time to real landscape features? In these hypothetical very simple cases, the spatial limit of cosmos or ritual integration might be at the scale of the Warao, for example. When social organization seeks larger scales of integration, is the attachment to relatively local natural features limited – as is largely assumed in

anthropological thinking? Localized versions of cosmos presumabely did not integrate ritually at larger scales. Did a wheel record such as figure 50 provide an understandable cognitive pattern that in effect radically extended the attachment of fixed cosmic elements (azimuths), and integration to a Mesoamerican scale? How did it fix the older, simpler directions of space and time into the wheel that also contained all the orientions of site positioning and feature layout with landscape pyramid domains and hearth maps?

Upon closer inspection, the azimuth wheel of figure 50 includes strong correspondence to the simple quadrant structure found in Maya myth, art and ethnographically observed ritual. Notice how the azimuths space themselves to the cardinal quadrant directions, leaving intercardinal voids. More to the point, as seen in the list of all azimuths (figure 69), the greatest number of orientations that are close to identical (emphasized directions) are some nine north-south meridians and eleven east-west cardinals. This clustering of cardinal azimuths can't be graphically shown in figure 50. Furthermore, as detailed earlier, some azimuths are coincidental with ancient directional astronomical markers, particularly associated with the Cerro Gordo and Atitlán domains.

Graphically, besides the numerous cardinal azimuths which don't really show in figure 50, the intercardinal voids may be interesting. If one looks at the number involvement of individual sites as one of azimuth pairs, figure 49, La Venta and Atitlán X not surprisingly are head and shoulders above the rest. This axis, including the accurate alignment of the upper pool of the El Chiflón cascades, and late terminus at Utitlan (*Popol Vuh*), might be the most highly regarded symbolic direction, particularly for Mayans in their design of hearths at El Mirador, Tikal, Copán and Calakmul. Is it chance that this azimuth (from La Venta 222.39030) centers on a void in the Olmec Frame wheel of about 25°. If the frame wheel was an actively kept record and "cosmic map", could the sacredness of this azimuth have kept other directions from being recorded in this void? Additional symbolism layered on this line will be discussed shortly. Design simulation thus far has not found any likely azimuth that would run in the middle of the opposite intercardinal void, an arc of about 20° across from La Venta – El Chiflón – Atitlan X.

Was this "cosmic" wheel of fixed azimuths, also a clock? Returning to the first Olmec landscape pyramid, created by La Venta's location atop its meridian, its east ray to San Salvador Medio point has an azimuth of 254.98696. This is quite close to the direction of the sunrise at Nadir (the previously detailed natural coincidence of the Atitlán-Acatenango-Agua Nadir line is

254.79835). The La Venta line might also be associated with the naturally coincidental Nadir line from Mount Tlaloc-La Malinche-Orizaba of 255.75 (or the precise line from La Malinche to Orizaba used in Teotihuacan 254.62). The west ray of the La Venta landscape pyramid runs to Cerro de Aguila at 286.10421. This line is close to the summer sunrise at Zenith (the average of the alignment from Chocolá to San Pedro, again is 285.50). One doesn't know if the Nadir and Zenith rises were observed from some La Venta high point, but they could have aligned (within the greater variation used by archaeoastronomers) with the two rays of the landscape pyramid, running south to their *Medio* intersection points.

Both rays of the La Venta landscape pyramid layout of course depend fundamentally on meridian and equinox related cardinal east-west structure (the slight diagonal from Zempoaltepetl to Tzontehuitz at 265.05998 again links the two wider equinox pairs and their lines on each end). However, none of the Olmec Frame azimuths recorded align with any observation of summer or winter solstice rises from La Venta. Could the association with both Nadir and Zenith rise directions have been part of the original design process of choosing this apex point at equal angles to Cerro de Agula and San Salvador Medio? The positioning of La Venta seems to have involved two geometries, symbolically both demonstrating the power of the vertical. First the meridian was extended up from the intersection point on the Orizaba – Atitlán X -- San Salvador diagonal, and then the two rays used to fix the latitude both involve, albeit perhaps coincidentally, the times when the Zenith-Nadir geometry occurs.

Only two other azimuths are close to astronomical pointers (disregarding any marked variation from elevation differences between observation and rise points such as is the case with Chocolá – San Pedro). In addition to the Cerro del Aguila (zenith) line mentioned above, the azimuth of La Venta Medio to Calakmul is close to this orientation (286.37384). The winter solstice line from Cerro Gordo to Orizaba (244.37781), is close also to San Lorenzo – East X (244.18212), the pivotal ray of the right angle important in Tikal landscape pyramid innovation. No azimuth of the frame wheel lies close to the summer solstice rise.

The second question about an Olmec/Mayan azimuth wheel asks whether time could somehow be associated with all azimuths, not just those coinciding with discussed ancient astronomical markers of the 365-day Haab cycle. To this author's limited Mayan knowledge, the 260-day Tzolk'in count is discussed mostly in context with its use in the linear Long Count, rather than the cycle between the two zenith passages occurring at the 15° latitude band.

Apparently, scholars have yet to firmly identify the source of the ancient 260-day cycle with its 13 segments of 20 days each (Green 2014). When one thinks about dates on Mayan stela, it seems like the Long Count time of a ceremony was a first consideration by priests, and then sites were located, and urban form was laid out somewhat secondarily. Given an assumption about the structuring limitations of simple cosmological pattern at Mesoamerican scale, in terms of integrating ritual practices, in the Maya at least, time has become the paramount structure of symbolic process. If, however, Mesoamericans can eventually be proven to have created something lika an azimuth wheel, both as cosmic image and as a technical means of designing and socially integrating a large cultural region, then questions can be raised about how this presumably powerful ritual system could function as a secondary consideration of particularly the linear Long Count. Could there have been some attempt to create a timing device that would provide both the primacy of the spatial azimuth, as well as a unique time for all azimuths. One simulation exercise in this regard can be offered.



Figure 51. La Venta location as possible origin of 13 segments of 260 day Tzolk'in count; coincidence of zenith rise azimuth with Cerro del Aguila - La Venta, and winter solstice rise with line from La Venta to the intersect of the Atitlan meridian with the *Medio* line; possible coincidence of La Venta - Atitlan azimuth with segment line between 1 and 2.

Beginning logically with the apex of everything, La Venta, the designer asks whether its primary timing features, or extensions thereof, might have provided a sort of initial construct for a timed azimuth wheel. What we are looking for is an aboriginal 260-day pattern of 13 twenty-day segments. With a bit of exploration, one finds that a line from La Venta down to the intersection point (245.41225°) of a vertical from Atitlán with the west-east *medio* base from Tzontehuitz to San Salvador Medio (and Victorial Peak) is quite reasonable as a winter solstice direction. Symbolically adding to this idea is the way the line from La Venta tracks to the intersection point, vertically down to Atitlán and the out to its winter solstice line to San Salvador (245.68670°), see again figure 6. The winter solstice ray from La Venta, when taken with the zenith related western ray to Cerro del Aguila, creates an arc of 140.40498° which can be divided into five sections of a relatively accurate 13 part cyclical construct. 360° divided by 13 gives a segment of 27.69°, and 5 times this is 138.46°, an error of about two degrees with the La Venta zenith-winter solstice arc.

It is also topographically true that a direct line from La Venta to Atitlán comes close to forming a (first?) segment line with the Atitlán vertical intersection point; this precise arc is 26.94°, about three quarters of a degree shy of the ideal figure. Also, less coincidentally precise is the azimuth of the fifth mathematical segment (106.95)—reading counterclockwise—with the La Venta – Cerro de Aguila line (105.00727°). Variations in how the winter solstice rise was observed from La Venta, or how a zenith azimuth was associated with the La Venta to Cerro de Aguila line, could of course produce a range of accuracy for the thirteen segments of a 260 day "clock". Nevertheless, considering La Venta's omnipotent role in the extensive frame itself, the added coincidence of the quintpartite division of time from its zenith and winter solstice azimuths seems interesting.

If one were to lay the La Venta diagram of figure 51 over the azimuth wheel, would it be possible to associate Long Count dates with specific azimuths? Thus, given the list of azimuths associated with a site, these might not only infuse the design fabric of each ceremonial setting with ritually observed symbolic maps, but possibly also with a long count date that further differentiates and integrates particular landscape histories and associated social groups. While "aboriginally" structured by the frame focus of La Venta, the possible integrated 260 day "cosmos" might move independently of the traditional 365-day solar cycle. Can one expect that

as the count increases for each azimuth, these numbers of days will likely coincide at special times with astronomically determined solar cycle directions?

How might numerical abilities to record days and longer counts relate to possible units of angular degrees? Curiously enough, if one divides a 365 day count by 13, the number of solar days for each section is 28.0769. This number is virtually identical with the division of degrees of the La Venta arc (140.40495°) by five i.e. 28.08096. Did the Mayans conceptualize and record the solar year as a circular calendar where each day equaled one degree? If this were the case, then each of the directions of the Olmec/Mayan azimuth wheel would be a particular day of the year, perhaps rounded off to the nearest whole day. This might be the most efficient way of recording azimuths after surveying: simply a yearly number that after laying out a circular 365° round on the ground could be reproduced. This would practically and symbolically integrate all azimuths as suggested above for the 260 day count.

But their numerical devices more clearly involve the Tzolk'in, suggesting that they did not count the solar days in the manner most useful to an integration of the azimuth wheel. Whatever it was that symbolically drove the creation of the 260-day cycle, the spacing of zenith passage at the 15° latitude band perhaps, how accurately might they have associated azimuth directions to days of the cycle, where one day equals 1.38° of a 360° circle? All the presently calculated, surveyed landscape azimuths given herein do of course use this conventional geometric means of recording arc distance. But how did priests adapt the time unit of a day to the arc distance of 1.38°? There must have been some rounding of the precise surveyed azimuth, as measured by points in the large-scale landscape, as these directions were somehow recorded. And given the present drawing accuracy and scale limitations of the simulated applications of these directions to site layouts, one cannot begin to discern how precise the physical records were. It may have been technically possible to lay out circles in an area of say 30 meters or so, such that angles of about 1.38 degrees could be defined (perhaps easier with 260 rays rather than 360 or certainly 365).

After laying out a large-scale line, surveyors might have inscribed a circle around an end point, perhaps 20-30 meters in diameter. A meridian would be the necessary first ray (cord) to be added. All 260 rays wouldn't need to be laid out, only those in the arc segment in which the new azimuth occurred. Given the initial meridian, shorthand geometry (cording) most probably could locate the involved arc segment points, within which 19 cords could be equally spaced.

The 1.38° arcs are about 0.48 meters wide at 20 meters distance from the center and could be adjusted by simple visual estimation. If lines could be laid out fairly accurately 1.38° apart, then the greatest distance an azimuth could fall from a 260° section line would be about three quarters of a degree or about 25 cm of layout circle arc. Every found direction would be recorded as a Tzolk'in date. If half day points were added to the time count, then azimuths might have been recorded at accuracies off in a worst case in the range of 0.35°.

Summarizing the azimuth wheel, in addition to its possible integration with the 260 day count, it has at the very least a general cardinal image—meridians and west-east cardinals—as well as some coincidence with solar year directions. Yet from all indications, most sites, aside from La Venta, do not rely upon solar directions to either locate the site or lay out primary geometry of the ceremonial settings—even though many architectural features may well be aligned to solar year astronomical phenomena. Intuitively, given the complexity of the Olmec azimuth frame, timing of related ritual cannot rely primarily on solar year markers. These directions are too ubiquitous and hence do not temporally and socially distinguish, nor integrate different social groups across a well populated landscape.

## 1.7.2 Sky maps and time

Linda Schele's "encounter with creation" paints a persuasive alternative kind of sacred map, one not laid out on a frame of landscape features, but one defined in the physical realm by the Milky Way and constellations, particularly Orion (Freidel, et.al.1993:75-106). In several places in this segment of their volume on the Maya Cosmos, myth speaks of celestial frames for rituals of the gods which are homologic to maps on the earth, e.g. Shele (79) says: "I realized that since the sky was still lying down upon the earth on 4 Ahaw 8 Kumk'u, the act of seating the stones [Orion's belt] in the triangular pattern of the earth created an image on the face of the earth and in the sky at the same time. The two were, after all, then joined together".

Schele's encounter, however, is focused almost exclusively on sky maps in the absence of attempts to find corresponding maps in the larger landscape. She describes multiple sky patterns that focus on the Milky Way as all-powerful *axis mundi* as it moves to a vertical position

at certain times of night and year; equally important in her analysis of the sky from myth, EQUINOX : MAR. 21, 500 B.C. 22:15 SOLSTICE : DEC. 21, 500 B.C. 4:15



Figure 52. Reflected azimuth orientations of meridian from Orion's Belt to north polar point and Milky Way diagonal as seen at spring equinox and winter solstice, 500 B.C.; fall equinox has no night sky meridian and at summer solstice Orion not visible at night.

particularly the *Popoh Vuh*, is the spatial concept of hearth, as the three stars of Orion move to prominent positions informed by the actions of creator gods. The ecliptic, or path that the constellations take, is also a place for symbolic action.

The first two of these spatial concepts at least, are quickly recognized in patterns thus far described in the Olmec frame. First, as seen from the Northern Hemisphere, all stars rotate about a north point, as today's pole star, disappearing for significant periods of time at both nightly and yearly scales. While all stars we see with the naked eye are in our own Milky Way galaxy, the "haze" that runs linearly across the sky is the intensity of stars as seen from within the galactic plane. Thus, unlike relatively few brighter stars and their abstract constellation patterns, the Milky Way can only be defined primarily for its general linear orientation rather than any layout based on specific stars. Shele, an artist by education, illustrates dramatic images of how the *axis mundi* Maize Tree can be superimposed over a "vertical" Milky Way, page 83. From a perspective of highly accurate large-scale land surveying, however, it can be noted that in the Mesoamerican latitudes, the Milky Way never really stands vertical, lying always off 10-15 degrees during the half of the year when it comes closest. One recognizes that watching the Milky Way transform itself from a curved feature running across the northern sky to a more or less vertical could be a symbolically interpreted event.

When the Milky Way does stand, as recognized by Shele, the Mayan hearth as the three stars of Orion's Belt, lies at the center of the canted *axis mundi*, thus integrating the two key night phenomena. More frequently associated with a meridian position of Orion however, may well be the times when the Milky Way locates itself as a clearer diagonal running from NW to SE. The sky maps of figure 52 show this configuration of the two features at specific times of night during Equinox and Solstice dates. The pattern also occurs many times at other nights of the year (Orion not visible at summer solstice). In looking at frequently occuring examples of this relationship, a first pattern of a somewhat more geometrically accurate symbolism might occur as a meridian axis from Orion's Belt up to a north point in the void a few degrees west of today's pole star. This point in the void could quite easily be understood by sighting from some true north linear feature on the ground. Then, the Milky Way diagonal that occurs each time the hearth moves to the *axis mundi*, not only seems somewhat more linear and definable—though still nothing as aligned as the Orion vertical—but may coincidentally reproduce the most important line of the Olmec Frame, the azimuth La Venta-El Chiflón-Atitlán X at about 222.4°.

It is important to note here the translation process as one attempts to map coincidence between sky and earth patterns. In two places in Shele's section in the Maya Cosmos, where the orientation of an architectural feature is the focus, the star map associated with the feature is vertically reflected so that what is west in the sky becomes east on the ground, and vice-versa. In the present illustrations, all sky maps are already reflected, to be ready to associate with earth patterns.

Powerful is Shele's art association of mythic actions of paddling gods and the sky canoe with the Milky Way (pg. 90, 91,93). The rotation of the Milky Way can vary in these associations, while usually involving some climatic event at Orion. Is it possible, altering Shele's views a bit, that the paddling expression might have been most powerful when the Milky Way rotates to a coincidence with La Venta – El Chiflón – Atitlán X ? The interim point of the El Chiflón cascades now seems clearly associated not only with recurring hearth symbolism at multiple sites, but perhaps even with tiered section of the large pyramid at Calakmul.

## 1.7.3 Temple 22's integration with the Copán hearth grid

Though not emphasized by Shele, two additional sky elements can be added, the fairly accurate azimuths from Orion rise and set points on the horizon up to the pole point. While such simple sky patterns would have been available at many times for many people anywhere in the Olmec Frame, it may have been possible to integrate them into the azimuth based ritual system. As an example, one can look at the way night patterns at two long count dates at Copán might have been involved in the positioning and following layout of Temple 22.

On Tuesday, July 6, the king 18-Rabbit ascended to the throne at Copán. That night there was no vertical stand of the Milky Way, but the Orion set at 10:30 created an approximate azimuth of  $309^{\circ}$  running from SW to NE. The frame azimuth most closely associated with this direction is Atitlán X – East X ( $311.32^{\circ}$ ), a direction that occurs four times in the layout of Copán. The second date is Sunday, November 29, 711 when Temple 22 was dedicated (date on its threshold). On this auspicious night, Orion has both a rise point to the east and a vertical stand at six in the morning. The fact that the earlier rise occurs very close to midnight—often associated with an *axis mundi* in traditional cultures--may have added additional symbolism to the final Orion based meridian. The azimuth of the Orion rise at this date is about  $231^{\circ}$  and does

# TEMPLE 22's INTEGRATION WITH COPAN HEARTH GRID



as expressed in Orion meridian and Milky Way azimuths reflected in site layout; note that the Orion rise azimuth does match azimuths of the frame as thus far simulated.

Sky above 17°N 94°W at Sun 711 Nov 29 0:10 UTC

TEMPLE 22

MILKY WAY AT **ORION MERIDIAN**  not immediately associate with any previously identified Copán lines. But as with all Orion stands, a Milky Way axis also occurs at the same time, again this is about 222° an azimuth which occurs twice in the Copán layout. Is it possible that at least three of the possible sky azimuths could have been involved in locating Temple 22, along with frame directions seen in figure 54?

The general site location of Temple 22, one of the most sculpturally affluent of all Mayan temples (von Schwerin 2011), again serves to culminate the ritual sequence moving from the north down around Temple 16 (Atitlán X?) and then north again. Was there a royal ascension line (the roughly identical Orion set to polar north line and the Atitlán X – East X azimuth) from the Caimen platform (prominent on Temple 16's alignment with Atitlán X and Tacana) up to Temple 22? If so, had it early in the Copán layout been preordained not only for the ascension of an important king, but for his later temple and site climax? It is symbolically interesting that this ascension line pointing to the eventual Temple 22 runs nearly perpendicular (91.06°) to the all-important azimuth La Venta – El Chiflón – Atitlán X, also the Milky Way when Orion forms its meridian with the north polar point at that time. Is it as if the king, on his way to his temple passes through the sacred cascades of El Chiflón? It is the often-reproduced image of the gods of the Milky Way that informs the threshold to the central chamber of Temple 22. (Shele et. al. pg. 85). Whether or not the front door to the temple is on a meridian with a point near the SE corner of Temple 16 and Stela 11 remains to be more accurately seen.

The precise positioning of Temple 22's possible first feature, its front entrance may have been at the intersection of the ascension line and the upper line of the principal hearth plan at this time, i.e. the El Chiflón – East X azimuth that runs from feature 7 across through the plaza feature at the base of Temple 11's north stairs. This line too might always have been intended to run to the entrance of the climatic Temple 22.

Through this first point, then could have been laid out a line perpendicular to the primary Copán to San Salvador axis of the acropolis. With these points established, designers would have now established both the primary orientation of the temple and its width (drawing "A" in figure 54). Plan drawing "B" then shows how the "Milky Way" diagonal (La Venta – El Chiflón – Atitlán X), along with the Atitlán X – Atitlán Medio azimuth (identical with East X – Tikal) helps lay out the Milky Way frieze chamber. This latter line occurs at larger scale at Copán, three times at Piedras Negras, and twice at Palenque. Then in drawing "C" the El Chiflón – East



X azimuth is reused along with a perpendicular to the major Calakmul – Tikal – Copán azimuth to finally position the principal and lateral chambers.

Drawing "D" expresses the way the principal hearth map pervasive in the larger Copán layout—La Venta, Atitlán X, and East X at the vertexes--resides in the ultimate plan of Temple 22. While the "East X" point of the hearth is perhaps less impressive despite its two possible points along its eastern heath azimuth, "Atitlán X" as the center of the temple entrance space and "La Venta" as NW corner of the temple are much more so.

The final image of figure 54 shows the Milky Way frieze as seen looking north in front of the door to the principal chamber of Temple 22. Shele's reproduction of the frieze (85) is side by side with a sky map of the Milky Way with a highly irregular line added as an outline. The time of this sky map is sunset at winter solstice, December 21. The orientation of the frieze on Temple 22's longitudinal axis is about seven degrees south of due east (perpendicular to Copán – San Salvador, 352.69996). In looking up the sky map at this time in 711 A.D. the Milky Way actually appears to have a cant the opposite direction, i.e. north of due east. Furthermore, prior to this sunset time on the winter solstice, as seen in figure 52, Orion would have formed a meridian with the north point at 4:00 am that night, with its accompanying major hearth axis of about 222° as the Milky Way always lines up.

Contrary to Shele's solstice interpretation of the frieze's orientation, it may be more likely that its direction itself does not replicate star patterns, rather the symbolic, ritually used threshold between the climax of the Copán site and the volcano San Salvador, with all its expressive frame power thus far simulated. Yet one should not diminish Shele's overall interpretations the Milky Way and Orion as mythic images of hearth and *axis mundi* meanings of the vertical as threshold between sky and earth worlds. Rather than think of the frieze as primarily linked with solstice time, the present simulation of the Temple's positioning with 1) the king's ascension axis, 2) the bisecting of the "Milky Way" west hearth azimuth, and 3) the possible meridian from the Stela 11 area all speak louder, perhaps to its sky meaning.

# 2.0 Probability Exercises

Today one can find many websites by affectionados of the prehistoric that draw lines between ancient sites on maps claiming that they were intentionally aligned. In reviewed archaeological literature, in contrast, virtually no such assertions exist except in cases where physical roads or causeways are discovered. Alignments of points or sites is perhaps the simplest of geometric patterns possible in design. Virtually no discourse exists about how one can statistically prove that geometric patterns are designed and not random phenomena, even with the simplest of patterns such as a three-point alignment. To both architects and archaeologists, a designed artifact is obvious to the eye, and needs no computer testing to distinguish from the random. Many geometric aspects of the Olmec Frame simulated in section one of this report, seem to the designer to be more artifact than the result of chance. And given the complexity of frame patterns, and the absence of probability testing for even simple patterns like alignments, it seems unlikely that the following statistical tests, rudimentary as they are, can reasonably comment on possible "artificiality" of the total frame. Or so it would seem.

