

## THE INTERPRETATION OF THE PECKED CROSS SYMBOLS AT TEOTIHUACAN: A METHODOLOGICAL NOTE

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### *Introduction*

It was the opinion of several British participants at the 1981 Oxford archaeoastronomy conference<sup>1</sup> that the interpretation of some Mesoamerican archaeoastronomical evidence might well benefit from the use of a more overtly hypothesis-testing approach. Their Mesoamerican colleagues were quick to point out the importance in their work of the independent strands of evidence which bear upon astronomical practice (other than the mere statistics of alignments): the archaeological, the ethnographic (which may bear direct relation to the cases being studied) and the ethnohistoric. A rigorous approach should, of course, be applied when attempting to tie together all these different strands, not just when studying alignment data in isolation.

In order to make methodological points, we attempt in this short paper to apply a more rigorous approach to a specific problem, the interpretation of some of the Teotihuacan pecked cross symbols<sup>2</sup> as architects' bench marks used to establish correctly oriented base lines<sup>3</sup> and hence to lay out the Street of the Dead and the remainder of the Teotihuacan street grid. In doing so we shall consider the available archaeological evidence as well as the statistics of the alignments. We shall not, however, discuss the possibility of the pecked cross symbols having alternative or additional and related functions such as calendrical devices or gaming boards;<sup>4</sup> these are hypotheses not exclusive of the bench-mark one and upon which a wider range of evidence should arguably be brought to bear.

The two principal street orientations at Teotihuacan are set out consistently over several square kilometres to within a few minutes of arc. Yet they are not quite at right angles to each other.<sup>5</sup> They are also offset both from the cardinal directions and from the local lie of the land; rivers were re-routed, for example, in preference to distorting the grid.<sup>6</sup> All this argues not only that the street grid was laid out with precision, but also that it was required to conform to pre-conceived orientations of some importance: one or two plausible astronomical explanations have been proposed.<sup>7</sup> The use, then, of bench marks in setting out base lines for this grid is not in itself unlikely.

The hypothesis we shall discuss is that the sites of pecked cross symbols TEO 1, TEO 5 and TEO 6<sup>8</sup> served as such bench marks. According to Chiu and Morrison<sup>9</sup> the two principal street grid orientations at Teotihuacan (hereinafter "TEO N-S" and "TEO E-W") are each consistently defined to within  $0^{\circ}.1$ , although the angle between them deviates from a right angle by about  $1^{\circ}.0$ . The base lines would be expected to be perpendicular, rather than parallel, to the relevant grid directions if subsequent work by the builders was to be minimised.<sup>10</sup> The 3 km-long alignment between TEO 1 and TEO 5 falls perpendicular to TEO N-S to within a tolerance of  $0^{\circ}.2$ . The 7 km-long alignment TEO

1-TEO 6 seems, from map work undertaken by Chiu and Morrison, to be perpendicular to TEO E-W to within a tolerance of at most  $0^\circ.4$ , but the exact value needs to be determined by field survey.

### *Statistical Evidence*

In order to test the bench mark hypothesis statistically against the alternative that the alignment coincidences are fortuitous, we need information about the selection of data. A total of fourteen pecked cross symbols (TEO 1-TEO 12, TEO 17 and TEX) are presently known in the vicinity of Teotihuacan. Nine of them are situated within the ceremonial centre itself and the remainder are outliers situated within 15 km of it. All but one of the symbols were listed and described by Aveni *et al.* in 1978;<sup>11</sup> TEO 17 was discovered early in 1982.<sup>12</sup> (The numeration of the new symbol was arrived at by including TEX and TEP 1-TEP 3 in the TEO sequence, even though the latter three are situated some 33 km from Teotihuacan itself and are not directly intervisible with it.)

Whether or not alignments were a factor in the siting of some of the pecked cross symbols, other factors may also have influenced their siting, many of which are now inaccessible to us. In practice, we can only test the bench mark hypothesis against the alternative that the alignments between the pecked crosses are randomly distributed in azimuth. Thus we must check, wherever possible, that any conceivable alternative hypotheses *would* actually lead to a random distribution of azimuths. Otherwise the results of a statistical test may be misleading.

Four of the symbols within the ceremonial centre, TEO 2, 3, 10 and 12, are in fact situated within 6 m of one another in the floor of a single building. It is clearly highly unlikely that this clustering is fortuitous. Thus the four symbols are not independent for the purposes of determining the significance of long-distance alignments and we count them as a single location. We are left with an effective total of six significant locations (TEO 1, 2, 4, 8, 9 and 17) within the Teotihuacan ceremonial centre and five (TEO 5, 6, 7, 11 and TEX) within 15 km of it. The central locations are clearly clustered within the general confines of the ceremonial centre, and our statistical test must not be influenced by this fact. However we assume that the relative placing of the six symbols within the ceremonial centre is random, and that the outer symbols are placed independently of one another.