# 2.1 Analysis of three-point alignments among 50 early Mayan sites

## 2.1.1 Background and Site selection

The following are results of previously unpublished work done just prior to the design exploration of the Olmec Frame. In contrast to the *simulation* of possible frame patterns through architectural expertize, modest scientific methods can discern *probabilities* that very simple geometric elements, here three-point alignments, may have been (intentionally) designed. It should be pointed out from the outset, however, that the following exercises do not claim that the overwhelming majority of mathematically described existing large-scale alignments are in fact designed. Most are random phenomena. To discover which patterns might hold the most promise to have been designed one compares the geometric patterns of existing site points in the larger landscape with some number of sets of randomly generated points in comparable areas. This limited research rests on the following generalizations:

1. <u>Mayan surveying technology</u>: can one assume that a culture in possession of clearly demonstrated mathematical and architectural expertise could have surveyed large scale geometry with some precision (see again Doxtater 2009, 2019a)?

2. <u>Large-scale vs. small scale formalization</u>: alignments or axes in the larger landscape are not dissimilar in kind to ritual layouts of religious features at building or city scales. This assertion is of course at the core of the frame simulation but can be assumed much more broadly.

3. <u>Random large-scale geometry</u>: any set of landscape points of some number will create random formal patterns of geometry at multiple levels of accuracy. Thirty years ago, computer exercises proved this point, e.g. Williamson & Bellamy 1983. Such results were largely used to discredit ideas that prehistoric cultures designed patterns in the landscape. These cultures, however, had no maps or computer knowledge of random patterns among their religiously used built and natural places on the land. Yet given a technical skill to execute accurate, simple surveying, a society might well design larger formalized patterns among sites, holding them to be sacred, even though surrounded by some number of unknown random geometries. Chacoan studies, however, do reveal probable design knowledge of a small number of coincidental formal alignments among wholly natural features. These may have been used to anchor more systematic frameworks used to locate principal ceremonial sites such as great kivas (Doxtater 2019a). For this first Mayan analysis, however, in contrast to the simulation, only six prominent natural features are included, with no special emphasis on coincidental alignments with astronomical events.

4. <u>Choice of sites for analysis</u>: The Mayan prehistoric record spans well over two millennia, and certainly one may be tempted to readily dismiss choosing a set of sites either from a particular archaeologically accepted time period, and/or from criteria of site scale or features in the literature. Only very experienced archaeologists attempt to do this. Ideally the best way around this for present purposes is to find such a piece by wise oldsters, and simply use his/her/their list of sites. Having initially considered the piece by Freidel & Schele (1988) on Late Preclassic" sites to be the solution, it was soon realized that others were also listing earlier sites (e.g. Hansen 1998, Clark 2000), and that the lists among these generalizing authors differed significantly according to their particular agenda. It was experience in analyzing early and later great kiva locations in the Ancestral Pueblo that led to an interest in older sites (Doxtater 2019a, Chapter 2) given their greater involvement in large-scale alignments.

As it turned out the eventual list of "earlier" sites--many of course overlap with later periods--became so large at 50, that the goal of a bullet proof logic of site selection becomes moot. The reason may not be clear to one who doesn't do this kind of existing/random analysis. "Cooking the books" is extremely difficult. With a much smaller number of sites, one could, by trial and error, shop around for sites that create a large number of patterns that nicely exceed anything created by a requisite number of random sets. With 50 sites, however, most of which

seem "earlier", the number of total sites within which to choose would be very large, not to mention the nightmare of trial and error to discover and select existing sites with good looking pattern arrays. The number of alternate sets—using all possible combinations—is exponentially huge. This should become more apparent to the reader, since in the first exercise, the existing sites do OK, but are seriously out performed by a number of random sets. The existing Mayan 50 don't do nearly as well as great kivas in the seemingly less technically accomplished Ancestral Pueblo. The reader is reminded that in these exercises no overall conceptual pattern of frame, or "cosmos" is for the most part tested, rather primarily just the way individual three-point alignments occur among a number of points on the landscape.

The following final list of sites provides the source for plans and dating with some exceptions: 1) Altar de Sacrificios: Willey 1961, 2) Barton Ramie: Petrozza 2015, 3) Becan: Ball 2014, 4) Calakmul: Folan, et.al. 2001, 5) Cerros: Scarborough & Robertson 1986, 6) Chalchuapa (lago): Sharer & Gifford 1970, 7) Chiapa de Corzo: Sullivan 2015, 8) Chinkultic: Cáceres & Juárez 2002, 9) Chocola: Sánchez 2004, 10) Civil: Estrada-Belli et.al. 2003, 11) Colha: Jacob 1995, 12) Copán: Sharer & Traxler 2010, 13) Cuello: site plan from Norman Hammond, 14) Dzibanché: Nalda & Balanzario 2014, 15) Dzibilchaltún: Orlando 2001, 16) **Dzibilnocac**: no site plan found, visible in satellite images, 17) **Edzna**: Benavides 2002, 18) El Baul: Safi, et.al. 2012, 19) El Mirador: Šprajc, et.al. 2009, 20) El Palmar: Doyle 2013, 21) El Porton: Sharer & Sedat 1987, 22) El Tigre: Pacheco 2010, 23) El Tintal: Mejia, et.al. 2005, 24) Homul: Rego 2011, 25) Ixkun: Laporte 1994, 26) Izapa: Lowe 1965, 27) Kaminaljuyu: Cash 2005, 28) Kichpanha: Root-Garey 2010, 29) Kohunlich: Nalda & Balanzario 2014, 30) Komchen: site plan from E. Wyllys Andrews V, 31) La Venta: Clark & Coleman 2014, 32) Lamanai: http://www.lamanai.org.uk/lamanai-maps.html, 33) Los Naranjos: Nell 2002, 34) Nakbe: Hansen 2002, 35) Naranjo: Quintana & Wurster, 2004, 36) **Nixtun-Ch'ich** http://www.itzaarchaeology.com/preclassic-period-nixtun-chich/, 37) Palenque: Sanchez 2005 [site plans for Palenque and Tikal are mislabeled], 38) Quirigua: Sharer 1990, 39) Rio Azul: Adams 1999, 40) San Bartolo: Urquizú & Hurst 2011, 41) San Lorenzo: Hirth et.al. 2013, 42) Seibal: http://io9.gizmodo.com/ancient-maya-discovery-shedsnew-light-on-the-origins-o-481053780, 43) Takalik Abaj: de Lavarreda 1994, 44) Tikal: Ponciano 2011, 45) Uaxactun: Valdéz & Fahsen 1995, 46) Uxul: Benavides 2012, 47)

Xtobo: Anderson 2011, 48) Xultun: Rossi et.al. 2015, 49) Yarumela: Dixon et.al. 1994, 50)Yaxuná: González & Stanton 2014.

Because of work in the prehistoric Southwest, where coincidental alignments between a small number of most prominent natural features appears to found the formalization of the Ancestral Pueblo landscape as early as the 6th century A.D., six natural features in the Mesoamerican region (now better defined in the present simulation) are added to the 50 cultural sites: Orizaba and Popocatepetl again the two highest peaks in the Mexico area, together with Tzomtehuitz and Victoria Peak, both pairs with cardinal east-west alignments, and then the two highest (volcano) peaks of the southern Mayan area, Tajamulco and Tacana (see figure 55). Also, two important Olmec sites, San Lorenzo and La Venta were included in the list of built sites, looking for some indication of influence by these earliest of locations in this probability exercise.



Figure 55. Natural and built site locations from first alignment probability study prior to design simulation.

5. Formal geometry: The test areas of the present analyses are simple rectangles that can be composed to include all landscape areas where sites exist. Given all the possible socioecological reasons for site location, typically considered in depth by archaeologists, how can one just scatter random points on landscape maps and achieve equivalence to existing sites? Certainly computer simulation of functioning landscape morphology today -- for all sorts of reasons, from understanding animal or plant habitats to detecting structures used by terroristswould be able to develop a more definitive discourse. Yet lacking the resources and background to include this technology in the present exercise may not be as critical as it first seems. First, virtually all the landscape where the Maya built their sacred cities lacks large-scale natural or built, formal, geometric Euclidian pattern. While archaeologists have used fractal geometry to analyze architectural or urban features (Brown at.al. 2005), they have not done so at large scales of natural landscape. Fractals, of course, are not primarily about alignments or orientation but really an opposite, the reproduction of interwoven, curvilinear scales of form as might be seen in relatively dense, "organic" urban pattern, perhaps mostly among dwellings. The essential geometry of ritual, as well as for almost all monumental architecture, is Euclidian. Is there any way natural form in the greater Mayan landscape can create Euclidian patterns between sites?

At small scales like Stonehenge, a naturally straight geological track of a few hundred yards points coincidentally to the sunrise at summer solstice and may have been a reason for site location and orientation. At the much larger scales of the present study, up to a thousand kilometers at an extreme, however, no such aligning features exist. Certainly rivers, valleys, or mountain ranges have rough alignments, and might influence a sense of pattern to sites along them, but these are technically gross compared to surveying down close to visual acuity; they are of a different order.

It seems reasonable therefore to disregard as highly improbable that formal, Euclidian large-scale natural form influences location of Mayan sites. This should also be the case for random points. "Non-geometric" issues like adjacency to flowing water including irrigation features, topographic elevation, or access to other natural resources in prehistoric landscapes can also be disregarded, because they do not in themselves contribute to any large-scale Euclidian pattern. Finally, it is true that in the present random test areas, some points will be positioned on sites that are topographically unbuildable. But even if one were able to define all the buildable

land, in which to locate random points, the area would still be quite large, and logically would not influence or contribute to formal Euclidian geometry between sites.

6. Location of analysis point on site: While Mayan ceremonial cities are generally quite large and irregularly laid out, one can position a point in an approximate "center" of the overall built setting. This can be seen in the site sequences of Figure 56 which reproduce the plans of all but two of the 50 sites. Coordinating these site drawing points with accurate latitude/longitude positions is a second issue. Many published drawings precede GIS technology, with no lat/long references provided. While Wikipedia provides lat/long locations of most Mayan sites, it doesn't indicate the location of these reference points on the site. Either by locating some feature on satellite images identifiable on published site plans, or by e-mailing site archaeologists themselves, all points on the 50 sites of the analysis were relatively accurately associated with lat/long numbers. One of the more recent site publications (Anderson 2011) somewhat uniquely provides UTM numbers on the overall plan grid, by which one can establish an accurate position for any feature. The only two sites for which a published plan could not be found were San Lorenzo and Dzibilnocac. The major Olmec site was nevertheless located by published site locations, while at Dzibilnocac the lat/long point of a major feature visible in satellite images was used.

At three of the largest sites, El Mirador, El Tintal, and Tikal, the largest pyramids lie on the perimeter of the overall site and were tested separately from the more central points of the sites. At El Mirador, the number of three-point alignments involving the site center and Danta, the massive pyramid to the east, were identically very low (the center was used). At El Tintal, the involvement was higher for both locations but relatively equal (again the center was used). The largest pyramid at Tikal, Temple IV, however, attracted a higher number of alignments than the overall site center and this point was used. It will later be questioned whether this choice at one site prejudices the comparison by choosing a best point to compare with random phenomea. While Dzibilchaltun is a much smaller site, its pyramid on the causeway to the east was also tested separately, but relatively equal involvement again resulted in using the center point.

\*All sites shown in the analysis are scaled together--including volcanos—and are sequenced in the illustration by size, largest first, as can be roughly approximated. Where possible, site orientations have been adjusted by comparisons to satellite imagery. Illustration borders of site plans are all oriented to true cardinal directions.







Figure 56c. Smallest of 50 sites used in the analysis, scaled together, with latitude and longitude of point used; illustration borders are true cardinal directions.

## 2.1.2 Comparing three-point alignments among existing sites with random sets

A full discussion about present software that defines large-scale of geometrical patterns and compares occurrence among existing and random points can be found in Doxtater (2007). Once the list of 50 "earlier" Mayan sites and six pairs of coincidentally aligned most prominent natural features was assembled, again prior to the design simulation work and independent from those sites, test areas were composed that included all built sites, figure 57. The two sites of San Lorenzo and La Venta, along with the six natural points are held constant or fixed in the tests; thus, the fact that some of these fall outside the test areas does not alter the evaluation. The four natural sites that are located within the test boxes remain "on" in all tests or are not replaced with random sites. In each test random points are generated in each rectangular area equal to the number of existing sites within.

From previous work with Chacoan great kiva sites, accuracies in a range from  $0.05^{\circ}$  to  $0.15^{\circ}$  adequately captured three-point alignments that might possibly have been prehistorically surveyed. Thus, in this first probability exercise, an accuracy of 0.10 is used, for both existing and random points; this is incidentally right about the alignment relationship between Yaxchilan, Bonampak and Tajamulco discussed early on in this volume (the average deviation of the El
Chiflón point from the La Venta – Atitlán X line is 0.033°, and the deviation of the Atitlán X point from the Orizaba – San Salvador line is an overly accurate 0.0008°). Angular relationships among all possible threesomes of sites are calculated. Then a search is made of all pairs of three-point accuracies that when averaged together is at or less than the deviation set in application options, in this case 0.10°. The average is a measure that considers both deviations of the interim point from each end of the line, which unless the interim point is exactly in the middle, differ because of the two different line lengths. One can additionally search for some number of individual three-point alignments that internally have pairs of sites in common with others, i.e. finding alignments with more than three points. The first comparisons with random phenomena, however, are restricted to only individual three-point alignments. Several existing alignments with more than three points will be described later.

The set of 50 existing "earlier" sites, together with 6 natural features, creates 48 three-point alignments within the 0.10° range of accuracy. As seen in the upper portion of figure 57, six of the existing sites are not involved in any alignments, Dzibalchaltun, Cerros, Nakbe, Naranjo, Palenque, and La Venta; among the natural points, Popocatepetl and Victoria Peak have no involvement. The visual pattern of the 48 existing three-point alignments seems initially interesting in its inclusion of almost 90% of the sites and its apparent intensity at Tikal.

When one runs comparative tests of 100 sets of 50 random points each, however, it is immediately clear that this number of points, at this accuracy and scale, produces a large number of three-point alignments! The set of existing sites is only around the 75<sup>th</sup> percentile, with 24 of 100 random sets equal to or exceeding the existing. The highest random set generates 54 three-point alignments, while the lowest has 24—compared again to the existing 45. When looking at these two random sets, highest and lowest, diagraming their alignments as figure 58, one sees less focus of lines in the lowest set, but in the highest an intensity occurs in the central area not that dissimilar from the existing pattern.

At this point in pretests, one considers just quitting the probability project. Even though larger numbers of random alignments do not logically rule out some designed patterns among existing sites, the case seemed intuitively less promising. Chapter 2 in work with Ancestral Pueblo locations (Doxtater forthcoming), makes a stronger argument by comparison. When testing 61 great kiva sites from Basketmaker III – Pueblo III (seven in Chaco Canyon), including





Figure 57. Existing three-point alignments (48) among 50 sites and 6 natural features at 0.10° accuracy (above, sites not involved circled); test areas where equivalent numbers of random points replace existing sites (below, natural features circled).





Figure 58. Lowest and highest numbers of random three-point alignments among 100 sets @ 0.10°; numbers indicate test area and random point in the set.

21 most prominent natural features: at an accuracy of  $0.105^{\circ}$  the existing matches the highest random (149); at  $0.12^{\circ}$  the existing exceeds the highest random by three (164/161); at  $0.135^{\circ}$  the existing exceeds the highest random by six (195-189); and at  $0.15^{\circ}$  the existing is one less than the highest random (210/211). Great kivas have a relatively high probability of participating in some formalization on the Southern Colorado Plateau; many of the more interesting patterns are defined and explained in this forthcoming volume.



### 2.1.3 Using Doyle's Middle Pre-Classic E-Group sites to test alignments

Figure 59. Viewshed territories of seven early sites reproduced from Doyle 2012 (left); test area where random points are substituted in 100 sets of seven each while 43 sites are held constant (right).



In tracking down a good site plan for El Palmar, the author ran across the landscape ideas of James Doyle in his piece about early E-Groups (2012). Without attempting to engage the copious Mayan literature he cites, one can extract issues related to the present analysis. His ideas come primarily from GIS methodology *per se*, more so perhaps than from any thread of archaeological investigation and theory about spatial relationships between sites. Doyle uses commonly used GIS tools to map viewsheds between 22 Middle Preclassic sites with an E-group, essentially in the area around Tikal and its neighbor to the west, El Palmar. His effort

supposes that early on, some "ritual" purpose, i.e. a context of social relationships, influenced the choice of site location.

Doyle's landscape map reproduced in figure 59 (2012:367) focuses on seven Middle Preclassic E-group sites where GIS analysis most clearly illustrates his argument. Here is a group of sites selected by a mainstream Mayan archaeologist which are argued *to have been intentionally located in part by defined social relationships between them*. Without attempting to overlay "E-group" discourse to analysis of large-scale alignments—there are, with the exception of Tikal, no site features, only chosen "central" points—what happens if one tests Doyle's seven sites against random alignment phenomena? While they are chosen because they seem to allude broadly to socially influenced site selection, most importantly, someone other than the present author did the choosing.

Figure 59 also illustrates the test area drawn around the seven sites of Nakbe, El Palmar, Tikal, Uaxactun, San Bartolo, Cival, and Naranjo. Seven random points are substituted in each of 100 sets, while the rest of the 50 existing sites (43), together with the six natural features are held constant in each test. The number of three-point alignments involved in each of the seven random points is recorded; this includes alignments with both the 43+6 constants, and with other random points of the seven. The total number of alignments for each random set is also recorded. One additional measure tracks how the number of alignments per site (among the seven and among the existing) varies with the size of the site. One of the purposes of scaling all 50 existing sites together is to allow an approximate ranking of the sites primarily by size of built area. Doyle's seven existing sites rank: 1) Tikal, 2) Nakbe, 3) Narango, 4) Uaxactun, 5) San Bartolo, 6) Cival, 7) El Palmar. For each random set, the numbers one through seven imitate a site size ranking; "1" is the largest, "7" the smallest.

Numbers from the test of 100 sets of seven random points each at 0.10° accuracy are listed in Figure 60. Doyle's seven existing Middle Preclassic sites are involved in 25 total three-point alignments, just over half of the 48 total for all existing sites as recorded for the first exercise. Restricting the comparison with random points to only these seven in the test area—in this second set of 100 -- has the effect of increasing the comparative performance of the existing sites. In terms of the seven, only one random set of 100 is higher than the existing, 26 vs. 25 alignments. Even the total for all 50 built plus 6 natural points is much closer; there are three

EXISTING SITE SET @ 0.10 alignments per Doyle's seven sites 25 (49):1-9,2-0, 3-0, 4-4, 5-5, 6-3, 7-4 100 SETS - 7 RANDOM PTS. EACH alignments per each random point	16 (43): 1-4, 2-2, 3-2, 4-4, 5-4, 6-0, 7-0 [12] 16 (43): 1-3, 2-3, 3-1, 4-2, 5-2, 6-2, 7-3 [15] 16 (41): 1-0, 2-5, 3-1, 4-3, 5-1, 6-4, 7-2 [25] 16 (43): 1-3, 2-2, 3-2, 4-4, 5-4, 6-0, 7-1 [33] 16 (44): 1-4, 2-4, 3-3, 4-1, 5-1, 6-2, 7-1 [42] 16 (44): 1-4, 2-2, 3-2, 4-1, 5-3, 6-2, 7-2 [45] 16 (45): 1-1, 2-3, 3-4, 4-2, 5-3, 6-1, 7-2 [47] 16 (43): 1-2, 2-2, 3-4, 4-3, 5-2, 6-1, 7-2 [54]
26 (50): 1-2, 2-2, 3-6, 4-5, 5-3, 6-6, 7-2 [97] 25 (50): 1-6, 2-3, 3-4, 4-2, 5-4, 6-4, 7-2 [20] 24 (47): 1-2, 2-1, 3-2, 4-1, 5-3, 6-5, (7-10) [31] 24 (50): 1-6, 2-3, 3-3, 4-2, 5-5, 6-2, 7-3 [73] 24 (47): 1-1, 2-1, 3-5, 4-6, 5-6, 6-3, 7-2 [75] 23 (49): 1-5, 2-4, 3-3, 4-5, 5-2, 6-4, 7-0 [24] 23 (45): (1-7, 2-1, 3-3, 4-3, 5-4, 6-2, 7-3 [61] 23 (49): 1-4, 2-2, 3-4, 4-3, 5-3, 6-5, 7-2 [91] 22 (46): 1-2, 2-1, 3-3, 4-5, 5-2, 6-4, 7-5 [65] 22 (46): 1-2, 2-1, 3-3, 4-5, 5-2, 6-4, 7-5 [95] 21 (46): 1-4, 2-0, 3-4, 4-3, 5-5, 6-2, 7-3 [40] 21 (44): 1-4, 2-3, 3-5, 4-2, 5-7, 6-3, 7-1 [43] 21 (44): 1-4, 2-3, 3-5, 4-2, 5-4, 6-2, 7-1 [55] 21 (46): 1-2, 2-0, 3-1, 4-6, 5-6, 6-4, 7-2 [96] 20 (46): 1-3, 2-3, 3-3, 4-3, 5-5, 6-1, 7-4 [8] 20 (46): 1-3, 2-3, 3-3, 4-3, 5-5, 6-1, 7-4 [8] 20 (46): 1-3, 2-3, 3-3, 4-3, 5-1, 6-3, 7-4 [9] 20 (45): 1-4, 2-3, 3-2, 4-2, 5-3, 6-5, 7-1 [29] 20 (44): 1-4, 2-2, 3-4, 4-1, 5-3, 6-2, 7-4 [48] 20 (44): 1-5 (2-8), 3-2, 4-1, 5-1, 6-1, 7-2 [57] 20 (44): 1-4, 2-2, 3-4, 4-1, 5-3, 6-2, 7-3 [66] 20 (44): 1-5 (2-8), 3-2, 4-1, 5-1, 6-1, 7-3 [78] 20 (44): 1-2, 2-0, 3-6, 4-2, 5-0, 6-4, 7-6 [79] 20 (44): 1-2, 2-2, 3-7, 4-3, 5-1, 6-2, 7-3 [82] 19 (46): 1-4, 2-0, 3-2, 4-3, 5-5, 6-2, 7-3 [30] 19 (44): 1-3, 2-4, 3-2, 4-3, 5-1, 6-4, 7-2 [56] 19 (44): 1-4, 2-1, 3-4, 4-1, 5-3, 6-2, 7-4 [35] 19 (44): 1-4, 2-1, 3-4, 4-1, 5-3, 6-2, 7-4 [35] 19 (44): 1-4, 2-1, 3-2, 4-4, 5-5, 6-2, 7-4 [35] 19 (44): 1-4, 2-1, 3-2, 4-3, 5-1, 6-4, 7-2 [56] 19 (44): 1-1, 2-4, 3-2, 4-3, 5-1, 6-4, 7-2 [56] 19 (44): 1-1, 2-4, 3-2, 4-3, 5-1, 6-4, 7-2 [57] 18 (44): 1-3, 2-4, 3-2, 4-3, 5-1, 6-4, 7-2 [27] 18 (44): 1-3, 2-4, 3-2, 4-3, 5-1, 6-4, 7-2 [27] 18 (44): 1-3, 2-4, 3-2, 4-3, 5-1, 6-4, 7-2 [27] 18 (44): 1-3, 2-4, 3-2, 4-3, 5-1, 6-4, 7-1 [37] 18 (46): 1-1, 2-4, 3-3, 4-2, 5-3, 6-1, 7-4 [33] 19 (43): 1-1, 2-1, 3-3, 4-2, 5-4, 6-5, 7-0 [85] 18 (45): 1-1, 2-2, 3-3, 4-1, 5-2, 6-2, 7-4 [68] 18 (45): 1-1, 2-4, 3-3, 4-2, 5-4, 6-5, 7-0 [85] 19 (44): 1-4, 2-2, 3-1, 4-4, 5-4, 6-5, 7-0 [85] 19 (45): 1-4, 2-2, 3-1, 4-4, 5-4,	16 (42): 1-3, 2-4, 3-1, 4-4, 5-0, 6-3, 7-1 [71] 16 (45): 1-3, 2-1, 3-0, 4-2, 5-4, 6-2, 7-4 [74] 16 (43): 1-3, 2-0, 3-4, 4-1, 5-1, 6-4, 7-3 [81] 16 (41): 1-3, 2-2, 3-3, 4-2, 5-5, 6-0, 7-1 [99] 16 (39): 1-4, 2-2, 3-2, 4-2, 5-2, 6-2, 7-2 [51] 16 (42): 1-3, 2-4, 3-2, 4-3, 5-1, 6-4, 7-3 [52] 15 (44): 1-3, 2-4, 3-2, 4-3, 5-1, 6-1, 7-1 [5] 15 (43): 1-1, 2-2, 3-3, 4-4, 5-5, 6-2, 7-2 [6] 15 (44): 1-5, 2-3, 3-3, 4-0, 5-1, 6-2, 7-1 [10] 15 (40): 1-2, 2-2, 3-3, 4-4, 5-6, 6-3, 7-1 [63] 15 (42): 1-5, 2-2, 3-2, 4-3, 5-1, 6-1, 7-1 [64] 15 (42): 1-5, 2-2, 3-2, 4-4, 5-0, 6-3, 7-1 [63] 15 (42): 1-1, 2-2, 3-3, 4-4, 5-2, 6-3, 7-2 [72] 15 (42): 1-1, 2-2, 3-3, 4-2, 5-2, 6-3, 7-2 [72] 15 (42): 1-1, 2-3, 3-5, 4-1, 5-2, 6-3, 7-0 [87] 15 (40): 1-0, 2-1, 3-2, 4-2, 5-2, 6-3, 7-5 [90] 14 (43): 1-2, 2-2, 3-2, 4-4, 5-4, 6-0, 7-0 [1] 14 (45): 1-1, 2-3, 3-3, 4-2, 5-2, 6-1, 7-2 [2] 14 (40): 1-2, 2-2, 3-2, 4-4, 5-4, 6-4, 7-0 [26] 14 (42): 1-2, 2-2, 3-2, 4-4, 5-4, 6-4, 7-0 [26] 14 (42): 1-2, 2-2, 3-2, 4-2, 5-0, 6-1, 7-5 [53] 14 (40): 1-1, 2-1, 3-2, 4-5, 5-1, 6-2, 7-2 [69] 14 (39): 1-3, 2-2, 3-2, 4-2, 5-0, 6-1, 7-3 [59] 14 (39): 1-1, 2-1, 3-2, 4-5, 5-1, 6-2, 7-2 [69] 14 (40): 1-3, 2-0, 3-2, 4-2, 5-2, 6-1, 7-4 [80] 14 (40): 1-3, 2-0, 3-2, 4-2, 5-2, 6-2, 7-3 [86] 14 (40): 1-3, 2-3, 3-0, 4-1, 5-0, 6-3, 7-4 [89] 14 (41): 1-2, 2-2, 3-1, 4-3, 5-1, 6-2, 7-2 [34] 14 (41): 1-2, 2-2, 3-1, 4-4, 5-2, 6-1, 7-3 [37] 13 (38): 1-2, 2-2, 3-1, 4-4, 5-2, 6-1, 6-3 [58] 13 (38): 1-1, 2-1, 3-2, 4-3, 5-1, 6-2, 7-3 [23] 13 (38): 1-2, 2-2, 3-0, 4-1, 5-4, 6-2, 6-2, [28] 11 (39): 1-2, 2-2, 3-0, 4-1, 5-4, 6-2, 7-2 [34] 14 (39): 1-2, 2-2, 3-0, 4-1, 5-4, 6-2, 7-2 [34] 14 (39): 1-2, 2-2, 3-0, 4-1, 5-4, 6-2, 7-2 [34] 14 (39): 1-2, 2-2, 3-2, 4-2, 5-2, 6-1, 7-3 [62] 13 (40): 1-2, 2-2, 3-2, 4-2, 5-2, 6-1, 7-2 [75] 11 (37): 1-0, 2-2, 3-0, 4-1, 5-4, 6-2, 7-2 [39] 11 (39): 1-0, 2-0, 3-4, 4-2, 5-2, 6-1, 7-2 [75] 11 (39): 1-1, 2-1, 3-2, 4-0, 5-1, 6-2, 7-2 [78] 9 (36): 1-2, 2-1, 3-0, 4-1, 5-1, 6-2, 7-2 [78]
18 (44): 1-2, 2-1, 3-3, 4-1, 5-3, 6-4, 7-4 [88] 18 (46): 1-1, 2-0, 3-6, 4-1, 5-6, 6-0, 7-4 [92] 17 (44): 1-5, 2-4, 3-3, 4-1, 5-3, 6-1, 7-4 [3] 17 (44): 1-5, 2-3, 3-2, 4-1, 5-3, 6-2, 7-1 [11] 17 (44): 1-5, 2-3, 3-2, 4-1, 5-3, 6-2, 7-1 [21] 17 (44): 1-5, 2-4, 3-3, 4-1, 5-1, 6-2, 7-1 [21] 17 (44): 1-5, 2-4, 3-3, 4-1, 5-3, 6-2, 7-3 [17] 17 (44): 1-3, 2-2, 3-3, 4-1, 5-3, 6-1, 7-4 [14] 17 (44): 1-5, 2-2, 3-2, 4-1, 5-3, 6-2, 7-2 [32] 17 (43): 1-3, 2-3, 3-1, 4-3, 5-2, 6-2, 7-3 [36] 17 (43): 1-4, 2-2, 3-2, 4-4, 5-4, 6-0, 7-1 [46] 17 (43): 1-4, 2-2, 3-2, 4-4, 5-4, 6-0, 7-1 [46]	Figure 60. Total of alignments in each of 100 sets of seven random points each @ 0.10°; breakdown of each set as to numbers of alignments associat- ed with each of its seven, ranked from 1-7 to indicate largest to smallest site.
17 (42): 1-3, 2-1, 3-3, 4-1, 3-3, 6-4, 7-0 [84] 17 (42): 1-1, 2-3, 3-1, 4-4, 5-5, 6-2, 7-1 [98] 17 (42): 1-2, 2-1, 3-2, 4-5, 5-2, 6-2, 7-3 [100] 16 (43): 1-3, 2-2, 3-1, 4-3, 5-2, 6-2, 7-3 [4]	

random sets of the 100 with 50 alignments, while the existing is next in line with 48, which it shares with two of the random.

The way the number of involved alignments associates with the scale of the seven sites raises additional interest. In the existing, Tikal has a highest of 9 alignments associated with the largest site. The highest number of alignments associated with any random point of the 700 is 10, linked to the 7<sup>th</sup> largest site of set number 31; set 57 has 8 alignments associated with the number 2 random site. The best number one random site has 7 (set number 61). This site scale relationship with alignments, however, does not hold for the rest of the existing sites. Neither Nakbe nor Naranjo have any alignments at 0.10°, and the second highest number after Tikal occurs at San Bartolo with 5. Uaxactun and El Palmar both have 4, and Cival 3.

To more fully test a range of accuracy, the high used in the author's Chaco work, 0.15° was used to generate a third comparative exercise of 100 sets, again focusing only on Doyle's seven sites. Listed in figure 61 are the highest 21 of the 100 sets of 7 random points each. In this case both the total involvement of the seven, and the total overall numbers of alignments becomes more positive for the random. The existing seven at 0.15° themselves create involvement of 38 alignments, while six of the random sets exceed this number, with a high outlier of 49. Looking at total involvement of all 56 locations, the comparison narrows a bit. The existing has 72, exceeded by only two of the random, with the high outlier clocking in at 78.

Temple IV, the selected point for Tikal, performs even better at 0.15°. It not only outdistances the highest random number for any of the 700 random points, 15 vs. 11 (site 6, set 81), but associates with the largest approximate site area of the existing seven. The highest random point involvement with alignments of the 700, associating with a number1 site, is 8 (sets 71 and 65). Curiously, the second most involved site of the seven in the 0.10° test, San Bartolo, keeps pace with Tikal at 0.15°, almost doubling its number of alignments from 5 to 9. There are only 3 of the random 700 that involve more alignments than San Bartolo, with two additional others having 9 (in the list of figure 61). Nakbe still has no alignments, while Naranjo picks up 2. Uaxactun stays the same, and El Palmar gains 1.

To what extent did the choice of using Temple IV prejudice this comparison? In one sense its use does not vary from choosing a central point of much smaller sites. While this work hasn't

EXISTING SITE SET @ 0.15 alignments per Doyle's seven sites 38 (72): (1-15) 2-0, 3-2, 4-4, 5-9, 6-3, 7-5 HIGHEST 21 OF 100 SETS 7 PTS. EA. alignments per each random point 49 (78):1-6, 2-7, 3-9, 4-5, 5-7 (6-10) 7-5 [53] 39 (73): 1-4, 2-6, 3-6, 4-9, 5-4, 6-8, 7-2 [25] 35 (71): 1-5, 2-1(3-12) 4-6, 5-5, 6-3, 7-3 [34] **39** (71) 1-5, 2-7, 3-8, 4-6, 5-6, 6-5, 7-2 [45] **35** (70) 1-8, 2-4, 3-2, 4-4, 5-5, 6-5, 7-7 [71] 39 (70): 4-6, 2-7, 3-3, 4-5, 5-3 (6-11) 7-4 [81] 38 (69): 1-5, 2-4, 3-5, 4-4, 5-8, 6-7, 7-5 [70 34 (69): 1-2, 2-5, 3-6, 4-5, 5-7, 6-6, 7-3 [90 7-5 170 38 (68): 1-4, 2-3, 3-6, 4-6, 5-5, 6-8, 7-6 [50] 33 (68): 1-3, 2-3, 3-6, 4-4, 5-8, 6-7, 7-4 [58] 31 (68): 1-6, 2-4, 3-5, 4-3, 5-5, 6-3, 7-6 [64] 34 (68): 1-4, 2-4, 3-8, 4-5, 5-5, 6-4, 7-4 [74] 32 (67): 1-7, 2-3, 3-4, 4-3, 5-5, 6-4, 7-6 [9] 33 (67): 1-5, 2-6, 3-5, 4-3, 5-2, 6-4, 7-8 [10] 33 (67): 1-2, 2-6, 3-4, 4-4, 5-7, 6-3, 7-7 [41] 31 (67)( 1-8,)2-3, 3-2, 4-3, 5-7, 6-1, 7-7 [65] 1-5, 2-4, 3-3, 4-7, 5-4, 6-6, 7-1 [14] 30 (66): 32 (66): 1-5, 2-5, 3-5, 4-5, 5-3, 6-7, 7-2 [19] 28 (66): 1-5, 2-3, 3-2, 4-3, 5-3, 6-7, 7-5 [28] 32 (66): 1-6, 2-8, 3-6, 4-3, 5-1, 6-2, 7-6 [62] 29 (66): 1-3, 2-5, 3-1, 4-3, 5-7, 6-5, 7-5 [95]

Figure 61. Highest 22 alignment totals of 100 sets with 7 random points each @ 0.15<sup>®</sup>; numbers of alignments associated with each point in a set with 1-7 indicating the ranking of site size.

tested a variety of locations in a variety of sized Mayan sites, it is quite likely that in the large majority the location of a single point *anywhere* within the site will only minimally change the number of large scale three – point alignments that connect. This has to do with the large distances of the alignments, and the scale relationship between line accuracy and site size. It is true, however, that at Tikal at least, this isn't so. Temple IV works best. But this really doesn't make any difference, if one assumes that because of the smaller scale of most other sites, the point choosen is also the best point. Thus, this brief study isn't too far off the ideal of choosing the points on existing sites that create the most alignments. As for the random points, given one hundered sets in which to compete with the existing, one can assume that there is ample opportunity for these points to be placed at optimum locations that largely serves as an equivalent to choosing Temple IV.

### 2.1.4 Alignments with Tikal and San Bartolo as focii

These two probability tests were again set up prior to the design simulation that constitutes the first section of this report. At that time three-point alignments were considered as primary large – scale structures, but not envisioned as part of any Olmec Frame. Yet the simulation and probability test converge in that the alignment Calalmul – Tikal – Copán is clearly part of the Olmec Frame, and seems to involve a strong three-point alignment pattern. The present work cannot obviously investigate the positioning and site layouts of some forty additional Mayan sites regarding any possible integration to the frame. Are they integrated, and to what degree are a considerable number of three-point alignments involved? Presently all that can be offered is a limited discussion of three-point alignments independent of frame possibilities, with exception of Calakmul – Tikal – Copán.

At present one should not use the term "design simulation" in discussing the following three-point alignments among Mayan sites that actually exist across the larger landscape. While alignments were more part of design investigations in the Chacoan world and are clearly so with Calakmul – Tikal – Copán, what is being discussed below is for the most part a response to the fact that in all probability some of these alignments were designed, recognizing as well that some are very likely to be random phenomena.

Figures 62 and 63 below show how alignment accuracies scale with Tikal and San Bartolo, the two of the seven sites with the greatest probability of design intent, though with no symbolic or social understanding of why these might be foci. Because of limitation of print space, site "boxes" cannot be graphically aligned with the focus site. Nevertheless, all sites remain scaled together enabling the reader to choose a particular three-point azimuth alignment and inspect the way lines relate spatially to end and interim sites--which are in an approximate geographical position to each other.

Each alignment involvement of two focus sites is illustrated, but only one of the two possible segments (same azimuth) for a three-point alignment is shown. All alignment accuracies in the tests of this study are averages of the two alignment azimuths possible between three points. Again, taken from each end, the angles between the opposite end and the interim point will be different, unless it is positioned exactly in the middle. The accuracy number set in the software setup option is the average of accuracies from both ends, i.e. less than or equal to  $0.15^{\circ}$ .



Figure 62. Fifteen sites aligned with Tikal's Temple IV at or under 0.15°



Figure 63. Nine sites aligned with San Bartolo @ 0.15°.

These two composite illustrations also give the reader a means of assessing the author's assertion that it would be extremely difficult to manipulate locations at almost all sites to maximize some

hypothetical point such as Temple IV at Tikal. With the exception of point selection on the three largest sites mentioned previously, movement of the site point within virtually all the other 47 sites is so relatively small in distance—given the very large distances of the study—that little or no difference is made in the creation of alignments within the larger accuracy limit of 0.15°. If the reader spends enough time imaging the accuracies of the diagrams of figures 62 and 63, and

### ACCURACIES OF ALL 3-PT ALIGNMENTS (72) AMONG EXISTING SITES - UNDER 0.15

< 0.03 [16]

- altar de sacrificioa, cival, lamanai, 305.51843
- chiapa de corzo, chinkultic, copan, 243.68018
- chinkultic, el palmar, colha, 299.26434
- dzibilchaltun, becan, xultun, 182.70245
- el mirador, los naranjos, yarumela, 212.71509
- el porton , el tintal , dzibilchaltun , 354.03884
- el porton, uxul, komchen, 354.47806
- el tigre, altar de sacrificioa, el porton, 190.31121
- izapa , cival , kichpanha , 310.39941
- izapa , nixtun-ch'ich , tikal , 312.83374
- orizaba , uaxactun , homul , 256.19742
- seibal, tikal, dzibanche, 329.63054
- tacana, altar de sacrificioa, cuello, 311.08435
- takalik abaj , el mirador , becan , 330.40659
- takalik abaj , nixtun-ch'ich , rio azul , 322.81420
- takalik abaj , tikal , xultun , 321.48291

### 0.03 - 0.06 [16]

- chalchuapa lago , tikal , dzibilnocac , 359.24017
- chalchuapa lago, uaxactun, dzibilchaltun, 359.43536
- chiapa de corzo , el palmar , homul , 279.08993
- chiapa de corzo, el tintal, kichpanha, 286.31235
- chinkultic, quirigua, los naranjos, 251.74687
- dzibilchaltun, rio azul, quirigua, 185.21248
- el baul, ixkun, colha, 324.56015
- kaminaljuyu, el tintal, dzibilnocac, 349.46834
- komchen, becan, san bartolo, 183.64097
- orizaba , el tigre , lamanai , 260.62932
- quirigua, lamanai, cuello, 351.46272
- san lorzenzo, chiapa de corzo, el porton, 238.65396
- tacana, altar de sacrificioa, tikal, 311.01845
- takalik abaj , el palmar , uaxactun , 323.49002
- tikal, san bartolo, kohunlich, 326.14269
- uxul , los naranjos , yarumela , 212.65963

### 0.06 - 0.09 [11]

- chocola, san bartolo, kohunlich, 326.01765
- edzna, calakmul, quirigua, 194.84751
- el tigre, edzna, dzibilchaltun, 338.42456
- kaminaljuyu , barton ramie , kichpanha , 329.04408

- komchen, cival, quirigua, 185.58981
- san lorzenzo , tzomtehuitz , quirigua , 246.21439
- seibal, el tintal, xtobo, 356.33574
- tacana , el palmar , san bartolo , 312.55491
- tajamulco, edzna, komchen, 340.21047
- tzomtehuitz, el tintal, kichpanha, 286.41793
- uaxactun , xultun , lamanai , 291.61050

### 0.09 - 0.12 [10]

- barton ramie , kohunlich , dzibanche , 352.55772
- calakmul, tikal, copan, 191.17758
- chocola, tikal, kohunlich, 326.08548
- copan, barton ramie, yaxuna, 355.43784
- izapa, nixtun-ch'ich, cerros, 312.94877
- kaminaljuyu, ixkun, cerros, 330.37741
- san lorzenzo, el tintal, san bartolo, 267.42826
- tacana, tikal, cuello, 310.86806
- xtobo , dzibilnocac , becan , 186.44968
- xtobo , san bartolo , copan , 185.48795

### 0.12 - 0.15 [19]

- altar de sacrificioa, tikal, cuello, 310.84154
- calakmul, naranjo, los naranjos, 208.54610
- chalchuapa lago , tikal, dzibilchaltun , 359.43536
- chocola, altar de sacrificioa, el tintal, 334.78285
- chocola, tikal, san bartolo, 326.12815
- dzibilnocac, san bartolo, copan, 185.24290
- el mirador, xultun, barton ramie, 240.38906
- el porton , calakmul , dzibilnocac , 351.97373
- el porton, el palmar, becan, 347.49797
- el tigre , calakmul , cuello , 268.65927
- el tigre, el mirador, san bartolo, 247.24124
- izapa , tikal , cerros , 312.88603
- komchen, homul, quirigua, 185.65312
- nixtun-chich, tikal, cerros, 312.88517
- orizaba, san lorzenzo, chinkultic, 241.14164
- san lorzenzo, palenque, tikal, 264.09480
- seibal, xultun, kohunlich, 327.37415
- tajamulco, seibal, naranjo, 309.07783
- yaxuna , colha , los naranjos , 186.17768

Figure 64. List of accuracies of all 72 three-point alignments of existing sites @ or under 0.15°.

the way lines miss site points--all within 0.15°--this should become evident.