Consider any pecked cross symbol within the ceremonial centre. Now consider the probability  $p$  that a single pecked cross symbol placed randomly at some distance will be aligned to within  $0^\circ.2$  of the perpendicular to either TEO N-S or TEO E-W.  $p$  is given by  $(2 \times 0.4)/180$ , or  $4.4 \times 10^{-3}$ . Consider further the probability  $P(\geq 2)$  that, of five symbols placed independently at some distance, two or more will be aligned in this manner.  $P(\geq 2)$  is given by

$$\begin{aligned} P(\geq 2) &= 1 - P(0) - P(1) \\ &= 1 - (1-p)^5 - 5p(1-p)^4 \\ &= 2.0 \times 10^{-4}. \end{aligned}$$

Consider finally the probability  $\mathbf{P}$  that, given six symbols independently

placed within the ceremonial centre, this will be true for one of them (as is in fact the case).  $P$  is approximately six times as large as  $P(\geq 2)$ , *i.e.* approximately  $1.2 \times 10^{-3}$ . This is below the figure of  $1 \times 10^{-2}$  which would indicate significance at the 1 per cent level, so this crude argument gives us no grounds to dismiss the alignments out of hand as fortuitous.

There are, however, two riders which decrease the significance of the statistical result. The first is that there is no clear evidence to date that the alignment TEO 1–TEO 6 actually does lie perpendicular to TEO E–W to within  $0^\circ.2$ . We must await first-hand confirmation from survey teams. The second rider concerns the fact that by testing only the tolerance quoted by other authors we may have chosen a value particularly favourable to the hypothesis. The dangers of doing this have been elaborated by Freeman and Elmore.<sup>13</sup> Thus we should repeat our statistical test for different tolerances. Two problems emerge when we attempt this with tolerances very much greater than  $0^\circ.2$ . Firstly, the fact that the central sites are clustered within the ceremonial centre becomes significant, for if one site yields a certain number of alignments with the outer sites then the others will tend to do so as well. Secondly, alignments intended to be parallel, rather than perpendicular, to the grid directions will show up as significant: in other words our hypothesis will become indistinguishable from the plausible alternative that outer sites were merely laid out preferentially in directions TEO N–S and TEO E–W from the ceremonial centre.

We conclude that we cannot confirm the bench mark hypothesis on statistical grounds alone, but that we cannot refute it either. We must now ask whether there is any independent evidence that might bear upon the bench mark hypothesis. Such evidence is examined in the sections that follow.

### *The Dating of TEO 1*

The most direct evidence bearing upon the bench mark hypothesis concerns the dating of the pecked cross symbols by their relation to archaeological features at Teotihuacan. Under the hypothesis as stated it is evident that the extant symbols at TEO 1, TEO 5 and TEO 6 must have been contemporary with the initial phases of construction of the street plan. TEO 5 and TEO 6 are inscribed on natural outcrops (respectively on Cerro Colorado and Cerro Gordo), and cannot be dated directly, but indirect evidence will be considered later.

The pecked cross symbol TEO 1 is situated roughly in the centre of the floor of building 15C in a group on the eastern side of the Street of the Dead. It is some 400 m south of the Pyramid of the Sun, and immediately to the north of the so-called Viking group.<sup>14</sup> The latter is a collection of buildings which were excavated by Armillas.<sup>15</sup> The investigations by Millon at Teotihuacan date the layout of the Street of the Dead to within the Tzacualli phase (*c.* A.D. 1–150).<sup>16</sup> Although Tzacualli phase debris is found on both sides of the street, Millon states that “it probably comes from redeposited fill in later buildings”. He goes on to add that little is known about “the actual disposition of Tzacualli phase structures in these areas”. Thus there is an immediate problem in positing that the extant pecked cross symbol was contemporary with the original layout of the street.

A shift of habitation emphasis occurred during the succeeding Miccaotli period (c. A.D. 150–200)<sup>17</sup> during which the Ciudadela compound was built. From the time of its construction, it seems to have functioned as the religious and ceremonial centre of the great city. Much of the monumental architecture visible today along the Street of the Dead dates to the Miccaotli phase and secure radiocarbon dates indicate that there was major building activity at this time.<sup>18</sup> According to Millon, the earliest occupation uncovered during Armillas's excavations appears to date to the even later Tlamilolpa phase (A.D. 200–450) and so the Viking group (an indicator of the chronology of structures in this area) may be even later in origin.

Thus the extant pecked cross symbol at TEO 1 must postdate the laying out of the Street of the Dead (at least in its main northern part) by at least 100 years, and probably by considerably more. The hypothesis that it was itself a bench mark is untenable and we are forced to posit instead that an earlier pecked cross symbol or series of pecked cross symbols existed directly below it.

#### *Evidence for Overlaying Pecked Cross Symbols*

Our working hypothesis (that three pecked cross symbols were bench marks) now rests upon a secondary one (that one of them is actually a later version of the original bench mark, 'repeated' through at least one floor layer of a building erected on top of it). Clearly it is strongly desirable to examine any evidence, direct or otherwise, that may justify the subsidiary assumption.

Aveni *et al.*<sup>19</sup> state: "As at Uaxactun, the penetration of the design pattern [TEO 1] through several layers of floor plaster is testimony to the importance of the location and intended permanence of the symbol." However, we know of no evidence that the exact overlaying of pecked cross symbols has taken place at TEO 1 or elsewhere in Teotihuacan, and indeed our reading of the excavation report argues against this.

Aveni's reference to the Maya site of Uaxactun concerns pecked cross symbol UAX 1. In a private communication to the present authors (1982) Aveni was kind enough to specify as three the number of layers through which UAX 1 allegedly penetrates. However the evidence given by A. L. Smith in the Uaxactun excavation report<sup>20</sup> does not support this interpretation. Symbol UAX 1 is located on the plaster floor of the Temple Court, itself an integral part of the structure A–V complex.<sup>21</sup> It appears to date to the Vault I phase, subphase C (Vault Ic). While it evidently *survived* through subsequent subphases of Temple Court construction Id and Ie there is no evidence that it was ever repeated (renewed) through successive floor levels. Such a practice was unnecessary as the construction of subphases Id and Ie did not interfere with the small area taken up by the pecked cross symbol. Construction only covered the symbol during subphase If, and when this happened it was definitely *not* renewed.

A. L. Smith has kindly confirmed these conclusions in a private communication to the authors (1983), and also points out that there is no actual proof that the pecked cross symbol was even carved during Vault Ic, despite its being shown in the Vault Ic diagram:<sup>22</sup> it might well date to subphases Id or Ie and thus have had an even shorter lifetime. The Vault If subphase is dated by

Stela 26<sup>23</sup> to 9.0.10.0.0. (A.D. 445) and the Vault Ic subphase in which the Temple Court was laid down is unlikely to date before the beginning of Baktun 9 (A.D. 280): thus the pecked cross symbol was exposed for some 150 years at the very most.

In conclusion it must be recognized that the bench mark hypothesis rests upon a secondary one for which (presently at least) there exists no independent backing, direct or indirect.

### *Archaeological Evidence*

We now ask how we might categorize the development of the pecked cross symbols on the basis of the archaeological evidence independently of any orientation considerations.

Aveni *et al.*<sup>24</sup> have discussed in some detail the design features of the various pecked cross symbols at Teotihuacan and elsewhere. It is clear that seven of the nine symbols occurring in the ceremonial centre itself are of fundamentally very similar design, as are two of the outliers (TEO 5 and TEX). Symbols TEO 2 and TEO 3, two of the group of four occurring within 6 m in the same floor, are variants with three rather than two concentric circles.<sup>25</sup> Of the remaining three outlying symbols, TEO 6 and TEO 11 are in fact not pecked at all, but are continuously carved petroglyphs. Their design consists not only of a circle with interior symbol reminiscent of the true pecked cross symbols, but of a spiral 'tail' of comparable prominence. Whether the remaining so-called pecked cross symbol, TEO 7, can really be classified as a variant is even more questionable: its design does not even incorporate a full circle.<sup>26</sup>

The five outlying symbols are all carved onto outcrops, whereas the nine occurring within the ceremonial centre are all carved into the floors of buildings. TEO 1, TEO 2 and its three adjacent symbols, and TEO 4, all occur within about 100 m. TEO 17 was discovered in the eastern wall of the Ciudadela (citadel), in the floor of building *Q* adjacent to its north wall. This structure, as those containing TEO 1, TEO 2 and TEO 4, dates at the earliest to the Miccaotli phase (*c.* A.D. 150–200), and is possibly as late as the succeeding Tlamilolpa phase. TEO 8 and TEO 9 are reported in structures adjacent to the Pyramid of the Moon which definitely date to the Tlamilolpa period (A.D. 200–450).