If while imaging these site realities, the reader wishes to know how each of the lines calculates in terms of accuracy, figure 64 lists the averaged accuracies of all 72 alignments that fall within the range of 0.15°. Then for additional understanding, both the involvement of all 56 sites in three-point alignments in the 0.15° range is provided, and the way certain alignments combine with others to create alignments with more than three points. Eight of these are detailed; one "six-pointer", one "five-pointer", and six "four-pointers". Present software

#### THREE POINT ALIGNMENTS WITH SITE PAIRS IN COMMON

<u>6 pt. - Copan, San Bartolo, Becan, Dzibilnocac, Komchen, Xtobo</u> Dzibilnocac, San Bartolo, Copan Xtobo, San Bartolo, Copan Xtobo, Dzibilnocac, Becan Komchen, Becan, San Bartolo

### Tikal "Meridian" and its three 4 pt. alignments

- 5 pt. Chalchuapa Lago, Tikal, Uaxactun, Dzibilnocac, Dzibilchaltun Chalchuapa Lago, Tikal, Dzibilnocac Chalchuapa Lago, Tikal, Dzibilchaltun Chalchuapa Lago, Uaxactun, Dzibilchaltun
- <u>4 pt. Chocola, Tikal, San Bartolo, Kohunlich</u> Chocola, Tikal, Kohunlich Chocola, San Bartolo, Kohunlich Tikal, San Bartolo, Kohunlich Chocola, Tikal, San Bartolo
- <u>4 pt. Tacana, Altar de Sacrificios, Tikal, Cuello</u> Tacana, Tikal, Cuello Tacana, Altar de Sacrificios, Tikal Tacana, Altar de Sacrificios, Cuello Altar de Sacrificios, Tikal, Cuello
- <u>4 pt. Izapa, Nixtun-ch'ich, Tikal, Cerros</u> Izapa, Tikal, Cerros Nixtun-Ch'ich, Tikal, Cerros Izapa, Nixtun-Ch'ich, Cerros Izapa, Nixtun-Ch'ich, Tikal

### Other 4 pt. alignments

- <u>4 pt. Chiapa de Corzo, Tzomtehuitz, El Tintal, Kichpanha</u> Chiapa de Corzo, El Tintal, Kichpanha Tzomtehuitz, El Tintal, Kichpanha
- <u>4 pt. Los Naranjos, Yarumela, El Mirador, Uxul</u> Uxul, Los Narangos, Yarumela El Mirador, Los Naranjos, Yarumela
- 4 pt. Quirigua, Homul, Cival, Komchen Komchen, Cival, Quirigua Komchen, Homul, Quirigua

### ALIGNMENTS INVOLVED EACH SITE @ 0.15

15 tikal 9 san bartolo 7 quirigua 7 el tintal 6 el porton 6 dzibilchaltun 6 altar de sacrificioa 5 xultun 5 san lorzenzo 5 komchen 5 kohunlich 5 el tigre 5 el palmar 5 dzibilnocac 5 cuello 5 copan 5 calakmul 5 becan 4 uaxactun 4 takalik abaj 4 tacana 4 seibal 4 nixtun-chich 4 lamanai 4 kichpanha 4 izapa 4 el mirador

4 chocola

4 chinkultic 4 chiapa de corzo 4 cerros 4 barton ramie 3 xtobo 3 orizaba 3 kaminaliuvu 3 homul 3 edzna 3 colha 3 cival 3 chalchuapa lago 2 yaxuna 2 yarumela 2 uxul 2 tzomtehuitz 2 tajamulco 2 rio azul 2 naranjo E 2 ixkun 2 dzibanche 1 palengue 1 el baul 0 victoria peak 0 popocatepetl 0 nakbe 0 los naranjos 0 la venta

Figure 65. Three-point alignments among existing sites with pairs in common creating four, five and six-point alignments; numbers of alignments at each of the 72 existing locations in the analysis. measures only three-point alignments, again an average of azimuth accuracies taken from both ends regarding the interim site. Subsequently, the software can search for those three-point alignments where some number of sites greater than one overlap, at a particular accuracy. While no mathematically more complex means has been developed by this researcher to precisely describe apparent alignments with more than three points, as a reasonable measure one can consider the accuracies of the three-pointers whose pairs combine. Most persuasive is the accuracy of each component three-pointer, looking for consistency in others that overlap. Yet just because two or more three-pointers all may be quite accurate, and have two points each in common, doesn't mean that relationships between non-overlapping points necessarily conform to that accuracy. If Mayan archaeologists develop an interest in large-scale prehistoric surveying, then possible multiple point alignments, such as the 6-pointer from Copán to Xtobo or Komchenin in figure 65, would need to be more precisely mapped, both in terms of mathematical description and cultural assessment. The two northern sites in this case appear to be alternative end points to some possible line involving Dzibilnocac, Becan, San Bartolo, and Copán

## **2.2** Testing points on the "Olmec Frame" against the first group of Mayan locations

### **2.2.1** Four categories of existing points: natural features, major sites, benchmarks and other early sites tested against random points

Curiously enough, when one compares the involvement of sites in Olmec Frame azimuth lines, figure 49, with involvement in three – point alignments in figure 65 above, one is struck with the fact that La Venta in the first instance is the most involved site, while among the three-point alignment patterns, it has no involvement. How could this be? Even though the design simulation of the first section of this book was done after and independently of the probability tests, and any definitive integration of the two methodologies is far beyond the goal of the present work, one couldn't help but think about combining frame and alignment sites in some simple test against randomness.

With an adjustment of "group membership", primarily separating the small number of sites in the first alignment tests that are part of the frame: Tikal, Copán, Calakmul, Takalik Abaj, Kaminaljuyu, Izapa, and Chocola. In the first tests, a central point was chosen at El Mirador, and in the simulation of the frame, only the Danta point was used which will be the case in the following test. At Tikal, only the Temple IV point continues to be used. La Venta and San Lorenzo in the first alignment tests were not part of the group replaced by random points. They acted like natural features, fixed for both existing and random site locations. Also, in the first alignment test, Yaxchilan and Bonampak, discussed in the introduction to this book, were not included in the large list of "early" sites; in this second testing with frame structure, they are now included in the list of 41 "others". In the following grouping of sites: 1) natural, 2) "benchmarks", 3) "major" sites, and 4) other "early" sites, La Venta and San Lorenzo are included as major sites. Some number of natural features are added to this new test, including San Salvador which wasn't included previously. "Benchmarks" are those points such as Atitlán X or Medio points necessary to construct the frame. Three sites, Monte Alban, Moon Pyramid, and Piedras Negras were not part of the first testing, and are now added as Major Sites. Figure 66 below lists the four groups and illustrates the geographical areas in which numbers of "other early sites" are replaced by random points in the analysis. Natural, Benchmark and Major sites are not replaced by random points but are tested in different combinations against the random replacements of the 41 "other early sites".

When the first test was made using a small number of natural sites with La Venta and San Lorenzo as fixed features, random arrays of replacement points for the early Mayan sites always did better in terms of numbers of three-point alignments than the existing sites. It was only when one restricted the randomization to Doyle's seven early sites, that Tikal and to a lesser extent San Bartolo rose above pure coincidence, seemingly indicating design. Given this propensity among larger numbers of Mayan site locations, one would expect similar results when adding frame points to the mix, especially when considering the lack of La Venta's involvement in producing three-point alignments.

This test focuses on two different kinds of site groups, the first is created by design simulation consisting of 16 Natural Features, 14 Major Sites, and 8 Benchmarks. The other 41 sites are simply a non-frame, non-overlapping list assembled from the archaeological record. Three-point alignments exist as design possibilities in both groups i.e. with the Calakmul – Tikal – Copán alignment and in the meridian and cardinal base lines in the simulation, and in the Other sites as radiating lines out from Tikal and perhaps San Bartolo in the first probability test. The

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NATURAL SITES Acatenango Agua Atitlan Cerro del Aguila Cerro Gordo El Chiflor La Malinche Mount Tlaloc Orizaba San Pedro San Salvador Santa Ana Tacana Tajamulco Tzontehuitz Zempoaltepec	MAJOR SITES Calakmul Chocala Copan Danta Iaminaljuyu Izapa La Venta Monte Alban Moon Pyramid Palenque Piedras Negras San Lorenzo Takalik Abaj Tikal	BENCHMARKS Atitlan Medio Atitlan X Atitlan Zenith Danta Medio East X La Venta Medio San Lorenzo Medio San Salvador Medio	OTHER EARLY SIT Altar de Sacrificio Barton Ramie Becan Bonampak Cerros Chalchuapa Lago Chiapa de Corzo Chinkultic Civil Colha Cuello Dzibalchaltun Dzibalchaltun Dzibalchaltun Dzibilnocac Edzna El Baul El Palmar El Porton El Tigre El Tintal Homul	IXkun Kichpanha Kohunlich Komchen Lamanai Los Naranjos Nakbe Naranjo Nixtun – Chich Quirigua Rio Azul San Bartolo Seibal Uaxactun Uxul Xtobo Xultun Yarmula Yaxchtlan Yaxuna

Figure 66. Test areas for 41 "other sites" replaced by equal numbers of random points in tests (above); lists of 16 "natural features", 14 "major sites" and 8 "benchmarks" held constant in varied combinations to compare numbers of three point alignments among existing sites and those using the 41 random replacements.

simulation group creates several three-point alignments at certain accuracies. The Other nonframe group of 41 sites, also contains some number of random three-point alignments, a moderate number of which show probability of possible design.

To a certain extent the two groups represent a contrast between a largely designed Olmec Frame landscape, and a landscape in which just one design element, the three-point alignment, possibly plays some minor role among probably much random alignment phenomena. What then, would one expect when the two groups are combined? Again, testing for only three-point alignments, given the sizable number of random alignments in the Other 41 and the minor role of alignments *per se* in the Olmec Frame, can one expect design influence in creating alignments when the two groups are combined? What happens when one replaces the Other 41 with an equal number of sites in their respective test areas, while varying the makeup of the three different kinds of sites the simulation group?

In the software list of all site points, one can begin by combining just one of the three simulation subgroups. First the 14 Major Sites can be combined with the 41 Others for a total of 55 existing sites. Then one creates 100 sets each with 41 random points to replace those Other sites not involved in the Olmec Frame design simulation. This evaluates the ability of kinds of sites in the frame to interact with the non-frame sites, again only using three-point alignments as the measure. These tests are run at a more median range of accuracy of 0.075°. As seen in figure 67, the combination of all built sites Majors and Others, even including Tikal, doesn't stand out as creating numbers of three-point alignments different from random phenomena. The number of three-point alignments created by these 55 existing sites is 32, while substituting the 100 random sets of 41 random points each, creates five sets better with a best of 46. Next testing the combination of 16 Natural sites with the 41 Others, which generates 33 alignments among the existing, this number too is similarly below the best random of 43. Then if one tests only the 8 Benchmarks, these plus the 41 existing (49 total) sites create 23 alignments, while the substitution of random points creates 27 of 100 that score better, and a high of 35.

It is logical to next combine the three frame simulation subgroups into pairs. The search is for evidence of the way possibly designed frame elements work together to generate more three-point alignments. Adding the Natural and Major sites to the Other 41 for a total of 71 creates 65 three-point alignments among these existing points on the landscape. Random substitutions of the 41 generates 12 of 100 that are better with a high of 77 alignments. Then pairing up Natural

### 14 MAJOR SITES + 41 RANDOM (0.075)



16 NATURAL SITES + 41 RANDOM (0.075)



8 BENCHMARKS + 41 RANDOM (0.075)



### 8 BENCHMARKS + 14 MAJOR SITES + 41 RANDOM (0.075)



16 NATURAL SITES + 14 MAJOR SITES + 41 RANDOM (0.075)

16 NATURAL SITES + 8 BENCHMARKS + 41 RANDOM (0.075)





Features and Benchmarks with the 41 Other gives a total of 65 that creates 63 alignments compared to the 100 sets of random points where 7 generate more alignments with a high of 65. Finally, the Major sites plus Benchmarks combine with the 41 Others to generate 46 alignments among these existing. The random point comparison produces 27 of the 100 with more alignments, with a high of 60.

There is a clear trend among these six tests for alignments among existing combinations of sites to be in the upper range compared with random phenomena from the 41 Other point

replacements. Among the single subgroups of the frame that pair up with the 41 non-frame sites, the Major Sites (with Tikal included), while still outperformed by the best random, are only slightly better than either Benchmarks or Natural features. When testing pairs of frame subgroups, none exceed the random, but the best pair, Natural features plus Benchmarks, do significantly better than either of the two pairs that involve Major Sites.

It is when we combine all three groups, Natural Features, Benchmarks, Major Sites, however, as in figure 68, that something rather dramatic, and wholly unexpected occurs. Now testing 100 sets of 41 points each at four different accuracies up to 0.15°, one finds a consistently expanding percentage of existing alignments that elevate above the highest random. As measures of the clear margin between existing and highest random numbers of three-point alignments, at 0.05° the existing is 8% beyond, at 0.075° the gap is 14.1%, at 0.10° the space continues to widen to 15.6%, and finally at 0.15° the distance culminates at 17.6% higher.

One can look more closely at the numbers of alignments in the frame and non-frame groups that produce these unexpected results. The 38 points of the frame combo (N+M+B) at  $0.15^{\circ}$  internally creates 60 three-point alignments, while the Other Mayan 41 sites internally generates only 23 alignments. The primary reason for the considerably larger number of alignments in the slightly smaller frame combo can be found in the multiplicity of lines that have several three-point alignments embedded in them. Examples here again are the Atitlán meridian, the cardinal east from Tzontehuitz to San Salvador Medio, or the key diagonals like those between Orizaba – Danta Medio, Cerro Gordo – Tacana, or Zempoaltepec – Tzontehuitz.

It needs to be reemphasized that Benchmarks are part of design simulation methodology and are intentionally created to generate greater pattern within the frame. Furthermore, the benchmark patterns couldn't exist without their design integration with prominent natural features and the major Mayan sites selected. Thus the 60 to 23 alignment comparison between the frame combo with the benchmark integration of natural and major sites, and the simple non-frame list of 41 other Mayan sites makes sense. The group of 41 after all, though slightly larger in number of sites, has no natural features or "connecting" points.

What is so unusual about the present tests, is the way the combination of the 38 NBM frame trio with the 41 other Mayan sites generates so many additional three-point alignments, i.e. 137 beyond the simple combination of 60 and 23 alignments (83) which each group generates independently, for a grand total of 220, compared to 187, the highest number when random



Figure 68. Unpredicted effect of 38 frame sites in generating high numbers of three-point alignments with 41 non-frame or "other" sites compared to replacements with random points.

points are substituted for the 41 in their test areas. Does this mean that the Olmec Frame, or some similarly designed formalized landscape layout intentionally integrates a significant number of the 41 non-frame Other Mayan sites—via three-point alignments?

Even though after the simulation process this designer had developed a healthy respect for the way Mesoamerican designers seemingly had logically laid out the frame, major site locations and urban design on the sites themselves, the revelation of the final act of the probability test was entirely unforeseen. Who could guess that a probability exercise might demonstrate the power of design, particularly how this kind of non-discursive thinking might be able to create foundational religious meaning from partially coincidental patterns of Natural features, Major sites and Benchmarks in a large landscape. Most importantly, the surprising effect of integrating these three kinds of sites via a landscape design process strongly suggests largely yet to be discovered social integration at this scale.

### 2.2.2 Adding tentative alignments from probability testing to the Olmec Frame record

While the probability exists that some three-point alignments were intentionally designed to connect frame elements to some of the 41 Other Mayan sites, none of these new potential elements have been design simulated as to possible integration of site location or creation of pyramid domain or hearth maps in urban design. It is primarily from the perspective of future work that these new three-point alignments are presently added to the total azimuth record, figure 69 a & 69 b.

Azimuths may be either frame directions that may or may not be composed of three or more aligned points, or three-point alignments from testing. Three-point alignments are not broken down by accuracy, all are simply under 0.15°. The list identifies three different kinds of directions: 1) <u>underlined</u> azimuths part of the Olmec frame (Natural + Benchmarks + Major Sites), 2) **bold** azimuths from early alignment testing, and 3) *italicized* azimuths of three-point alignments revealed in the frame/non-frame tests. Vacant text lines between listed azimuths indicate spaces greater than 5° along a 180° continuum. As great circle lines, again the azimuth number in the "eastern" hemisphere (here 180° - 360° counter clockwise) represents only one of the lines' two possible directions, each of course 180° opposite the other.

180.11810 Komchen - Tikal - Santa Ana 180.11810 Komchen - Uaxactun - Santa Ana 181.95767 Atitlan X - Piedras Negras 182.37787 Calakmul - Santa Ana 182.37787 Calakmul - El Palmar - Santa Ana 182.70245 Dzibilchaltun – Becan - Xultun 183.64097 Komchen - Becan - San Bartolo 183.64103 Xtobo - Dzibilnocac - San Salvador Medio 184.47190 Komchen - San Salvador Medio - Copan 184.48329 Uxul - Danta Medio - Chalchuapa Lago 184.91266 Uxul - Danta Medio - Santa Ana 185.21248 Dzibilchaltun - Rio Azul - Quirigua 185.24290 Dzibilnocac – San Bartolo - Copan 185.48795 Xtobo - San Bartolo - Copan 185.58981 Komchen - Cival - Quirgua 185.65312 Komchen - Homul - Quirigua 186.17768 Yaxuna - Colha - Los Naranjos 186.44968 Xtobo – Dzibilnocac - Becan 190.31121 El Tigre-Altar de sacrificios-El Porton 191.1778 Calakmul - Tikal - Copan (Temple IV) 191.27213 Calakmul - Tikal - Copan 194.84751 Edzna- Calakmul - Quirigua 197.07011 Atitlan Medio - San Salvador 198.90519 Palenque - Atitlan X 200.29000 Danta Medio - Copan 200.34786 Tajamulco - Tzontehuitz 204.31479 Atitlan Zenith – Santa Ana 204.31479 Atitlan Zenith – East X – Santa Ana 207.14219 Tzontehuitz - El Chiflon - Chocola 208.54610 Calakmul - Naranjo - Los Naranjos 209.43520 Piedras Negras - San Salvador 212.65963 Uxul - Los Naranjos - Yarumela 212.71509 El Mirador - Los Naranjos - Yarumela 213.07174 Danta - Los Naranjos - Yarumela 213.17378 San Salvador Medio – Los Naranjos - Yarumela 215.47030 Uxul - Danta - Uaxactun 217.36451 Tzontehuitz - Atitlan X - Agua 222.39030 La Venta - El Chiflon - Atitlan X 225.70459 Chinkultic - Altar de Sacrificios - San Salvador Medio 235.22655 La Venta - East X 235.33344 Cerro Gordo - La Malinche - Chocola 235.41370 Cerro Gordo - La Malinche - Tacana 236.08625 La Venta - Copan 236.59356 Orizaba - La Venta Medio - Chalchuapa Lago 236.69670 Orizaba - Atitlan X - San Salvador 236.89863 Moon Pyramid-Malinche-Atitlan X-Kaminaljuyu 237.00781 Mount Tlaloc - Tacana - El Baul 238.49666 Moon Pyramid - La Malinche - San Salvador 238.50019 Moon Pyramid - La Malinche - Chalchuapa Lago 238.65396 San Lorenzo-Chiapa Corzo-El Porton 239.40375 Mount Tlaloc - Chalchuapa - San Salvador 240.38906 El Mirador - Xultun - Barton Ramie 241.14164 Orizaba - San Lorenzo - Chinkultic 241.63859 Cerro Gordo - El Chiflon - El Porton 241.98191 Moon Pyramid - El Chiflon - El Porton 242.44811 Tacana - Acatenango - Santa Ana 243.07695 Tajamulco - Agua - San Salvador 243.33055 Tacana - Agua - San Salvador 243.44735 Tacana - San Salvador 243.68018 Chiapa de Corzo - Chinkultic - Copan 244.14030 Cerro Gordo - Orizaba 244.18212 San Lorenzo - East X

244.28090 Cerro Gordo - Orizaba - East X 244.58697 Atitlan - Santa Ana 245.37050 Moon Pyramid - Tzontehuitz - Yarumela 245.68670 Atitlan - San Salvador 245.96963 Tacana - Tajamulco (Solstice) 246.21439 San Lorenzo – Tzomtehuitz - Quirigua 246.26443 Monte Alban - Atitlan - Santa Ana 246.27699 Cerrro del Aguila – Chocola – Santa Ana 246.31715 Moon Pyramid - Orizaba - Quirigua 246.32994 Mount Tlaloc - San Lorenzo - Yarumela 246.59347 La Venta Medio - El Chiflon - Copan 247.02241 Monte Alban - Agua - Chalchuapa 247.24124 El Tigre – El Mirador – San Bartolor 247.42348 Palenque - Piedras Negras 247.48982 El Tigre - Danta - San Bartolo 248.90915 Cerro Gordo - Bonampak - Altar de Sacrificios 249.06694 Palenque - Atitlan Medio 249.29384 Moon Pyramid - Bonampak - Altar de Sacrificios 249.60796 Takalik Abaj - San Salvador 251.06895 La Venta – Atitlan Medio 251.74687 Chinkultic – Quirigua – Los Naranjos 251.95827 Tacana - Kaminaljuyu 252.35225 La Venta - Palenque 253.24090 San Lorenzo Medio – Quirigua – Los Naranjos 253.24090 San Lorenzo Medio - Chinkultic - Los Naranjos 253.75982 Orizaba-La Venta-Atitlan Zenith -Danta Medio 254.21346 Mount Tlaloc - La Malinche - Palenque 254.30461 Mount Tlaloc - La Malinche - Danta Medio 254.31760 Mount Tlaloc - La Malinche - Atitlan Zenith 254.36899 Mount Tlaloc - La Malinche - La Venta 254.40019 Monte Alban - Copan - Yarumela 254.67172 Mount Tlaloc - La Malinche - Orizaba 254.79835 Atitlan - Acatenango - Agua 254.87542 La Malinche - Orizaba - Nixtun-Ch'ich 254.98696 La Venta - San Salvador Medio 256.19743 Orizaba - Uaxactun - Homul 257.28215 Monte Alban - Bonampak - Ixkun 258.37487 Mount Tlaloc - Homul - Barton Ramie 258.45194 La Malinche - Uaxactun - Barton Ramie 258.79071 San Lorenzo - Atitlan Medio 258.92475 La Venta - Tikal 259.67410 Moon Pyramid - El Tigre - Rio Azul 259.72439 San Lorenzo - Danta Medio 260.62923 Orizaba - El Tigre - Lamani 261.01300 San Lorenzo - Piedras Negras - San Salvador Medio 262.28227 San Lorenzo - Atitlan Zenith 264.09480 San Lorenzo – Palenque - Tikal 264.45740 Tacana - Atitlan X - Copan 265.05998 Zempoaltepec - Tzontehuitz 265.56600 La Venta – Danta 265.86909 Tzontehuitz - Bonampak - Ixkun 267.07674 Cerro del Aguila – Tzontehuitz - Piedras Negras 267.42826 San Lorenzo – El Tintal – San Bartolo 268.54034 San Lorenzo Medio - Yaxchilan - San Salvador Medio 268.65927 El Tigre – Calakmul - Cuello 269.30948 Monte Alban - Yaxchilan - San Salvador Medio 269.99257 Atitlan Zenith - El Palmar - Tikal 271.22362 Cerro del Aguila – Piedras Negras - Narango 271.78537 Zempoaltepec - El Palmar - Tikal 271.82603 Zempoaltepec - Atitlan Zenith - Barton Ramie 271.83397 Cerro del Aguila - Atitlan Zenith - El Palmar 271.83799 Cerro del Aguila – Atitlan Zenith - Tikal 271.83799 Cerro del Aguila - El Palmar - Tikal 272.54779 Monte Alban - El Palmar - Barton Ramie (list continues next page)

Figure 69. Combined azimuth list for frame simulation and listed three-point alignments in probability tests; <u>underlined</u>, part of Olmec Frame; **bold**, azimuths from early tests; *italicized*, alignments revealed in frame / non-frame tests.

180.11810 Komchen - Tikal - Santa Ana 180.11810 Komchen - Uaxactun - Santa Ana 181.95767 Atitlan X - Piedras Negras 182.37787 Calakmul - Santa Ana 182.37787 Calakmul - El Palmar - Santa Ana 182.70245 Dzibilchaltun – Becan - Xultun 183.64097 Komchen - Becan - San Bartolo 183.64103 Xtobo - Dzibilnocac - San Salvador Medio 184.47190 Komchen - San Salvador Medio - Copan 184.48329 Uxul - Danta Medio - Chalchuapa Lago 184.91266 Uxul - Danta Medio - Santa Ana 185.21248 Dzibilchaltun - Rio Azul - Quirigua 185.24290 Dzibilnocac - San Bartolo - Copan 185.48795 Xtobo - San Bartolo - Copan 185.58981 Komchen - Cival - Ouirgua 185.65312 Komchen - Homul - Quirigua 186.17768 Yaxuna - Colha - Los Naranjos 186.44968 Xtobo – Dzibilnocac - Becan 190.31121 El Tigre-Altar de sacrificios-El Porton 191.1778 Calakmul - Tikal - Copan (Temple IV) 191.27213 Calakmul - Tikal - Copan 194.84751 Edzna- Calakmul - Quirigua 197.07011 Atitlan Medio - San Salvador 198.90519 Palenque - Atitlan X 200.29000 Danta Medio - Copan 200.34786 Tajamulco - Tzontehuitz 204.31479 Atitlan Zenith – Santa Ana 204.31479 Atitlan Zenith – East X – Santa Ana 207.14219 Tzontehuitz - El Chiflon - Chocola 208.54610 Calakmul - Naranjo - Los Naranjos 209.43520 Piedras Negras - San Salvador 212.65963 Uxul - Los Naranjos - Yarumela 212.71509 El Mirador - Los Naranjos - Yarumela 213.07174 Danta - Los Naranjos - Yarumela 213.17378 San Salvador Medio – Los Naranjos - Yarumela 215.47030 Uxul - Danta - Uaxactun 217.36451 Tzontehuitz - Atitlan X - Agua 222.39030 La Venta - El Chiflon - Atitlan X 225.70459 Chinkultic - Altar de Sacrificios - San Salvador Medio 235.22655 La Venta - East X 235.33344 Cerro Gordo – La Malinche - Chocola 235.41370 Cerro Gordo - La Malinche - Tacana 236.08625 La Venta - Copan 236.59356 Orizaba - La Venta Medio - Chalchuapa Lago 236.69670 Orizaba - Atitlan X - San Salvador 236.89863 Moon Pyramid-Malinche-Atitlan X-Kaminaljuyu 237.00781 Mount Tlaloc - Tacana - El Baul 238.49666 Moon Pyramid - La Malinche - San Salvador 238.50019 Moon Pyramid - La Malinche - Chalchuapa Lago 238.65396 San Lorenzo-Chiapa Corzo-El Porton 239.40375 Mount Tlaloc - Chalchuapa - San Salvador 240.38906 El Mirador - Xultun - Barton Ramie 241.14164 Orizaba - San Lorenzo - Chinkultic 241.63859 Cerro Gordo - El Chiflon - El Porton 241.98191 Moon Pyramid - El Chiflon - El Porton 242.44811 Tacana - Acatenango - Santa Ana 243.07695 Tajamulco - Agua - San Salvador 243.33055 Tacana - Agua - San Salvador 243.44735 Tacana - San Salvador 243.68018 Chiapa de Corzo - Chinkultic - Copan 244.14030 Cerro Gordo - Orizaba 244.18212 San Lorenzo - East X

244.28090 Cerro Gordo - Orizaba - East X 244.58697 Atitlan - Santa Ana 245.37050 Moon Pyramid - Tzontehuitz - Yarumela 245.68670 Atitlan - San Salvador 245.96963 Tacana - Tajamulco (Solstice) 246.21439 San Lorenzo - Tzomtehuitz - Quirigua 246.26443 Monte Alban - Atitlan - Santa Ana 246.27699 Cerrro del Aguila – Chocola – Santa Ana 246.31715 Moon Pyramid - Orizaba - Quirigua 246.32994 Mount Tlaloc - San Lorenzo - Yarumela 246.59347 La Venta Medio - El Chiflon - Copan 247.02241 Monte Alban - Agua - Chalchuapa 247.24124 El Tigre - El Mirador - San Bartolor 247.42348 Palenque - Piedras Negras 247.48982 El Tigre - Danta - San Bartolo 248.90915 Cerro Gordo - Bonampak - Altar de Sacrificios 249.06694 Palenque - Atitlan Medio 249.29384 Moon Pyramid - Bonampak - Altar de Sacrificios 249.60796 Takalik Abaj - San Salvador 251.06895 La Venta – Atitlan Medio 251.74687 Chinkultic – Quirigua – Los Naranjos 251.95827 Tacana - Kaminaljuyu 252.35225 La Venta - Palenque 253.24090 San Lorenzo Medio – Quirigua – Los Naranjos 253.24090 San Lorenzo Medio - Chinkultic - Los Naranjos 253.75982 Orizaba-La Venta-Atitlan Zenith -Danta Medio 254.21346 Mount Tlaloc - La Malinche - Palenque 254.30461 Mount Tlaloc - La Malinche - Danta Medio 254.31760 Mount Tlaloc - La Malinche - Atitlan Zenith 254.36899 Mount Tlaloc - La Malinche - La Venta 254.40019 Monte Alban - Copan - Yarumela 254.67172 Mount Tlaloc - La Malinche - Orizaba 254.79835 Atitlan - Acatenango - Agua 254.87542 La Malinche - Orizaba - Nixtun-Ch'ich 254.98696 La Venta - San Salvador Medio 256.19743 Orizaba - Uaxactun - Homul 257.28215 Monte Alban - Bonampak - Ixkun 258.37487 Mount Tlaloc - Homul - Barton Ramie 258.45194 La Malinche - Uaxactun - Barton Ramie 258.79071 San Lorenzo - Atitlan Medio 258.92475 La Venta - Tikal 259.67410 Moon Pyramid - El Tigre - Rio Azul 259.72439 San Lorenzo - Danta Medio 260.62923 Orizaba - El Tigre - Lamani 261.01300 San Lorenzo - Piedras Negras - San Salvador Medio 262.28227 San Lorenzo - Atitlan Zenith 264.09480 San Lorenzo – Palenque - Tikal 264.45740 Tacana - Atitlan X - Copan 265.05998 Zempoaltepec - Tzontehuitz 265.56600 La Venta – Danta 265.86909 Tzontehuitz - Bonampak - Ixkun 267.07674 Cerro del Aguila – Tzontehuitz - Piedras Negras 267.42826 San Lorenzo – El Tintal – San Bartolo 268.54034 San Lorenzo Medio - Yaxchilan - San Salvador Medio 268.65927 El Tigre – Calakmul - Cuello 269.30948 Monte Alban - Yaxchilan - San Salvador Medio 269.99257 Atitlan Zenith - El Palmar - Tikal 271.22362 Cerro del Aguila – Piedras Negras - Narango 271.78537 Zempoaltepec - El Palmar - Tikal 271.82603 Zempoaltepec - Atitlan Zenith - Barton Ramie 271.83397 Cerro del Aguila - Atitlan Zenith - El Palmar 271.83799 Cerro del Aguila – Atitlan Zenith - Tikal 271.83799 Cerro del Aguila - El Palmar - Tikal 272.54779 Monte Alban - El Palmar - Barton Ramie (list continues next page)

Figure 69. Combined azimuth list for frame simulation and listed three-point alignments in probability tests; <u>underlined</u>, part of Olmec Frame; **bold**, azimuths from early tests; *italicized*, alignments revealed in frame / non-frame tests.

# **3.** Conclusive proof of Mesoamerican prehistoric surveying and a new vein of archaeological knowledge? stop

### 3. 1 First test of simple alignments among early Mayan sites

Work on both a formalized Chaco and Olmec originated frame explore two kinds of new processes: design simulation and probability tests -- if in fact Ancestral Puebloans and Mesoamericans had the technical ability to accurately survey at large scales. At present, in the absence of enough interest in and funding for a field exercise to emulate prehistoric surveying in the New World, what can one actually prove? *While it can be said that no particular geometric pattern, whether in the present simulation or probability tests, can be proven to be a cultural artifact, this volume does, however, strongly suggest that among the mix of azimuth patterns, some must have been designed and surveyed.* 

Review first the use of Doyle's seven sites. Does this test provide additional explanation to his paper's focus on E-groups? Probably not, given the very uneven involvement of alignments with these seven, i.e. Tikal with 15, Nakbe with 0. Using viewshed methodology to plot larger-scale social relationships in the landscape seems more related to territorial uses of space, than surveyed lines that imply specific ritual relationships between sites. Territorial distances, in this case radiating out ubiquitously from E-group sites, may be far more useful as a defensive, rather than integrative phenomenon, (not venturing here into the function of wall features on Tikal's greater perimeter). Even if a site involved "extension" alignments, each line's connections to two to four other sites would have been socially specific, involving ritual relationships used more hierarchically, perhaps, than seemingly less territorial "intension" alignments. In sum, the present paper only inadvertently overlays two different ideas about social space and research process; certainly, both are plausible in the Mayan landscape, though probably not superimposed or functioning at the same time (see discussion of Golden & Scherer 2013 below). Again, the primary reason Doyle's sites were used is that the list was created by someone other than the author.

So, what can be concluded in a study where so much random geometry clearly exists in comparison to the existing? What rises above pure happenstance? While Doyle doesn't really distinguish between Tikal and the other six Middle Preclassic sites, this location clearly stands out in several dimensions that might have involved land surveying.

1. Largest number of alignments involved: Tikal's Temple IV point involves 15 alignments at 0.15°, compared to the 12 that occur in the highest one of the 700 random points in the test areas of 100 sets of seven each. To produce this result by either manipulating chosen points on the other 49 sites, or to do so with some large number of additional fraudulently "discarded" sites in the analysis, is simply impossible. The probability that Tikal's alignment involvement is totally coincidental must be extremely low.

2. Number of involvements related to site size: The scaling of sites together allows numbers of alignments to be associated with a size ranking of the seven focus sites. The largest alignment involvement number among the 700 random is 12, occurring at a third ranked site. Comparing the association of Tikal's involvement (15) and size (1) further reduces the probability that its location is a random phenomenon with respect to possible large-scale surveying.

3. <u>Largest built structure on the site</u>: Also, to be considered in this list of components that diminish probabilities of coincidence—along with alignment involvements and site size—is the association of Temple IV, Tikal's largest pyramid. Present work did not develop a measure that would determine a largest feature to each of the seven random sites. This is primarily because the largest features at the other six sites lie closer to the site "center" point and somewhat automatically associate with involved alignments. At Tikal, however, from an architectural design perspective, it seems quite logical, i.e. not coincidental, that Temple IV's more clearly "specialized" location about 700 m from the core would associate with highest alignment involvement and largest site size.

4. <u>Relation to most prominent natural features</u>: Compounding this list of lowering probabilities of randomness is Temple IV's precise alignment on axis from the high point of one of the two volcanos in the south. What if this fact were presented by itself, i.e. what are the odds that given the 5.4998° angular spread between Santa Ana and San Salvador volcanos to the south (from the Tikal point) that Temple IV will come within 0.0106° from a meridian from one of them? Given the acceptance of the designed meridian between the two great houses on the rims of Chaco Canyon, would archaeologists at least consider the much larger scale possibility that the Tikal point might have been intentionally aligned (even though Temple IV is not the earliest feature on the larger site)? Such a consideration on its own would further diminish the randomness probability aggregated by alignment involvement, site size and largest feature.

5. <u>Relation to E-group prototype</u>: Given the prototypical E-group point at Uaxactun, what are the odds that it should align with the Tikal point with the greatest number of alignment involvements, at the largest scaled site, marked by its largest built feature, and on a meridian axis with a volcano at the southern edge of the landscape?

### 3.2 A designer's view of the Olmec frame

Given the spatially structuralist (ritual) idea that La Venta created a first middle integrator between a north (Cerro Gordo landscape pyramid) and south focus (Atitlán/Tajamulco)--fueled by assumptions of land surveying technology-what does one intuitively make of the fact that La Venta and Atitlán X can be designed to have clearly the highest number of involved azimuths of site location and site design in the frame? In retrospect, only in a few places does this simulation of Mesoamerican design not discover relatively simple, geometrical logical formalities, particularly in site location. Certainly, any geometric pattern, regardless of how accurate or formal, can be coincidental. Yet as the simulating designer moves through successive sites, beginning with coincidence among prominent natural features, an understanding of possible Mesoamerican and Mayan design thinking matures. The first of these predicted patterns occur in the way the two great diagonals intersect with the great Medio stretching across Mesoamerica from Cerro de Aguila to Victoria Peak (an emulation of the equinox base pairs in the Cerro Gordo construct). They both create meridians up to landscape pyramid apex sites, La Venta and San Lorenzo. It follows then that the locations of Piedras Negras and Monte Alban, Palenque, and El Mirador all work off these earliest patterns, primarily using La Venta, Medio points and Atitlán X (understood as part of the first diagonal). Tikal, again, while cardinally related to La Venta and Atitlán X via the Atitlán Zenith meridian point, creates its vertical to Santa Ana independent of the great diagonals from Orizaba and Cerro Gordo.

Once azimuths began accumulating somewhat naturally in the simulation process with repeated use of La Venta and Atitlán X, how much did this influence the search for additional patterns linked to these two points? Having taught architectural design for close to forty years, the author understands that even given a relatively brief program of needs, and a relatively constrained open site, fifteen students will come up with seemingly endless variations of formal geometries as architecture. For this reason, no computer application presently exists that can measure the probability that a certain design will emerge from the process. While mapping

applications like Space Syntax, sometimes used by archeologists, can infer simple social control, they work from post occupation analysis of (existing) form, not some total potentiality of design outcomes. Furthermore, Space Syntax has seemed less adaptable to capturing symbolic or religious meaning of geometrical patterns, i.e those used ritually.

For the author, the present simulation led to several unpredicted kinds of patterns, ones not at all present in initial concepts of opposed domains and *axis mundis* or even the early focus on La Venta and Atitlan X. The simulation began with a primary intention to show how major sites might have been located in relation to a large – scale frame. As one located sites, such as Izapa, the possibility emerged that design aspects of sites, particularly a major axis, might be reproductions of astronomically integrated ritual experiences among coincidentally aligned volcanos—here the observation from Tacana of the winter solstice rise over Tajamulco. Eventually this design idea didn't seem to work for many other sites. It was only when looking at the well drawn site plan of Piedras Negras, however, did it come to mind that what might be transferred as homologue at smaller urban scales, were the azimuths of the frame itself. Socially this began to make better sense. Rather than reproducing quite a small number of key frame experiences among the volcanos--somehow available to all--an alternative emphasis on larger scale, diverse, connecting frame azimuths speaks more to ritual participation of spatial dispersed populations.

Testing for such patterns became not only fascinating as process, but relatively easily provided logic to site layout. Again, after finding the best drawing of a site, and correctly orienting it via satellite imagery, then a perfect meridian was drawn on an Adobe Illustrator layer above the plan. Making a copy of the vertical, one enters the precise azimuth of a frame feature. The new landscape-based line can be moved around by the mouse pointer without changing its azimuth. In many cases the designer can look at the relation between two prominent temple features, for example, and thinking about the site's location in the frame, correctly predict with some frequency which azimuth would create a good pattern between the features in question.

The existence and location of the cascades at El Chiflón occurred somewhat incidentally in the design process, while, after Piedras Negras, using the site layout of El Mirador to help predict the rationale for the site's location in the large-scale frame. While experimenting with a mathematically derived vertex point for El Mirador's inverted landscape pyramid, the tourist destination of El Chiflón was discovered. Given the description of Paddler Gods and the like in

the literature, this location immediately became symbolically interesting. Only when simulating Tikal, however, was it understood that the upper pool of the cascades accurately aligns with La Venta and Atitlán X.

The idea of emulation of not only individual frame azimuths, but actual "hearth" shaped maps, particularly involving Atitlán X, Atitlán Medio, El Chiflón, and East X, along with La Venta of course, led to seeking these patterns at each successive site, culminating with Copán and Calakmul. While very much confirming Bassie-Sweets' hypotheses that Mayan myth references specific places in the landscape, both the scale and transportability of these "hearths" can now be seen as a much more formalized, ritually powerful design element. The hearth landscape concept wasn't just represented by the three volcanos at Lake Atitlán, but by (later?) La Venta / Atitlán X related patterns that began perhaps at Piedras Negras. Furthermore, scales of hearth existed, beginning with the landscape pattern of frame elements, then its emulation in the positioning of features in layout of the ceremonial site, and finally at smallest scale in architecture and sculpture (though less investigated herein).

In the present simulation, *Popol Vuh* myth can be associated spatially with the key hearth element, the azimuth from La Venta – El Chiflón – Atitlán X, whose alignment runs to Utatlán as its late base, the place where the myth was recorded. This fact should resonate with anthropologists and perhaps even raise significant questions about where cosmic structure comes from, and how this symbolism translates to social, organizational effect. What is the relation between myth as passed on orally or even written, and ritual as practiced, particularly in large scale landscape? Attempts are made in the Chaco book to introduce these issues relative to Ancestral Pueblo literature, where the link between myth and archaeological record is perhaps less well defined than among the Maya. Even among the Maya it makes a nicer argument, perhaps precisely because of their greater organizational complexity, to see early formalization in the landscape, while having continuity with shamanism, as developing much greater formalized detail, both geometrically and socially. The myth of Popol Vuh can speak generally about cardinal cosmic structure but cannot begin to invoke the symbolic or social specifics of a large-scale frame system, if such existed. This may not mean that myth does not participate in rituals both on site and in the landscape, but that something like "core" meaning may be carried primarily by pieces of formalized space and how devotees move through them, perhaps

integrated with concepts of time. After all, why was the *Popol Vuh* recorded at the base of what might have been the most important azimuth in the evolved Olmec Frame?

### 3.3 Design simulation provides an unexpected probability proof

Given the present simulation of a Olmec/Mayan design process, and how the resulting patterns seem very logical from a design perspective, it was never envisioned to somehow merge aspects of frame geometry with any probability testing focusing on three-point alignments among early Mayan sites—even though the first probability test with its emphasis on Tikal had been done before the simuation. The union of the two processes was a complete after thought.

Two groups of existing sites were created, first all those involved in the Olmec Frame, and second those early Mayan sites from the first probability test not involved in the design simulation. The frame group is subdivided into 16 Natural features, 8 Benchmarks (survey points necessary for the logical layout of the frame), and 14 Major Sites, and there are 41 Other non-frame sites, 79 total for the two groups of existing locations together. Again, one cannot ask the relatively simple computer application to grasp any true measure of the possibilities of design relationships. Tests are limited to using accuracies of three-point alignments as a measure of at least some design intent vs. randomness.

From the results of the first probability test, it is possible that some three-point alignments (here at or under 0.15°) within the "Other" site group may be intentionally designed, but that a large number will likely be random phenomena. Within the frame group, however, some number of three-point alignments *are* intentionally designed as part of the simulation and involve all three kinds of sites in the frame group of 38 sites total, e.g. the Atitlán meridian points or benchmarks on the *Medio* line. Additionally, some number of coincidental three-point alignments occur on their own, e.g. La Venta – El Chiflón – Atitlán X. Thus, one sees a somewhat lessor importance of three-point alignments in the frame, or at least a subordination to more complex design logic. In the Other group of 41, however, one found the importance of three-point alignments at least to Tikal. But even though in this second probability test Tikal is moved to the Major Sites of the frame (out of the "Other" group), one still might predict that three-point alignments might be difficult to discern from the random.

Again, the typical probability test compares the number of three-point alignments created by an existing group of sites, with the number of alignments when existing sites are replaced by

an equal number of random points in the same area. In the present case one cannot logically replace the frame sites with random locations to look for design intention--again cannot even imagine being able to calculate randomness among complex design patterns. Somewhat illogically, however, one can replace with random points the 41 Other sites studied for their three-point possibilities. The question is whether designed frame sites use three-point alignments to involve the Other 41 sites at a rate higher than the random? The two existing frame and non-frame site groups are unified and numbers of three-point alignments are recorded, then 100 sets of 41 random points each are tested against the frame group.

Varied combinations of each of the three groups of the frame—<u>N</u>atural features, <u>M</u>ajor sites, and <u>B</u>enchmarks—were first combined with the 41 <u>O</u>ther (non-frame) sites to establish the number of three-point alignments created by existing sites, and then compared to the number when random points replace the 41 Other. The six variations of frame groups are [M + O], [N + O], [B + O], [N + M + O], [N + B + O], and [M + B + O], excluding the combination where all are included. In none of the six does the existing number of alignments rise above the related number using 100 sets of 41 substituted random points each. All existing sites numbers, however, are in the upper third of numbers produced by 100 random sets. Even with all of Tikal's three-point alignments added to the Major sites group, it fares no better than either the Natural or Benchmark group. The best performing combination is [N + B + O], though still not rising above the 90<sup>th</sup> percentile of the random 100.

All three frame subgroups seem to push the number of alignments towards upper numbers in the random chart, suggesting at least some probability of design, meaning that each of the groups independently may have some reason to create alignments with some of the Other Mayan sites. This, however, really says little about any alignment effect of the whole frame *per se*, intimately integrated as it is by design. What should one expect? Given that three-point alignments are not most primary elements in the frame, i.e. the integrative glue connecting the three kinds of sites, it seemed most likely that combining all three frame groups would produce existing – random comparisons very similar to the testing of the six frame variations. This is something of a null hypothesis, aside from the tendency of the six tests to fall in the upper strata of random sets.