The similarity in form of TEO 5 to TEO 1 and TEO 17 strongly suggests that all three symbols are at least broadly contemporary. The archaeological evidence does not contradict this and suggests that they date to a period later than Tzacualli. It is reasonable to surmise on the evidence available that the remaining symbols inside the ceremonial centre were also broadly contemporary.

Thus without regard for the orientational possibilities the most reasonable hypothesis on the basis of the evidence currently available seems to be the following. The development of the pecked cross symbol in its "classic" form (TEO 1, TEO 5, TEO 17, etc.) is correlated with the expansion of the city to its zenith: TEO 5 is within the metropolitan area which expanded as far as Cerro Colorado, and TEO 1 and TEO 17 are in floors contemporary with this phase. TEO 6, TEO 7 and TEO 11, which are far outside the city bounds, bear no real

relation to the pecked cross symbols and could even be earlier petroglyphs. Certainly they could predate the expansion phase.

### *Discussion*

It is clear on purely archaeological grounds that the pecked cross symbols occurring on floors within the ceremonial centre were constructed some while after the initial phases of construction at Teotihuacan, and therefore could not themselves have functioned as bench marks. Moreover there is no evidence, direct or indirect, for a practice of overlaying which would mean that the surviving cross symbols were constructed over earlier versions. The idea does of course remain testable by excavation: but considering the amount of survey and excavation carried out at Teotihuacan over the years the non-appearance of a superimposed set of pecked cross symbols may itself be significant. In the present state of knowledge the most likely hypothesis is clearly that TEO 1 was *not* a bench mark.

TEO 6 (like TEO 7 and TEO 11) is a petroglyph which appears to belong to an earlier stage in the development of pecked cross symbols, if indeed it represents a precursor at all. If, following field survey work, the TEO 1–TEO 6 orientation is found to be perpendicular to TEO E–W within a small tolerance, as is suggested by Chiu and Morrison,<sup>27</sup> then we must seek other explanations for the alignment. At present the most likely hypothesis seems to be that TEO 6 was deliberately aligned TEO-north of (*i.e.* in line with) the Street of the Dead to an accuracy of about a degree. Its precise position in relation to TEO 1, even if this turns out to be perpendicular to TEO E–W to within 0°·2 or better, is completely fortuitous.

TEO 1 and TEO 5 are symbols of similar form, apparently both dating to the expansion phase (long after the original street grid directions had been set up). Their orientation perpendicular to TEO N–S still demands an explanation even if the TEO 1–TEO 6 alignment is shown not to be precisely perpendicular to TEO E–W. In the present state of knowledge, it appears that the explanation should take into account the apparent construction of TEO 1 and TEO 5 long after the street grid was laid down, rather than before it.

Rather sooner than many of their European counterparts, Mesoamerican archaeoastronomers have tended to stress the importance of independent strands of evidence which need to be considered alongside the statistics of alignments. In the Mesoamerican case these strands are not merely archaeological. However, even the archaeological evidence alone, when considered fairly and with some rigour, can provide quite a tight rein on archaeoastronomical hypotheses. In some cases at least, it appears to need much fuller consideration than it has received to date.

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## COMMENT

Ruggles and Saunders's paper on the interpretation of the Mesoamerican pecked cross symbol is both an important contribution to the literature and an excellent example of how the critical archaeological perspective, too long lacking in Mesoamerican archaeoastronomy, can serve to aid in the development and revision of hypotheses.

In the first part of their paper, these authors apply statistical tests in order to determine whether certain pecked circles might have been placed fortuitously. While deliberate placement of the pecked crosses is neither confirmed nor denied by these tests, a few remarks on the nature of the method are in order. While the application of these tests may have the appearance of increasing the rigour of one's approach, the methodology employed by Ruggles and Saunders, which tends to isolate and examine one cause at a time for a given phenomenon, often can be counterproductive.

For example, if we applied a similar test to the ceques lines of Cuzco<sup>1</sup> we probably would not be able to discover that only a few of them, in fact, function as astronomical sight lines—indeed, several chroniclers tell us this is so. Moreover, we know from the ethnohistoric evidence that many ceques cannot be sight lines. Indeed, the written record states that there were multiple and interconnected reasons why the ceques were arranged as we find them today, astronomy being but *one* factor *some* of the time. Likewise, we already suspect a number of uses for pecked circles—as game boards, counting devices, etc. This knowledge complicates the apparent simplicity of testing the hypothesis that all of them as a class are placed for orientation purposes.

It may be premature to assume that TEO 6, 7, and 11 bear no real relation to the pecked cross symbols because they do not conform to the “standard design” and because they are not in direct view from the ceremonial centre. (It is not clear whether the authors visited the sites of each of the petroglyphs they rejected.) Indeed, we have made an argument for the inclusion of these designs in the orientation program.<sup>2</sup>

Further concerning the taxonomy of the TEO petroglyphs, one would think that the mode of execution of the design (pecked *v.* scratched over) is subordinate to the general shape of it: like TEO 1 and 5, both TEO 6 and 11 are *quartered circles*. Indeed, a closer look at TEO 6 *in situ* reveals that the design, like the TEX petroglyph, was probably originally pecked, then scratched over much later, perhaps even in recent times. One still can feel the remains of some of the pits on the periphery of the circle. That the addition of a spiral tail to a quartered circle symbol ought to exclude that symbol from the bench mark class seems arbitrary.

Ruggles and Saunders's second task concerns the testing of the bench-mark hypothesis. Stated in its earliest form by Millon *et al.*,<sup>3</sup> this hypothesis inquires whether the pecked circle designs were employed to assist Teotihuacan architects in laying out the rectangular grid of the ceremonial centre. Millon *et al.* and Dow<sup>4</sup> expanded the hypothesis by proposing general and specific astronomical motives respectively; later Aveni<sup>5</sup> further elaborated the astronomical hypothesis.

Ruggles and Saunders isolate the definition of bench mark to mean an original marker of some sort, *i.e.* one that affected the initial plan of the city. Such a marker must be dated to the earliest building phase and, if reproduced at all, it is required to overlay itself precisely. Given this definition, they have succeeded fully in demonstrating the absence of contemporaneity between the TEO 1 design and the earliest building phases of the city. However, they remind us that the bench-mark hypothesis cannot be put to rest until all of the floors of the structure which houses TEO 1 are excavated.

Regarding supportive evidence for the overlaying of designs, this author stands corrected on his earlier interpretation that the UAX 1 petroglyph penetrated through several layers of floor. He is guilty of having misread Ledyard Smith's archaeological map, which actually indicated that the UAX 1 petroglyph survived three building phases Ic–Ie, during which the floor, in fact, was unaltered. (A lesson learned: let the archaeologists interpret the archaeological data.) We note that there were two other circles, presumably at the same floor level,<sup>6</sup> on the Temple Court floor south of Str. C which Smith says



he removed in order to excavate below. A few years ago, at his suggestion, the writer undertook an unsuccessful search of the Peabody archives for notes and photos relating to these markers. Indeed, if they actually lay at the same level, it is curious that they do not appear in Smith's Figures 60–62.

An altered version of the bench-mark hypothesis, with which Ruggles and Saunders's analysis seems concordant, states that the pecked circles were employed as (non-original) bench marks to affect a reorientation of the city. Retention of the word 'bench mark' in this hypothesis seems appropriate since there is plenty of evidence that this type of marker was used to establish orientations elsewhere.<sup>7</sup> The fact remains that the TEO 1 petroglyph is situated in a west-facing temple that looks out upon the horizon where TEO 5 is located and the line between them fits the E–W axis of the grid. Given the great length of the baseline one could establish a reorientation without the need of precisely superposing one design exactly over another.

On the involvement of TEO 6 with the N–S grid, we call attention to a paper in which Aveni and Hartung<sup>8</sup> point out that a line from the centre of the Pyramid of the Sun to TEO 6 is parallel (to within 31') to the Street of the Dead. While this alignment involves a pyramid and a pecked circle rather than two pecked circles (pyramids are not admitted as data in Ruggles and Saunders's test procedure), we would hesitate to remove the possibility of a north-south orientation from consideration at this time. Given the discovery of other pecked circles in the Ciudadela<sup>9</sup> nearly in line with the southern extension of this axis, a reinvestigation of the entire Teotihuacan orientation problem may be in order.

Finally, a comment on the role of archaeology in archaeoastronomy. One ought to be concerned that the casual reader might perceive Ruggles and Saunders's note as an example of how archaeology *only* functions to provide a tight rein on archaeoastronomical hypotheses. Indeed, the careful work these authors performed can create some new ideas. For example, they have managed to show quite clearly that the UAX 1 and TEO 1 petroglyphs can be dated to very nearly the same time. This conclusion is consistent with other evidence for Teotihuacan influence in the Peten. If the TEO 1–TEO 5 alignment still is regarded as significant, one now may deal more specifically with the non-original bench-mark hypothesis. With the bolstering of the hypothesis for the astronomical use of pecked circles by new evidence at Alta Vista (Chalchihuites), Ruggles and Saunders might care to follow the implications of their conclusions a bit further, rather than only placing restrictions on the earlier hypothesis.

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