What happens of course is that for some unexplained reason combining all frame sites has the effect of dramatically increasing the comparative relationship between alignment numbers from existing (together with the 41 Other) and random sets. Instead of hanging in the top third

of numbers from random sets, the alignment numbers generated by the total group of existing sites rise about 17.6 % above the best random of 100 sets. At  $0.15^{\circ}$  variation, the three frame group kinds of sites together create 60 alignments, while the Other Mayan 41 sites generate 23 internally. While the first six tests do not specifically track which alignments appear during variations of combining groups, one does know that when the total frame group is fused with the 41 Others, existing alignment numbers go from the addition of the two internal numbers, 60 + 23 = 83, to the new total of 220, an increase of 137. When the frame group is fused with 100 sets of 41 random points, the best alignment number is 187.

This appears to be substantial proof that the geometric way the three kinds of frame sites combine creates the probability of designed three-point alignments that connect some number of Other Mayan sites to the system. If so, then, the frame test along with the tests of Doyal's six sites and the prominence of Tikal, should together provide good evidence that Mesoamericans, and particularly the Mayans were accurately surveying and ritually formalizing the larger landscape—even if one cannot at this point clearly differentiate all designed from random pattern.

This partial proof will not of course be quickly accepted, nor will some interdisciplinary sub group of archaeology develop in the short term around the obvious mapping and analysis that needs to be done. The one thing that could stimulate this kind of research would be to find some evidence that Ancestral Puebloans and Mesoamericans both used "benchmarks" for their framing. Even though these facilitating formal features may have been regarded more as part of a sacred natural landscape not to be built upon—like volcano tops—it may be possible to discover minimally artefactual indication of their existence.

In all likelihood neither Chaco nor Olmec Frame volumes will be published by any peer reviewed academic house. Is there a danger, however, if this content is self-published and freely distributed—along with accurate latitude/longitude data for all points--that sites like Atitlán X, East X, or the Medio points, not to mention upper El Chiflón, could lose what minimal evidence of frame use that presently exists?

### 3.4 Yaxchilan & Bonampak

Beyond the blog idea that Bonampak's site layout points accurately to Yaxchilan, or even the description in this book's introduction that an accurate line from Tajamulco to Yaxchilan runs

through Bonampak's plaza, one can suggest in conclusion the possibility of a much greater geometric integration of these two sites into the Olmec originated frame. One begins with Piedras Negras, upriver from Yaxichlan. Returning to figure 16, the positioning of Piedras Negras depended heavily on the same line that created the eastern *Medio* point for San Lorenzo's pyramid landscape, i.e. a perpendicular (to the line unifying the southern ends of the two great diagonals, Tacana to San Salvador) up through Atitlán X to Atitlán Medio on the eastern *Medio* line. Piedras Negras could have been located by the line from La Venta to Atitlán Medio and by a 90° angle between Atitlán X and a new base for La Venta (Medio 2). Much of the logic that positioned Piedras Negras carries over to design strategies for Yaxchilan and Bonampak.

First, the line between the La Venta Medio 2 point and Atitlán Medio passes coincidentally and accurately through the Yaxchilan is three plus kilometers south of the major site, figure 70. The isthmus point creates, moving north toward Yaxchilan, a natural threshold to the peninsula. The spatially focal Structure 33 and Yaxchilan's acropolis does not form a right angle to the isthmus point and the La Venta Medio 2 – Atitlán Medio line. The line from Structure 33 that runs through Bonampak's plaza down to Tajamulco, misses Yaxchilan's isthmus point by about three degrees and similarly doesn't provide a second accurate positioning line for the Yaxchilan site itself. It is presently unclear how the Yaxchilan building complex was located within the peninsula. It can be said, however, that the coincidence of the natural isthmus point and the La Venta Medio 2 – Atitlán Medio line does provide a fixed landscape position. Did the location of the complex work from this point? Could it have involved the peninsula high point (16.89, -90.97), about 700 meters from the complex high point at the South Acropolis. Curiously enough, the azimuth from the South Acropolis to the peninsula high point (226m in elevation) is about 311.5687° close to the Atitlán X – East X (311.32351) azimuth prominent as the eastern hearth ray (with the western ray La Venta - El Chiflón - Atitlán X and El Chiflón - East X) at Copán. As the reader will see shortly in the discussion of the Yaxchilan urban plan, the line from the peninsular high point to the South Acropolis does not appear to be reflected in the site layout.

Returning to the blog ideas about "Orienting Bonampak", what now can be said about which features at Bonampak might or might not align to Yaxchilan? Working from the corrected north orientation of the topo map, the best match for Bonampak's plaza orientation is the azimuth line from the Atitlán Medio Base up to San Salvador Medio (316.43832) as seen in figure 74. The





Figure 70. Coincidental location of Yaxchian isthmus point on La Venta Medio 2 - Atitlan Medio line, Atitlan Medio Base - Atitlan X -Atitlan Medio azimuth struck north and south through isthmus point, right angle from La Venta Medio 2 and Atitlan Medio Base creates Bonampak site point; additional azimuths from Atitlan Medio Base to Atitlan Medio, Danta Medio, and San Salvador Medio may be expressed in Bonampak site design; layout points of plaza can be simulated by cardinal lines from center feature. reader will recall the importance of the Atitlán Medio Base point, on the line between the two great diagonal termini, Tacana and San Salvador, and positioned to create a 90° perpendicular through Atitlán X and up to Atitlán Medio, the key point for the location of San Lorenzo and Piedras Negras (via La Venta). The layout of Piedras Negras, figure 18, prominently featured the 90° grid using the Atitlán X – Atitlán Medio and Tacana – San Salvador lines, with a strong axis from J-3 to J-4 at the center of the acropolis hearth triangle. Given the geographic relationship of Yaxchilan and Bonampak to Piedras Negras via the Usumacinta river, it is not surprising that one finds common use of key azimuths like Atitlán X – Atitlán Medio (continues to Atitlán Medio Base).

One of the two positioning lines for Bonampak could have been this Atitlán Medio Base – Atitlán Medio azimuth (333.09274) taken from the isthmus positioning point for Yaxchilan, 333.14774°. For Bonampak's second locating point--perhaps emulating Piedras Negras 90° pattern with La Venta Medio 2 and Atitlán X--a point on the azimuth down from the Yaxchilan isthmus point might have been found that forms a 90° relationship with La Venta Medio 2 as well, with the other leg to the Atitlán Medio Base point instead of Atitlán X (as occurs with Piedras Negras). This Bonampak azimuth appears to create the eastern limit of the massive acropolis construction, running through the plaza center to its northwest entrance. Along with the plaza orientation, such a line gives us two layout azimuths using the Atitlán Medio Base as southern poles. A third using this point may exist in the strong axis that runs from Edificio 15 through the plaza center to Edificio 2 on the acropolis; this is the major Piedras Negras line which may have also helped position Bonampak, i.e. Atitlán Medio Base – Atitlán X – Atitlán Medio. This could be the original positioning line from the Yaxchilan isthmus point.

The landscape position of Bonampak, with now three related lines, appears above all else to be symbolically expressing relationships to the Atitlán Medio Base point on the Tacana – Sal Salvador line (connecting the termini of the two great diagonals), first the 90° positioning leg up to Bonampak and then the two benchmarks on the *Medio* line, Atitlán Medio and San Salvador Medio. Furthermore, the reader will recall the importance of the Danta Medio point on the *Medio* line in the positioning of that eventually great feature and El Mirador. Thus, Bonampak's positioning line to Atitlán Medio Base appears to set up the site up as an organizer of the power of three important *Medio* points: Atitlán Medio, Danta Medio, and San Salvador Medio. The center of these three benchmark axes, that to Danta Medio, may be expressed in the

Bonampak site axis that runs from an apparent center of its acropolis, through the plaza center point and up to the mound feature to the northeast. It is flanked by the Atitlán Medio and San Salvador Medio lines and features expressed on the site. These three *Medio* benchmarks first appeared as landscape pyramid frame elements all from La Venta: 1) the first leg to San Salvador Medio, 2) the line from Orizaba to Danta Medio, and 3) the line to Atitlán Medio, positioning Piedras Negras.

While these azimuths expressed in Bonampak's site plan could condense landscape meanings involved in both the developed frame and the site's location, it appears that cardinal directions, always important for *Medio* benchmarks and positioning meridians, may also be embedded in the layout. Figure 70 shows cardinal lines from the plaza center that seem to create its corners. Thus, symbolically, the plaza orientation provides a "grounding" to more explicitly expressed azimuths. Does the apparent coincidence of the plaza as ground and azimuth to San Salvador Medio symbolically reproduce the importance of that point vital to the first positioning of La Venta, i.e. *medio* west from Tzontehuitz and meridian south to the volcano San Salvador, the terminus of the great diagonal from Orizaba?

The four lines from Atitlán Medio Base expressed in Bonampak's site plan accurately model the actual large-scale landscape. Looking more closely at this landscape domain in the map of figure 70, one sees an additional azimuth coming up from Atitlán Medio Base running to Yaxchilan; this line creates an eastern ray in a much smaller triangular landscape whose southern base is the azimuth from La Venta to East X, and western ray that runs from El Chiflón to Yaxchilan. This small triangle reproduces itself in the layout of Yaxchilan, but rotates 180° as the reader will shortly see, not unlike the "hearth" domain of Piedras Negras' acropolis area.

Given Bonampak's dependency upon Yaxichlan, presumably positioned and laid out concurrently, why the difference in size of the two landscape domains. Is it possible, given the determination of Yaxchilan's location by only one element of the frame--La Venta Medio 2 – Atitlán Medio, working with a coincidentally aligned isthmus point--that one of Bonampak's symbolic purposes was to communicate the site combo's relationship to greater pieces of the frame: i.e. the Base – Bonampak – La Venta 2 perpendicular, and the three lines from the Base to Atitlán Medio, Danta Medio, and San Salvador Medio?



Figure 71. Simulated layout sequence beginning with possible site high point (South Acropolis); South Acropolis as apex to inverted hearth map in site design (right hand diagram in insert); 180° rotated hearth (left hand diagram in insert) correctly mapping small landscape pyramid shown in figure 70; approximate distance of Piedras Negras (upper Ball Court) - Altar de Sacrificios line from site high point.

If Bonampak and Yaxchilan were created as a pair in part for this reason, then one might expect to see some related use of azimuths in the layout of the much larger Yaxchilan complex. Looking now at this site plan, figure 71, it is possible that the high point of the complex (South
Acropolis) was selected as the initiating point for the greater site. Its azimuth to the primary site positioning point at the peninsula isthmus is 338.50212. Returning to the site plan of Piedras Negras, figure 17, the reader will recall the importance of the site expression of the azimuth from Atitlán Medio to La Venta in the site positioning map of La Venta's pyramid domain. Not unexpectedly then, at Yachilan, one might expect a similar move. The perpendicular to the Isthmus point – South Acropolis line is within about 0.27521° from being 90° to La Venta from this eventual site high point. This vertex, however, is not very precise, a fact that will invite an alternative explanation shortly.

After establishing this first site point, by these or other means to be mentioned below, the next act might have been to run an azimuth from the high point north to the river (ultimately to feature E 18). The chosen azimuth is that from the Atitlán Medio Base point to either the South Acropolis (350.52682) or the peninsula isthmus point (350.68862), indistinguishable at site layout scales. This makes sense as an initiator in a coordinated layout with Bonampak, given the expression of its three lines from the Atitlán Medio Base point.

On this line at E 18, the influence of Piedras Negras, or at least commonalities of azimuth expression, are pronounced. Evident first is the dominant grid at Piedras Negras that reproduces at multiple turns the perpendicular that created the powerful Atitlán Medio point, i.e. the 90° relationship of Atitlán X's Base point on the Tacana – San Salvador line that unified the two great diagonals. Again, the Atitlán Medio Base – Atitlán X – Atitlán Medio line coincidentally is almost identically parallel to the East X – Tikal line. This is also one of two grids used at Palenque, figure 21. At Yaxchilan, E 18 is positioned on the north running axis from the site high point such that this powerful symbolic axis works with the natural topography to create what might have been the major entrance from Yaxchilan from the peninsula south. This creates the first leg of the prominent grid at Piedras Negras. The E 18 structure appears to be oriented to this grid with its primary axis running east to the Ball Court in the linear (river related?) plaza.

If the high point to E 18 axis was considered the first of three sides of a hearth shape to position the Great Acropolis at its focus, then the second azimuth of the hearth triangle might have been struck from the now fixed E 18 point. This line as shown in figure 71 could have emulated the azimuth from La Venta to East X, this latter benchmark perhaps having been created during Tikal design processes. Reflecting hearth shapes at several other major sites, e.g.

El Mirador, Tikal and Copán, the third hearth azimuth at Yaxchilan could have been the azimuth El Chiflón – Yaxchilan, laid out from the site high point (South Acropolis) to the northeast. The intersection of this line with that from E 18 appears to have been eventually marked by a large, formal feature perhaps as threshold to the main plaza.

The azimuths of this new Yaxchilan hearth shape reproduce, as mentioned regarding figure 70, an identical shape in the larger scale landscape. But how can one explain the reason why designers chose to rotate the site layout exactly 180° from the actual landscape domain? Geometrically, at Yaxchilan, the landscape base of La Venta – East X forms the top of the triangle, while the two sides are reversed. The key to this design mystery, perhaps, may lay in the possibility that despite the importance of East X to the positioning and site layout of other major sites, at the time of Yaxchilan, no line from La Venta directly to East X existed in their azimuthal repertoire. Perhaps when predesigning the Yaxchilan layout and hearth, the two side azimuths of an imagined hearth emanating from the peninsula high point had been tentatively positioned first, given the established symbolism of these lines and their two southern points, El Chiflón and Atitlán Medio Base. Missing was a base in the actual larger landscape. Did they for the first time survey a line from La Venta to East X to complete the homologue? This could be the reason why the scale of the landscape domain is small compared to that laid out from Bonampak.

Given some intended use of the two hearth sides, and natural site determinants, designers could only lay out the La Venta – East X azimuth in its east – west orientation *north* of the site high point if it was to be considered as an inverted "Yaxchilan" hearth apex. Is this a case where topography ruled the day? It may have been obvious that the linear space running along the river made a much better place for a main plaza than a hearth base running elsewhere in the site—through considerable variation of topography. The solution was to use a perhaps newly surveyed La Venta – East X azimuth as the major site and plaza orientation, spatially inverting the hearth base along the river. And by reversing the positions of the second and third sides of the hearth as they did, the unity of the actual landscape domain is symbolically maintained. More will be said shortly about this tendency to invert hearths.

The position of the hearth interior focus at E 33 might logically have come from the intersection of azimuths from the two ends of the La Venta – East X axis. The first, from E 18, is the azimuth of Piedras Negras - San Salvador, strongly reproduced in three major axes, figure

17, on the same Usumacinta River about forty km. north of Yaxchilan. Then the second intersecting line is a cardinal west from the northeast corner of the urban hearth map. This would have positioned E 33 and the focus of the Great Acropolis.

At some point the Ball Court could have been positioned by replicating the west hearth side (as rotated from the landscape domain), i.e. the Atitlán Medio Base – Yaxchilan azimuth. Whether or not a 90° grid perpendicular to the major site entrance axis, Atitlán Medio Base – Atitlán X – Atitlán Medio, was struck east from E 18 to create a positioning intersection point for the Ball Court, is difficult to determine from existing site drawing scale and clarity. The extension of the perpendicular into the western plaza makes sense, however, because this is the Tacana – San Salvador azimuth, the prominent Piedras Negras grid element. The axis orientation of the Grand Staircase to the E 33 structure seems to align with Stela 1 in the main plaza. Its orientation is about 311.75°, close to the azimuth of Atitlán X – East X at 311.32351. Is E 33 symbolically related via its building and stair orientation to both the rotated hearth base from La Venta to East X, as well as the Atitlán X – East X azimuth, the prominent east side of the Copán hearth, figure 33?

Finally, the large interim feature on the Yaxchilan western hearth side may be oriented as a perpendicular to the line that marked the site high point from the peninsula isthmus, orienting perhaps to La Venta. Is the large feature the 90° vertex point with legs to La Venta and the isthmus point? A similar azimuth line appears to define a formal axis from E 33 to the center of the Small Acropolis plaza to the west.

How interested will archaeologists be in the use of layout azimuths in all three sites possibly involving the frame relationship between the La Venta point and the San Lorenzo pattern that unified the two great diagonals, again the perpendicular from the diagonal connector from Tacana to San Salvador? This unifying 90° angle from Atitlán Medio Base – Atitlán X – Atitlán Medio is strongly expressed at all three sites. At Piedras Negras it appears three times, including the hearth axis from J-3 to J-4 to the hearth focus, and then as part of the grid down through the site (figure 19). At Palenque, it is the azimuth from Temple XX to El Sol, and from the Temple of Inscriptions to Temple X (figure 22). At Yaxchilan this azimuth provides what may have been the principal entrance to the complex from the peninsula south, and a grid 90° to the Ball Court. Then at Bonampak, it was used as perhaps the major site axis running from Edificio 15 through the plaza center to the center of the dominating acropolis feature. This line

may have performed a threshold like relationship to the site positioning line from Atitlán Medio Base to Bonampak to the west, and the azimuth from the Base point to San Salvador Medio to the east.

Then one can list the reproduction of the Piedras Negras – San Salvador azimuth as one of the acropolis positioning lines from E 18 at Yaxchilan. The three major Piedras Negras site axes, figure 17, may associate features along these azimuths to the act of creating the Yaxchilan E 33 acropolis point from the pivotal E 18. While Bonampak doesn't appear to use this azimuth, it may have participated in another pattern relationship with Piedras Negras. This goes beyond but is akin to the relationship all three sites have to the La Venta Medio 2 benchmark: 1) the La Venta – La Venta Medio 2 "meridian" with the line from this base to Piedras Negras and 90° down to Atitlán X; 2) the coincidence of La Venta Medio 2 – Atitlán Medio that passes through the Yaxchilan isthmus; and 3) the 90° relationship of Bonampak's position with La Venta 2 and Atitlán Medio Base. It is as if Yaxchilan, limited as it was in its isthmus positioning, wished to emulate Piedras Negras' dual perpendicular relationship to La Venta and Atitlán X. Its satellite Bonampak might well have been created in part to provide this missing element in Yaxchilan's azimuthal heritage, the perpendicular positioning pattern of La Venta Medio 2 – Bonampak – Atitlán Medio Base providing the symbolic strength vis-à-vis Piedras Negras.

Deviations from Piedras Negras do exist, however, and one wonders if these are created by a time lapse between that site's origin and when Yaxchilan /Bonampak were laid out, though dating discourse must be left to archaeologists. Azimuths involving East X and El Chiflón do not appear at Piedras Negras but help create two of the three hearth sides at Yaxchilan. The Piedras Negras hearth seen best in figure 19 is also an inverted triangle with its base azimuth as Tacana – Atitlán X, this continuing line running to Copán's pivotal Temple 16. Piedras Negras east hearth side is the azimuth directly from Tacana to Atitlán Medio, and the west side the azimuth from Atitlán Medio to San Salvador.

# **3.5** The late Classic development of antagonistic Piedras Negras and Yaxchilan territories in context with Altar de Sacrificios

While the important paper on this subject comes from two prominent archaeologists, Golden & Scherer 2013, much of their theory derives from social anthropological views about large scale social organization and particularly "state" entities. Thus, as a social anthropologist/architect,

the author dares comment on this discourse. One is very much reminded of two views of the Chaco phenomenon, one where an essentially hierarchical entity moves into Chaco Canyon in the 10<sup>th</sup> century and creates a large-scale polity on the plateau, and the other a phenomenon more like Stonehenge which operated as a large-scale pilgrimage destination but without permanent hierarchical control at this focus. In the case of this latter perspective, the big question is how does a large-scale prehistoric social organization hold itself together, particularly in the absence of clear evidence of coercion by powerful lineages or royal kings? And finally, what causes the collapse of organization at this scale?

For present purposes, the question of collapse is less important than the serious landscape mapping by Golden and Scherer and ideas about social use and control in relation to major ceremonial sites. The landscape region they describe is roughly less than one hundred km. along the Usumacinta river. The spatial theme of the paper tracks how in the Late Classic, a bellicose territorial relationship develops between the two political foci of this area, Piedras Negras and Yaxchilan. Rather than see this late territoriality as imposed power that rises and falls with kings per se, they map "emic" or actual social behaviors on the ground, i.e. "generalized trust" that first permits the population growth in the Classic period but then also contributes to the eventual collapse. They acknowledge the obvious ritual and political power expressed in Piedras Negras and Yaxchilan but reveal important mitigating (emic) power that resided in communities and lessor ritual loci scattered throughout the region in question. In fact, in the Classic period when population was expanding, "the landscape between capitals (Piedras Negras and Yaxchilan) was essentially an uninhabited and vacant political frontier from the perspective of the dynastic center, where the authority of the royal courts was weak to nonexistent (ibid:398)". Clearly no religious meaning of the landscape is integrated with the symbolism and ritual of the centers, even though the architecture and sculpture of numerous smaller ritual foci exhibit not dissimilar evidence of a Mayan religion with deep associations to nature.

Golden and Scherer describe the development of settlements in the study region in the Pre-Classic from about 500 B.C. through AD 350. These had a "modest civic ceremonial center, including small pyramids, E-groups, and ball courts; Piedras Negras and Yaxchilan were merely two of the many similarly sized centers. By about 350 AD most of the PreClassic period settlements had been abandoned (ibid 404)". The arrival of fissioned dynastic lineages from the east to Piedras Negras and Yaxchilan apparently spurred the population movement, primarily for economic reasons, from the surrounding landscape to these centers in the fourth century AD. Thus, Early Classic was the time when newly arrived dynasties created the monumental settings rich with symbolism of sacred mountains, *axis mundis*, and other cosmic elements. It was in effect a replacement of possibly not-dissimilar meanings in earlier surrounding foci with the grandeur of the two major ceremonial centers. How then, does one attempt to reconcile the work of Golden and Scherer (and numerous others cited) with the design simulation of the present volume?

During the Pre-Classic period numerous settlements were functioning as Mayan religious foci, among which Piedras Negras and Yaxchilan were ordinary examples. There is one site mentioned by Golden and Scherer, however, El Cayo on the river between the two eventual major centers, that does *not* give up its sacred location and function all the way up to Terminal Classic times. Because no accurate site map and lat/long location is readily available for this place, one cannot evaluate its possible integration with the frame. The question is whether certain sites in the study landscape were religiously different than the others, hence more permanent, and possibly part of a surveyed frame system. What might have distinguished them from all the other settlements was their location and the unique "emic" ritual use of these special places for long periods of time (see related discussion in Imomata et.al. 2015). This may have amounted to less than a total political take over by the royal court, than a "etic" (discursive) layering over an "emic" (non-discursive) substrate (see Doxtater 1984).

This raises a serious question about initial socio-spatial assumptions in archaeological mapping. At what scale of landscape does one start? The missing ingredient of anthropological thinking about state societies, whether on the Colorado Plateau or along the Rio Usumacinta, is the almost total absence of any kind of recognition of the scale of landscape religion in probably most if not all precedent shamanistic societies in these places. Long before Mayans began to build religious settlement foci, ritually used structure existed at scales probably much larger than this small region around Piedras Negras and Yaxchilan. The choice of landscape study area in Golden and Scherer (2013) was primarily determined by the discovery of the defensive fortifications of the territorial tension between Piedras Negras and Yaxchilan. From a frame perspective one wonders why the large site of Altar de Sacrificios about 66 km upstream from Yaxchilan wasn't included as a third major ceremonial site.



Figure 72. Positioning of Altar de Sacrificios on four-point alignment with Tacana, Tikal and Cuello, intersect and site point may have been determined by alignment with extension of Piedras Negras - Yaxchilan line; landscape hearth pattern with inverted apex at Altar de Sacrificios, east ray parallel to Atitlan X -East X of Copan hearth, and inverted base line has possible parallels to El Chiflon - East X, three - point alignment of Piedras Negras, Yaxchilan and Altar de Sacrificios (Rio Usumacinta) may be interior focus.

The Altar de Sacrificios site (Willey 1961), when accurately mapped in the large-scale landscape, suggests a scenario where it might have formed an aligned triad with Piedras Negras and Yaxchilan. Returning to figure 71, this line passes about 242 m below the South Acropolis and possible site high point. Altar de Sacrificios, figure 72 and 73, smaller in size than the two aligned sites to the north, nevertheless possesses a clear duality of plazas and a sense of monumentality. Instead of being connected by a threshold (meridian) stair as in the two plazas of Piedras Negras, the mediating feature of Altar de Sacrificios is the ball court. The pair of perpendicular axes that organizes the two plazas is the same (east – west) azimuth that defines the inverted hearth base of the Piedras Negras acropolis area, i.e. the line from Tacana to Atitlán X (and Copán). The alignment azimuth Piedras Negras – Yaxchilan – Altar de Sacrificios is not however strongly expressed in the urban design of Altar de Sacrificios, except for the possibility of a line running from the center of the Ball Court to the center of the large west feature of the northern plaza. This may reflect the possibility that Altar de Sacrificios site location was not positioned by the Piedras Negras – Yaxchilan azimuth.

Clues to Altar de Sacrificios' site location might have been more strongly expressed in site design azimuths. Even though conventional wisdom sees this location as the byproduct of trade at the confluence of two smaller rivers, Pasión and Salinas, such might well not have been a reason for locating Piedras Negras and Yaxchilan. The strongest Altar site connection to the frame comes from its position on the alignment from Tacana to Tikal and Cuello (this runs much less accurately about 1,323 km west of a Nixtun-Ch'ich" center point). The precise line from the Tacana summit point to Temple IV at Tikal passes about 117 meters below the Altar Ball Court; the line is 351.849 km. This azimuth might be expressed by the line from the Ball Court to the center of the major east feature of the north plaza. If this site line were the actual large-scale survey line, its error would be less than 0.035° (average of deviations from both ends).

A second frame connection exists in the three-point alignment from Chincultic very accurately through Altar de Sacrificios—misses the Ball Court 24 meters above—to San Salvador Medio. A couple of things may mitigate against using this line as an intersector to locate Altar. First, the archaeologist must consider the dating of Altar and Chincultic. Second, Chincultic is a cenote site, meaning that this feature could have been the reason for its



ceremonial importance. This might not mean that the feature itself, sans monuments, couldn't

Figure 73. Large - scale line azimuths imported to Altar de Sacrificios site plan; possible site positioning axes of Tacana - Tikal and alignment line from Piedras Negras and Yaxchilan; orientation of axis between north and south plazas as part of a Tacana - Atitlan X - Copan grid; extension of site to the NW parallels main linear plaza along river at Yaxchilan; possible hearth map with inverted apex at central Ball Court, correctly maps landscape heart illustrated in figure 72 without rotation.

have been chosen to work with San Salvador Medio and the frame. This azimuth, however, does not appear to be expressed in the site layout.

Equally accurate is the three-point alignment from El Tigre to El Porton, both apparently quite early sites whose possible relation to the frame is not presently mapped. This line runs through both plazas about 58 meters west of the Ball Court and doesn't appear to be expressed in terms of the location of major site features. While one is now aware from the probability exercises that some three-point alignments might likely have been designed, a considerable

number of others will be random phenomena. In the case of Altar de Sacrificios, given the study whose conclusions focused on Temple IV at Tikal, the four-point alignment in question might be given greater weight as a possible positioner. Was the junction of the rivers itself a natural ritual locus, perhaps creating the second intersecting feature?

If the urban design of Altar de Sacrificios used the Tacana – Atitlán X azimuth as its primary grid, related perhaps to use of the same azimuth for Piedras Negras (inverted) hearth base, what of a possible hearth map at Altar? The first element that immediately comes to attention is the Tacana – Tikal azimuth that works as a double (parallel) in the azimuth record with the prominent eastern hearth azimuth at Copán, i.e. Atitlán X- East X. In figure 73 the Tacana – Tikal line works as an eastern side of a hearth map with its inverted apex at Altar de Sacrificios, and Ball Court on site. As a map, however, there is no known site that represents East X on the Tacana - Tikal line north of the Altar hearth. There is also no western side of an Altar hearth map that correspondes to the all-important La Venta – El Chiflón – Atitlán X axis. Instead, the double azimuth La Venta – East X / Palenque – Altar de Sacrificios might fit the symbolic bill. Significantly, this western map azimuth is Yaxchilan's inverted hearth base, and the primary plaza axis along the river. Yaxchilan's monumental stair alignment from feature E 33 to this plaza may be the Atitlán X – East X azimuth. Palenque, one recalls, shares several hearth characteristics with Piedras Negras, though not with Altar de Sacrificios directly. In Altar's site design, this western hearth axis may explain the positioning of the "B" group plaza and the extension of other features in this direction from the Ball Court center.

The orientation of the largest site feature at the upper end of the northern plaza might finally express the azimuth of the inverted hearth base. This may have been considered a "triple" parallel in the azimuth record, beginning with the most important, Orizaba – La Venta – Atitlán Zenith – Danta Medio, then that used at Copán, El Chiflón – East X, and finally a more local Palenque – Danta Medio (though again this map point at the eastern vertex of the Altar map is unknown). Since several of the other hearths have an internal azimuth from their inverted apex to a focal point, could Yaxchilan have played this role on the axis to Piedras Negras?

Finally, the simulation notes that the Piedras Negras – Yaxchilan – Altar de Sacrificios axis does not appear to be expressed in the urban design of any of these sites, as seen previously with the integration of the Calakmul – Tikal – Copán axis into site hearth patterns. While at first seemingly contradictory, the understanding here may be simple. The Usumacinta River *is* the

expressed axis connecting the threesome. By discovering via land surveying the alignment coincidence between the two unique river features – the peninisula and confluence point – with Piedras Negras, the river itself becomes a symbolic element present at all three sites, most likely facilitating ritual relationships along the axis.

Certainy more work needs to be done mapping Altar de Sacrificios possible integration into the frame. But at the very least, the present sketch suggests inclusion of other sites into any study of the landscape relationship between Piedras Negras and Yaxchilan. An integration of other ritual places in the greater landscape would go a long way in more fully describing both the "emic" resilience of the hinterland during the Pre-Classic and the way a continued tradition of local participation works up through the Middle Classic, despite the architecturalization of Piedras Negras and Yaxchilan. There may have been nothing more powerfully "emic" than socially integrating participation in the surveying and recording of azimuths across large distances in the landscape. Adding this dimension to the behavioral emphasis of Golden and Scherer might create an interesting theoretical footnote about how and when "discursive" (architecturalized) space finally wins the dialectic with the "non-discursive" (landscape)and overt territoriality rears its ugly head. It is not impossible that some early sites were *not* abandoned at end of early Classic; these were frame sites earlier located and therefore ritually most powerful. Later when architecturalized, azimuth patterns were added to urban design as a means of bridging the etic / emic divide.

## 4. Final Words

## 3.1. Chaco and Mesoamerica

Present work follows a pattern of thinking during many years with the Ancestral Pueblo record in the SW U.S.; the culmination of this research resides in the volume under review entitled *Chaco's place in a formalized landscape* (Doxtater 2019a). In this precedent work, design simulation of a systematic large-scale landscape frame is accompanied by numerous probability tests of certain geometric sub patterns of the structure. Early theoretical chapters in the book attempt to distinguish between "shamanistic" landscapes and earliest formalized constructs created by surveyor priests. While these ideas are not repeated at length presently, in Mesoamerica large scale landscape framing might have occurred religiously before Classic period phenomena of aggrandized monumental architecture, glyphs and royal dynasties. Have

<sup>191</sup> 

Mesoamerican archaeologists sought a theoretical distinction between Classic period religious practices and those that at some earlier point in time focused on a reverence for landscape, perhaps more akin to shamanism than the worship of divine kings? In time the Chaco phenomenon may prove to be a kind of evolutionary phase between shamanistic practices and essentially "pre-discursive" architectural foci where sites are located by framing, and layouts mimic patterns in a large-scale landscape. Documentation of this phase in Mesoamerica, prior to the discursive layer of artifacts expressing dynastic histories, might be missing in Mesoamerican archaeology

The first comparison between Mesoamerican and Chacoan patterns may suggest an ethnographic tie between Ancestral Pueblo systems and what may be a later evolution of the Olmec Frame, i.e. the strong meridian axis between Tikal and Santa Ana. To a large measure the founding Olmec Frame with its most powerful foci at La Venta and Atitlán X does not depend on a powerful central focus like Tikal with its multitude of radiating alignments to satellite sites. Is there a common centrality of Tikal and Chaco Canyon? While earliest Tikal seems to have been well integrated into the frame, perhaps at some later time the system evolved to a more radial pattern. Could this have been the concept of vertical, north-south axis or "meridian", along with other radial alignments, that evolved with a focus on Chaco Canyon? Could the Tikal evolution of the Olmec frame have been the most powerful system working at the time?

Lekson (1999) popularized the meridian term with his ideas about an elite group first setting up a ceremonial focus at Chaco, and then in later years laying out a designed, surveyed meridian axis linking Aztec to the north and Casas Grandes (Paquime) to the south in present day Chihuahua, Mexico—a line of over 700 km. Lekson describes this line having a three-point alignment error of about 2°, loosely paralleling a true north-south line. The most accurate Ancestral Pueblo "meridian" that virtually all archaeologists consider a designed artifact, is the far shorter, visible relationship between the great house Pueblo Alto on the north rim at Chaco, and Tsin Kletsin on the south rim. A line from much larger Pueblo Alto's west wall (the side where pilgrims entered the canyon from Aztec) across 3.726 km to the west wall of Tsin Kletsin measures a very precise azimuth of 180.007°--off about a half a meter at this distance. Furthermore, at the architectural scale of great houses themselves, no one doubts the meridian expression of the precise north-south wall bisecting Pueblo Bonito (this great house's position is not part of the meridian laid out between the two rim structures).

The author's Chaco related work contrasts from Lekson's by arguing that meridians and other large-scale surveying were anchored in the most prominent natural features, unlike surveyors starting with a position in Chaco and prolonging a meridian north and south exclusively to position sites. I have termed the process by which such "frames" begin with natural features as "intension", where surveying and ritual power initiate or flow from the perimeter, in contrast to "extension", where the survey process begins with a previously established site, and likely architectural feature, moving out from this center (see fuller discussion in Doxtater 2009). Specifically, in the Ancestral Pueblo landscape, the author has identified four such "intension" constructs formed as meridians involving prominent mountains in the north (Abajo Peak, Mount Wilson, Lizard Head), south (Baldy Peak, and Haystack Mountain), or middle (Ship Rock)—Doxtater (2019a, 2007, 2003).

This work hypothesizes that the first Chaco meridian was conceptualized and laid out as early as Basketmaker III times, about 500-600 A.D. (when Tikal was at its height perhaps?) and worked from an understanding of the coincidental meridian relationship between the highest mountain in the Ancestral Pueblo region, Mount Wilson to the north, and a late volcanic eruption (not mountain), McCarty's Flow to the south. This relatively accurate natural coincidence has a measured azimuth of 179.842°. An additional natural feature, the modest summit of Cerro Moctezuma with its circular great kiva like feature--visible just to the west of Paquime--also aligns quite accurately with the meridian. The northernmost of the first two great kiva sites in the canyon, Basketmaker 29SJ423, as well as immediately adjacent later great house Pueblo Peñasco, also are on the line. Farther south the "outlier" great kiva of Andrews community aligns, as does the formal center point of the huge, late complex of Aztec up north. Ultimately this original meridian line quite accurately relates seven points, three natural and four built.

Considering Tikal's possible latter day central position with respect to 15 axes through its Temple IV (*seven* more Tikal azimuths can be added from the summary list of figure 69), one suspects an "extension" process where a powerful group at a well-established site extends lines out in certain directions to create new and perhaps subordinate "outlier" sites, particularly as the extension of Copán – Tikal up to Calakmul. Variation might exist in patterns with four-point alignments involving the natural feature of Tacana, and the two major southern coastal sites of Izapa and Chocolá. This could be a pairing up with a preexistent Tikal to create a third or fourth site on particular alignments. Nevertheless, to the contrary, the positioning of Tikal itself by

cardinals to Santa Ana and a west line to Atitlán Zenith, not to mention hearth relationships to East X and El Chiflón, clearly speak to some original "intension" process.



Figure 74. All three - point alignments at 0.15° deviation or less among 50 existing sites and 6 natural features of first probability study; for numbers of alignments involving each site see figure 65.

From a graphic, architectonic perception of alignments of existing sites in probability testing, figure 74 (the group of Mayan sites from the first probability test), the most formal pattern with respect to Tikal suggests an "extension" meridian with a long axis between Chalchuapa as a southern base, and Komchen or Dzibilchaltun to the far north, a line close to 800 km that varies from true north about a half of degree. Uaxactun and Dzibilnocac also lie on this possible meridian, a five-point alignment giving added uniqueness to geometric data involving Tikal. Again, the only six-point line of the existing 72 is a diagonal from two of the three northern sites, Komchen and Xtobo, down through Dzibilnocac, Becan, and San Bartolo to Copán. With respect to Tikal on a possible central meridian, this side axis graphically has a somewhat formal counterpart to the west in lines running from either northern points or Dzibilnocac down through El Tintal, Uxul and Calakmul to El Porton with its relatively high number of six involvements (these three-pointers do not accurately overlap within 0.15°). Perhaps related to this discussion may be Quirigua's location with seven alignments over on the opposite east leg near Copán; three of its lines go to either Komchen or Dzibilchaltun at the top of the meridian (with Cival, Rio Azul and Homul). The best bisect relationship of this pattern of a Tikal meridian with dual side axes is with Dzibilchaltun at the zenith, Tikal in the middle, El Porton to the west, and Quirigua to the east. The error of this bisect angle is 0.067°, meaning that the center axis misses Temple IV (428.103 km distance) by about 500 meters even. The reader should know that while counterintuitive, random bisect relationships between four points occur considerably more frequently than random three-point alignments. Earlier publications by the author placed too much emphasis on bisects (Doxtater 2002, 2003).

Examining Tikal's location from an "intension" point of view in more detail produces the pattern seen in figure 75. Two prominent volcanos exist in the region directly south Tikal, Santa Ana, 15 km south of Chalchuapa and San Salvador about 30 km to the east. Again, the precise meridian line shows the extremely accurate north-south alignment between the present day high point on Santa Ana's rim, and Temple IV at Tikal; with the azimuth from Santa Ana of 0.00925° to the Tikal point, the line will miss by about 60 m at a distance of 372.696 km. Even if one moves the Santa Ana point around on its aerial photo to simulate possible topographic variation of the volcano over time—again, all sites are scaled together—the meridian line will still be very precise with respect to the Tikal site and Temple IV.

This extremely accurate "intension" line from Santa Ana continues north to also precisely align with the E-group annex of Uaxactun, said to be the prototype for these ritual assemblages built in many Mayan sites. The meridian azimuth from the Santa Ana rim point to the center of the Uaxactun E-group is even more accurate at 0.00086°, an error of about 6 m at the distance of 391.249 km. At the zenith, Komchen is more accurately positioned than Dzbilchaltun with respect to a Santa Ana meridian, but less so than either Tikal or the Uaxactun E-group. As listed



in the accuracies of Santa Ana and Uaxactun E-group alignments, figure 75, the analysis point of Komchen deviates from the Santa Ana/Tikal line about 0.11°.

While again, one cannot here engage the large E-group literature, it can at least be mentioned that the E-group point at Uaxactun, beyond its meridian relationship to Santa Ana, has two more three-point alignments at 0.15° than the Uaxactun "center" point used in the analyses. If these two had been added to the total of Doyle's existing seven sites, their number would rise to 40, making it better than all but one random set; the same is true for the overall number, from 72 to 74 (see again figure 61). If one includes Santa Ana in the site list, the Uaxactun E-group point would involve 8 alignments, one less than San Bartolo. The distance of the E-group point from the analysis point in the Uaxactun "center" (1,152 m), is great enough that in this comparison of involvement for each, only one three-point alignment is common to both lists of 4 or 6 (without Santa Ana).

## **3.2** Other meridians in the frame simulation

Even if Tikal was the most powerful meridian running at a time when landscape formalism was adopted by Ancestral Pueblo people up on the Colorado Plateau, meridians had long been at the core of Olmec framing. In addition to [Santa Ana – Tikal]: [La Venta Medio - La Venta], [San Lorenzo Medio - San Lorenzo], [Atitlán - Atitlán X - Atitlán Medio 1 or 2 - Atitlán Zenith], [Danta Medio – Danta], [San Salvador – San Salvador Medio], [Moon Pyramid – Bisect Point], [La Venta Medio 2 – La Venta], [Piedras Negras – Atitlán X], [Palenque – Izapa]. Furthermore, the more mythically associated framing that occurred in sky maps, may have further emphasized meridans, particularly as times when Orion's belt serves as base for a vertical up to a point calculated to be polar north. And while the present exploration sees the Milky Way's diagonal orientation that occurs at Orion stand times as a reproduction of the all-important earth frame azimuth La Venta – El Chiflón – Atitlán X, the sculptural images shown in Maya Cosmos (Freidel et. al. 1993) clearly express the huge religiosity of vertical conceptions. Of course, the Milky Way does often nearly stand vertically at other times. Having academically written a dissertation on the cultural concept of axis mundi in Norwegian farm setting-both pre and post Christianization (Doxtater 1981), the copious discovery of not dissimilar spatial structures of ritual and religion in the Maya, e.g. at San Bartolo, is highly predictable and warrants minimal text space in the present work. In this vein, while recently rewriting my "axis

*mundi*" entry for the updated Encyclopedia of Vernacular Architecture of the World (Doxtater 2019ab) as a culmination, I added Linda Shele's drawing (#170) of the Accession Panel from the Temple of the Cross at Palenque, figure 76.



Figure 76. Mayan spatial concept of meridian or *axis mundi* as expressed in the Accession Panel from the Temple of the Cross at Palengue (drawing by Schele, # 170).

In addition to most probably powerful expressions of *axis mundi* in components of the Olmec Frame, one also finds meridians as contributing elements in the layout of major ceremonial sites. Perhaps best of all is the division of Piedras Negras by an *axis mundi* aligning four principal temples, one paramount at the northern most pole, with a monumental stair as impressive urban design threshold connecting the two hemispheres. Given Tikal's possible creation by the axis from Santa Ana, the homologue meridian running from its northern most temple point to the central Ball Court, might likely have been similarly understood in spatial conceptions of site and related ritual practice. Palenque, Copán and Calakmul as well embed similar verticals in the core of their ceremonial complexes. Teotihuacan's largest feature, the pyramid of the Sun, for its part may well have replaced the implicit axis *mundi* that ran south from Cerro Gordo at the apex of that northern landscape pyramid. While some southern point on

this vertical may well have been ritually understood and used in practice for a great period of time, the later location of the Sun Pyramid on the meridian from Moon Pyramid to the pyramid landscape bisect point between Tlaloc MA and Popocatepetl appears to be a logically designed element that links this vertical of the north with the vertical of the south—Atitlán X via its alignment from Moon Pyramid through La Malinche.

## 3.3 Ideas of "landscape pyramid" as first organizers of larger scale cultures

Potentially most interesting about the design simulation of the "Olmec Frame", in this writer's landscape biased opinion, is the way the coincidental layout of highest volcanos, aligned to solstice, equinox and zenith/nadir, created a pyramid shaped landscape domain about 260 km at its base and about 70 km in height. Is it possible that no piece of dominating monumental architecture expressed the ritual center of this geographical place for a millennium or more prior to Teotihuacan, even though the Olmecs had used the pattern as prototype for an even larger scale system integrating northern and southern foci? It is perhaps not a coincidence that the map profile of the Cerro Gordo pyramid landscape is quite similar in its vertexes to the elevation profile of the Sun Pyramid.

Pilgrimage foci such as Chaco Canyon or Stonehenge at the center of large landscape cultural domains are understood for their largely egalitarian power to attract and organize participants from great distances, even possibly including sub-cultural variations with different languages. Is it possible that in Mesoamerica as well, earlier culture used symbolically formalized landscapes (via land surveying) to integrate relatively diverse populations already spread throughout the region?

As tracked in figure 77, the first surveyed formalization appears to have created the landscape pyramid map with its apex at La Venta, a logical mediating location in between the power of the two highly coincidental ritual foci of Cerro Gordo and Atitlán. A key component to the La Venta map is the diagonal line from the highest volcano in the north, Orizaba, down to the base volcano of the pyramid's eastern point, San Salvador. Fueling the power of this asymmetrical diagonal—Orizaba and Salvador are of a different measure of prominence as natural features—is the coincidence of cardinal lines from Tajamulco and Atitlán that intersect extremely accurately on this first "great diagonal", i.e. Atitlán X. Hence the symbolic

#### CERRO GORDO / TEOTIHUACAN



SAN LORENZO



MONTE ALBAN / PIEDRAS NEGRAS



TIKAL / COPAN / CALAKMUL



#### LA VENTA / ATITLAN X



EL MIRADOR (DANTA)







TAKALIK ABAJ / KAMINALJUYU



Figure 77. Five pyramid landscapes and six hearth patterns (four inverted and two rotated 180° as site design map).

association between La Venta as emulator of Cerro Gordo's apex position, and Atitlán X as unifier of the south's two most powerful natural features.

Intuited from the design simulation approach, some social competition might have occurred between La Venta and San Lorenzo. It too creates a landscape pyramid domain also with an apex meridian derived from the intersection point between a second great diagonal and the great *Medio* line from Cerro de Aguila to San Salvador Medio (possibly originally to Victoria Peak). This second diagonal runs largely parallel to La Venta's, but now expresses the unique coincidental alignment from Cerro Gordo – La Malinche – Tacana. Most importantly, perhaps, San Lorenzo's landscape pyramid domain couldn't have been laid out without the Atitlán Medio point on the great *Medio*. Constructed as a perpendicular to the line connecting the two end points of the great diagonals, Tacana and San Salvador, and positioned to run through Atitlán X, such integration suggests that while some competitive element might have entered into the evolution of the frame, additive entities might also assimilate by connecting design patterns. Is this then, a model for systematic change in the frame, an accommodation of both competition and cooperation?

The Piedras Negras/Monte Alban pair (despite its somewhat later design date?) would seem to logically follow the new linkage of the two great diagonals via Atitlán X – Atitlán Medio. This is particularly evident in the complex layout of especially Piedras Negras, with its 90° grid using the Tacana – San Salvador and Atitlán X – Atitlán Medio lines. Also innovative at Piedras Negras, might have been the site layout of a novel "hearth" landscape map, as well as focusing on the three key sites of Tacana, San Salvador, and Atitlán X, this in addition to its founding linkage to the original La Venta landscape pyramid pattern. In many of these design respects, the positioning and site layout of Palenque are quite similar and graphically constitute a strong pair.

As one moves east in frame evolution, El Mirador and Tikal pair up in new ways. The ultimately quintessential threshold site of the cascades of El Chalfón, appears to have been appropriated, as it were, by positioning strategies and surveying relating to Danta and El Mirador. Though still strongly linked to La Venta, the concept of a landscape pyramid with Danta at the apex, may have been difficult to construct this far east in the greater landscape. Instead, hearth shaped domains of both El Mirador and Tikal focus on El Chalfón. Piedras

Negras and Palenque, and for that matter Monte Alban seem *not* to include El Chalfón or the La Venta – Atitlán X line in their azimuth based site maps.

While both El Mirador and Tikal create large landscape pyramid domains each using La Venta as western anchor, the (inverted) apex of this now largest of associated landscape pyramids or hearths now lies with El Chiflón. The question arises as to when, in a design sequence, surveyors discovered the quite accurate coincidental alignment of the upper cascade pool at El Chiflón with the line from La Venta to Atitlán X. In the present design simulation, I didn't discover this fact until quite late in the process, given the absence of any commonly known Mayan prehistory of this unique natural feature. Did El Mirador people not know of this coincidence, and therefore reflected primarily on the parallel apex betweem the El Chiflón point and Izapa--this because of the coincidence of azimuths of both western and eastern rays of the two inverted pyramids or hearths?

The final evolution of hearth domains seems to associate with Tikal. Could this have been because of the discovery of the coincidence of El Chiflón? To create a hearth domain not unlike those embedded in Piedras Negras and Palenque, Tikal priests might well have avoided religious emphasis on San Salvador, given Tikal's position on the Santa Ana meridian. Instead, they discovered the East X coincidence; i.e. East X as the right-angle vertex point with San Lorenzo and Tikal which also aligns with Atitlán Zenith and Santa Ana, the two cardinal points that located Tikal. The addition of this new highly coincidental point to the record provided the religious opportunity for the ultimate hearth with El Chiflón and East X points as west and east points, and Atitlán X as inverted apex. The final layout of Tikal weaves both the El Mirador like landscape pyramid together with the new East X created hearth map.

Finally, the landscape pyramid domain that positioned Takalik Abaj and Kaminaljuyu appears to be intrusive to groups using the evolved Mayan frame, particularly with an emphasis on hearth maps. Even if this west – east pair right at the magic latitude might have been laid out prior to the architecturalization of the Cerro Gordo landscape pyramid, and Teotihuacan, both the pyramid shape and the alignment with Atitlán X, La Malinche, and the Moon Pyramid point could have occurred earlier, and somewhat independent of more Mayan evolution of the Olmec initiated frame. It is not clear, however, why priest surveyors didn't use the Moon Pyramid to determine the new apex angle to be transferred to position the southern pair of sites on the new Atitlán base. Instead, they used the Moon – Atitlán X – Kaminaljuyu alignment as eastern ray,

measuring the angle of the Cerro Gordo landscape pyramid to position the western ray and Takalik Abaj. Symbolically, however, one can clearly understand a socio-religious motivation to emulate or even impose the ancient power of Cerro Gordo, and its relation to both great diagonals, at the precise Atitlán X point, so important to evolving Mayan use of the frame.

Despite the list of azimuths involved in either site positioning or layout design simulation at site scale, figure 48, all present simulations are incomplete, given the necessity of site drawings with greater accuracy—a huge order to say the least. In the present, exploratory work, the GPS based site locational data seemed more certain than the drawings of specific features of site layout. As an architect, one is fully aware of the amount of work necessary to complete "as built" drawings of relatively contemporary buildings, a much more doable task than large prehistoric sites with multiple features, all with varying degrees of intact original structure, and/or excavation. Particularly incomplete for these reasons in the present list of major sites may be simulation of site azimuths at San Lorenzo (no site plan published?), Chocola, Izapa, Takalik Abaj, and Kaminaljuyu. It has been tempting to think about some sort of distinctive contrast between highly linear sites like Teotihuacan and perhaps all the southern coastal layouts including Monte Alban, and more complex multiple map conceptions like Piedras Negras, Palenque, and the eastern precincts of El Mirador, Tikal, Copán, and Calakmul. Yet any such typology will have to wait for better drawings, particularly of sites that seem to have a simpler formal emphasis of a particular azimuth, along with its perpendicular.

#### **3.4 Implications of social organization**

The first chapter of the companion Chaco book (Doxtater 2019a) discusses at length why diverse social groups across the Colorado Plateau might have developed a common religion—through large scale frames integrated with coincidental natural features on earth and in the sky. The technology of land surveying among the Ancestral Pueblo people is detailed in the appendix. What had been shamanistic use of prominent natural features, with surveying techniques may have led to discovery of ever larger scale coincidence. Hypothetically, that reliance on shaman visits to most significant natural features--returning this spiritual power to groups in dwelling and village settings--changes dramatically with greater surveying understanding of landscape scale and coincidence. The ethnographic Chaco chapter relies heavily on the work of Johannes

Wilbert (1993) who may have captured a transition point to what is being called here "formalized" landscape.

The Warao, a jungle and river tribe on the Orinoco basin in Venezula, not only use shamanism extensively in roundhouse ritual, but appear to have based those practices on a surveyed large-scale cardinal cosmos in their delta landscape. Freidel et.al. (1993:76) speak highly of their personal interaction with Wilbert, apparently benefiting from his replete knowledge of shamanistic symbolism and ritual, and particularly his admonishment to "always look to nature for a source of mythological symbolism". While Wilbert's ethnographic detail about shamanistic symbolism in myth, and particularly the physical setting of communal roundhouse as microcosm of the known large-scale landscape "frame", is among the finest to be found, he could not fully map any kind of systematic use of the frame, particularly as it might involve some sort of integration between different Warao village groups. Some years ago, when I e-mailed him about these possibilities, he said that he had only flown over the area that would geometrically be at the center of the frame, and that the ethnographic limitations of scale and time were simply too great in this regard.

Up in the Ancestral Pueblo plateau, the author's Chaco book, from archaeological evidence alone, does as best it can to suggest large scale social integration very early during Basketmaker times and their first two great kivas in Chaco Canyon. Archaeologists agree, I believe, that people moved about very early to find better places to plant maize, find mates, and even to participate in religious sodalities at a distance. There exists no agreement, however, or even investigation by archaeologists that large scale religious symbolism developed through largescale framing integrated with powerful natural features.

The title of the Chaco volume suggests the possibility that surveying was itself a form of ritual, always connected intimately with the development and practice of "frame based" religion. Not dissimilarly, perhaps, it seems the case that for several millennia prior to the fully architecturalized and more discursively defined Classical period, considerable populations with linguistic variations lived across Mesoamerica, a zone with far greater agricultural base that up in the desert Southwest. The major social problem might well have been the management of competing territoriality, the most fundamental but least cultural means of social organization. The Olmec ideas that may have inspired the design of the huge landscape pyramid not only emulated a yet non-architecturalized Cerro de Gordo pattern, but possibly integrated a "north"

and "south" spatio-religious opposition, now including Atitlán. Considerable politics behind this large-scale socio-religious undertaking notwithstanding, a primary enabling factor might have been the participation of multiple social groups in survey work, a practice which in itself serves to diminish territorial enmity.

Each ritual survey created a new azimuth, as well as further integration with the frame. Azimuths could have been recorded, remembered and symbolically re-created perhaps as part of subsequent ritual that took place at ceremonial sites in the frame. Did people from one place make pilgrimage to other sites to participate in origin rituals of azimuths cooperatively surveyed by their clans or ancestors? To what extent did the composite frame integrate or at least significantly diminish competition between Mesoamerican people?

## 3.3.3 Summarizing hearth patterns and foci of Mayan sites: Bassie-Sweet's idea expanded

The idea that the spatial diagram and sacred concept of Mayan "hearth" might have emerged from an actual geographical area at Lake Atitlán, symbolically defined as landscape domain, is most clearly asserted in Bassie-Sweet's thinking. Present work extends this idea to hearth maps, representing different landscape domains, in the actual layout of these urban ceremonial sites. The present simulation of Mesoamerican design did not initially set out to find hearth shaped homologues laid out at Mayan sites; the goal was primarily to map a frame system that positioned major sites. The idea did exist, however, that certain site axes, such as at Izapa and Teotihuacan, might relate to the frame or at least frame features, and that these azimuths were transported as it were from somewhat distant places in the landscape. Not until the complex urban design of Piedras Negras site was simulated--with its excellent site drawings—that a triangular space seemed to define the most important, usually acropolis, part of the larger urban plan. So, expanding on Bassie-Sweet's idea, if ceremonial sites are reproducing powerful natural features like volcanos, not only might these relate to some ancient place, but it makes sense that technically accurate spatial relationships that unify these features in the actual landscape might have been reproduced as well.

Present simulations have mapped seven possible Maya hearth patterns at the cores of Piedras Negras, Palenque, Yaxchilan, El Mirador, Tikal, Copán, Calakmul, and perhaps Altar de Sacrificios. Other sites positioned by the frame in the present exploration, appear to not have

woven such hearth patterns into their sites. But limitations in site detail for several of these might explain this apparent absence in present simulation. The extension of thinking suggesting hearth maps as urban design will undoubtedly be met with skepticism. Some probability exercise might be possible with new software but can only be briefly described here. If one takes some number of site points (major features), perhaps less than ten or so, a test area could be set up, within which equal numbers of random points could be distributed. Repeating these eight times (the number of sites with hearths), one could then compare the azimuths between pairs of points of each random set with others of the eight. At set angular tolerances, how frequently do the random azimuths of the seven tests create hearth like triangles with shared elements as in the existing patterns of figure 78?

If such an exercise found low probabilities of randomness or higher probabilities of design, this wouldn't answer the question of whether design simulation that consciously seeks hearth shapes at site foci, replicates Mayan practices. This is different than the earlier exercise where the design component is the Olmec Frame as Benchmarks, combined with Natural Features and Major Sites. With a hearth study the elements of the design patterns themselves—locations of prominent architectural features on the sites—are randomized in some number of comparative layouts. This may disclose the presence of design but doesn't say who the design component that consists of frame benchmarks cannot be replaced by equivalent numbers of random points in the total geographical area. The patterns are much too complex to be understood from sets of random points. Again, present software can only find very limited combinations of three-point alignments, ninety-degree angles, and relationships of two cardinal points.

The uncovering of possible "hearthscape" maps at the cores of major sites became a design interest following the broader understanding that after positioning of the site, designers were lifting distant azimuths from the landscape frame to lay out urban site maps using architectural and sculptural features. Below are summarized patterns of the eight simulated hearthscapes:



- <u>Hearths point southwest</u>. When Yaxchilan designers ran the long base of their hearth along the river, 180° from the orientation of the same triangle in the larger landscape, it may not have been primarily because of site topography but compliance with some generally understood Mayan spatial concept that heartscapes are pointed "down" or south.
- 2. <u>Hearths point to Atitlán</u>. The downward pointing hearths may follow some very ancient understanding of a map of Atitlán as southern apex point, and San Pedro and Toliman as upper triangle base (*a la* Bassie-Sweet). In our eight major site hearths, five azimuths that involve focal features inside the triangular hearth space run to Atitlán X, standing as it does on the meridian through Atitlán X and Toliman and cardinal from Tajamulco. Additionally, while Piedras Negras, Palenque and Yaxchilan hearths have no "side" angles that involve Atitlán X, all the eastern sites of El Mirador, Tikal, Copán, and Calakmul use the ultimate azimuth La Venta El Chiflón Atitlán X as their western rays or sides. Copán and Altar de Sacrificios' east rays also run to Atitlán X at the south as an inverted apex point.
- 3. <u>Identical layouts of hearths</u>. a) The four azimuths of each of the hearths at Piedras Negras and Palenque are virtually identical; the only difference is that while the western point of the upper base runs from Tacana, one eastern destination is San Salvador, and the other Atitlán X. b) The three azimuths of each of the Tikal and Calakmul hearths are also identical, while lines from the southern apex to a focal point within the triangular domain are different. c) While the azimuths of a possible hearth at Altar de Sacrificios overlap much less, the common orientation of its western side with the river plaza axis at Yaxchilan symbolically may have associated the two sites. Altar's western axis replaces the powerful La Venta El Chiflón Atitan X with the novel but logically associated line La Venta East X, the third vertex of the Copán hearth.
- <u>Aligned southern hearth apexes of Tikal, Copán, and Calakmul</u>. These three points are very accurately aligned, a reality given more symbolic weight perhaps by the architectural and sculptural importance of what was built at each southern hearth apex: Temple 16 (Copán), *Mundo Perdido* (Tikal), and Temple VII (Calakmul).

- 5. Site hearths as reproductions of actual maps of landscape domain. The site triangles built into El Mirador, Tikal and more tentatively Calakmul site plans, all accurately represent actual geographical areas with La Venta as western base (north) point, Danta and Temple IV at Tikal as eastern base points, and all three with El Chiflón as apex (south) point. The identical hearths of Piedras Negras and Palenque, and Yaxchilan's hearth all reproduce accurate geographical domains when rotated 180°. The anomaly here is the difference in the base azimuths (north) of Palenque and Piedras Negras. The Palenque base, when rotated precisely conforms to geographical map and site azimuth Tacana -San Salvador. When Piedras Negras site map is rotated, its base, as mentioned earlier, does not match the geographical domain. The rotated base, however, does accurately fit geography, with its line from Tacana, not to San Salvador, but Atitlán X itself. Given that Copán's designers may well have extended this Tacana – Atitlán X in locating their site, the rotated Piedras Negras base works as a line completing its geographical domain. Yet the rotated now east side of the hearth, Atitlán Medio – San Salvador, runs about 50 km west of Copán. The site map at Altar de Sacrificios, a ceremonial center associated in multiple ways with Palenque, Piedras Negras and Yaxchilan, does not, however need 180° rotation to possibly reference an actual landscape domain.
- 6. <u>The hearth equivalence of apex points</u>. All apexes of the eight hearths emerging in the present simulation associate strongly with either Atitlán X or El Chiflón. In that both points accurately align coincidentally with La Venta suggests a clear symbolic unification of at least these eight Mayan ceremonial sites. This three-point alignment was not yet uncovered in the simulation when the La Venta's positioning was diagrammed. While the location of La Venta's meridian depended upon the major diagonal from Orizaba coincidentally through the Atitlán X point down to San Salvador, knowledge of the direct alignment of El Chiflón with La Venta and Atitlán X appears to have been a particularly Mayan innovation at a particular time in the evolution of the frame. Associations here with Milky Way mythology may converge.

As a designer/social anthropologist, it is extremely difficult to think of these hearth patterns as having been created independently from each other across the (mostly Mayan?) landscape. Logically from this perspective, if these azimuths were shared in some sort of spatial calendar, this knowledge had to have been accumulated through a long period of social time where people occupied and ritually practiced in a surveyed, formalized landscape. Something like the Olmec Frame had ancient origins but could serve to integrate new ceremonial foci into the system.

When doing this present work, the author kept two books on the desk variously left open to different illustrations. The first one was Schele and Freidel's *A Forest of Kings* (1990). Limited in my knowledge of Mayan archaeological texts and undoubtedly biased by Chacoan work on some sort of organizationally earlier formalized landscape--the assumption was that given the rise of kingships in the A. D. Mayan landscape, these logically would be largely independent territories, rather than integrated by any participatory ritual system founded in the landscape. Yet while the glyphs told of wars between kings, where were the fortifications? And clearly the powerful site symbolism in sculpture and architecture were shared across the Mayan and Mesoamerican landscape. How so? Most significantly, what was the relationship of ceremonial sites to the landscape and each other, a millennium or two *before* recorded times of kings?

The second book always open and available was of course Freidel, Schele and Parker's *Maya Cosmos*, out three years later in 1993. Here the ethnographic basis of much of this volume started to get at my questions about ritual relationships to landscape. Their comment that the ethnographer Johannes Wilbert had been an inspiration to their process stoked my fires. I had cited and exchanged emails with him about his seminal work, arguably the best description of the way a large scale, surveyed formalized frame is used ritually in relation to architectural foci--a among the Warao of the Orinoco river basin. The possibility of landscape surveying as a source of cosmic structure, however, is never explored in the *Maya Cosmos*. Some Mayan site patterns are compared to landscape related historical or modern Mayan rituals, and Schele spends interesting time with the association of celestial layouts of the Milky Way and Orion in association with myth and sculpture. Yet in the end one is left with the likelihood that even before the instutionalization of kings, territories were carved out and cosmic pattern was recreated from localized rituals and sky-based myth. What Wilbert couldn't do, because of an obvious expense of fieldwork time and resources, was to document the way a shared formalized landscape system somehow facilitated the integration of seemingly independent units within the

Warao. He does mention certain largely undocumented places in the landscape where some sort of social or ritual activity occurred in the absence of permanent architecture (their singular communal village house is rebuilt periodically). I asked him once whether any site or structure existed at the center of the landscape cosmos. He didn't know, having flown over the forested spot at one time without seeing anything.

The introduction of the possibilities of a surveyed frame, in all its symbolic manifestations, thus has no precedent in Mesoamerican or Mayan archaeology. Existing conventions about cosmic frames sees them as coming from myth, the sky or from the universal understanding of sun structure as observed on local horizons, all of which may influence spatial layouts at scales not larger than sites, though perhaps with an eye to *sakbe* extensions. The biggest immediate assumption that archaeologists are likely to make if somehow spending time with this work is that frame symbolism could not have influenced site location and layout in the time of the kings. To the contrary, however, this might well turn out to be the most interesting theoretical discussion, perhaps adding a new page to the way symbolic anthropology intersects with archaeology. This argument occurs among Chacoan archeologists, who discuss how seemingly authoritarian, architecturally defined entities can participate culturally across a large natural landscape. Was it a powerful lineage that moved into Chaco and forced participation, or were naturally hierarchical family clans moderated by sodalities cross-cutting the landscape at large scales? The idea of a Chacoan originated formal frame, with its emphasis on meridians and other benchmarks is at least presently known among SW scholars, though as yet not discussed as any driving religious foundation of large-scale social integration. The possibilities of an Olmec originated frame integrating ceremonial sites in Mesoamerica—continuously into the period of Mayan kings or elsewhere where there were no kings like Teotihuacan—could be a motivating precedent in the interpretation of Ancestral Pueblo culture.

## **3.3.4** What to do with this manuscript?

As clearly demonstrated by the inclusion of the very limited unpublished discourse in "Orientating Bonampak" blog, it is highly unlikely that presses publishing Mesoamerican archaeology will be able to find reviewers in the field. It is also probable that if sent to other arenas such as Symbolic Anthropology or Landscape History, their first move would be to try to find archaeologists to evaluate the work. Back to square one. In essence these geometric facts

and ideas constitute an exploratory "report" on work that should be ongoing particularly with the participation of archaeologists. As such it would not constitute any sort of discursive proof that any particular pattern was in fact a cultural artifact, but that such possibilities exist and need to be part of archaeological research. This material will be circulated, one way or another, and even if one were not to include latitude/longitude numbers for benchmark sites like Atitlán X or Medio points like Atitlán Medio, the locations could accurately be determined from geometric relationships with known natural and built sites.

If prehistoric surveyors did use benchmarks, as seem to have been necessary in both Chacoan and Mesamerican frames simulated by the author, they may well have been religiously considered extensions of paramount sacredness of natural features. As such they may have been minimally marked as shrines but not architectural features. If anything remains of such ancient usage—though these places may have had meaning in historical times—archaeologists should be the first to investigate this possibility. This won't happen, of course, unless this report is in the Mesoamerican record.

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