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Teotihuacan – orientation and water

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We outline and reject previous views that Teotihuacan was astronomically oriented and instead give evidence that a magnetic compass was used for its orientation. Further support for magnetic orientation of prehistoric ceremonial centers is found in Mesoamerica and China. In line with this view, we find from new paleomagnetic declinations that the Avenue of the Dead, dictating the layout of the whole future City of Teotihuacan, was probably set in 400 BC. Notes on water reservoirs in the Avenue of the Dead are added, with a simulation, with the aim to provoke interest of specialists.

Teotihuacan (150 BC - 700 AD) was one of the largest town in the world during its height (200 AD - 650 AD), a metropolis with great impact on many cities in Mesoamerica, a complex market place, art center and ritual site. The main buildings such as the Pyramid of the Sun, Pyramid of the Moon or Ciudadela (Citadel) along with the Temple of Quetzalcoatl (Figs. 1, 2) are already dates as AD, but the original settlement (villages nearby) began much earlier, probably ~600 BC. The „sacred cave“ later under the Pyramid of the Sun could have been used ritually from time immemorial. (Böhm, 2010, priv. commun.).

The basic orientation axis of the locality which gave the space orientation to the whole City is the Calzada de los Muertos (Avenue of the Dead), a “road” 2.2 km long and about 40 meters wide, with a clockwise deviation of about 15.5 deg (direction to the east of astronomical north), Fig. 2. It is pointing roughly to the western part of the top of Cerro Gordo (a nearby volcano about 3000 meters high). A line parallel with the Avenue intersecting top of the Pyramid of the Sun is directed to the eastern part of the top of this volcano. A line passing from the summit of the Pyramid of the Sun parallel to the axis of the Avenue crosses geometric center of the Citadel. The height difference between center of metropolitan Teotihuacan and the top of Cerro Gordo is about 800 meters. The height difference between the north and south ends of the present-day Avenue of the Dead is about 30 meters (the southern end is the lower). All these “geometric facts” are important components of a “harmony” having roots in “cosmic geomancy”, as nicely explained by Aveni [1]. Now, they can easily be verified using satellite images with high resolution on Google Earth (like in Fig. 2).

Once the Avenue’s alignment “15.5 deg“ was set it stayed constant notwithstanding later urbanistic alternations. The urban solution of the metropolis worked in fact with the two axes having the “inclination” 15.5 and 16.5 degrees from astronomical north to east and this fact has never been fully understood [1], although Šprajc [2] provided a reasonable explanation. The layout of the growing city never deviated from that “basic” original orientation and grid plan, a grand and sacred scheme. The terrain about Teotihuacan is more or less flat, so the orientation of the whole complex might have been diverse and arbitrary from a practical point of view. But on the contrary it was specific, intentional, strongly motivated. But when was the orientation of the original version of the Avenue of the Dead set? We will see that for a magnetic orientation of the original Avenue we need a date as early as possible, certainly before 150 AD and optimally around 400 BC. In fact little is known currently to date about the origin of the Avenue or the beginnings of Teotihuacan (Böhm, 2010, priv. commun.).

Astronomical orientation of Teotihuacan – usual explanations

The orientation of Avenue of the Dead might be defined conveniently with respect to the azimuths of the (heliacal) rising or setting of certain celestial bodies on specific days; for example by the Sun’s rising or setting on the days when it passes over the zenith. However these (for latitude 20 deg at Teotihuacan) are 20 May and 26 July, with azimuth of setting 291 degree (east of north) at the latter. These days and the Sun's azimuths are clearly not relevant to the orientation of the Avenue. Researches however consider the day 13 August as more important – it is the “beginning of the world” according to the Maya, namely 13 August 3113 BC when transformed to our calendar

using the GMT correlation. On 13 August, the relevant azimuth is 286 deg. The line with this azimuth crosses the Avenue of the Dead (having the azimuth 16 deg) at a right angle. Looking from the Pyramid of the Sun in this direction, the observer can see the Sun's setting behind a nearby hill.

According to Malström ([3] and older works) the grid of Teotihuacan is based on the position at which the Sun sets on 13 August, see Fig. 3 (reproduced from www.dartmouth.edu). Malström claims that "...the siting of the Pyramid of the Moon at the far end of the avenue was likewise done with such care that a sight-line directly over the top of the Pyramid of the Sun marks the meridian..." But the line labeled as "MERIDIAN" in Fig. 3 in reality deviates 2 deg west of (astronomical) meridian. We measured coordinates on the tops of both pyramids by GPS and computed that azimuth ten years ago. Now anybody can check it quickly and easily by Google Earth. Malström's "meridian" is mistaken. But more importantly, another problem with the astronomical view is with the GMT correlation, which is very probably not correct and should be replaced by another one, probably by Böhm&Böhm correlation, see [4]. Then 13 August (3113 BC) loses its significance and "the beginning of the world" is postponed to 29 August (3009 BC) where the Sun's azimuth at rise or set times have no close relation to the Avenue's orientation.

Aveni already in 1973 (see [1] for more references) suggested astronomical explanation of Teotihuacan through the azimuth of heliacal rising of Pleiades (an open cluster in the constellation Taurus): "The Pleiades underwent heliacal rising on the same day as the first of the two annual passages of the Sun across the zenith [20 May, see above, our comment], a day of great importance in demarcating the seasons... The stars appear in their exact position relative to the horizon about A.D. 150..." The problem is in that date 150 AD, the date when it was assumed that City of Teotihuacan had been laid out. A small error in this timing, say ± 50 years, means 0.4 deg change in the azimuth at the horizon, due to the effect of precession. The same problem would be with any other stellar object (not with the Sun). This makes Aveni's construction a little bit "artificial" (when we accept for example the age 400 BC instead of 150 AD). Moreover, rising/setting direction of Pleiades cannot explain "15.5 vs 16.5 deg" difference.

Šprajc [2] relies upon 13 August again (among other dates). The conclusions of Šprajc ([2] and other works) can be summarized as follows: „(a) the two similar but slightly different orientations dominating the Teotihuacan urban grid must have been dictated by those of the Sun Pyramid and the Ciudadela; (b) both orientations were related to the Sun's positions on the horizon on dates separated by calendarically significant intervals and composing a canonical agricultural cycle..." We guess that (a) the Avenue is older and dictated a grid for the whole city. We do not see any conflict with our new hypothesis as for the item (b).

Note also that rainfalls in Mexico City area today are dramatically different in winter and summer time; they are about 10 times lower in December-January-February than in June-July-August-September. Assuming that it was similar for Teotihuacan 2000 years ago, we find that meteorological conditions for astronomical observations in summer were poor; this also argues against an astronomical explanation of the orientation.



Fig. 1: Classic view on Teotihuacan from north, from Pyramid of the Moon, with Pyramid of the Sun and Avenue of the Dead. Photo © J. Klokočník, 2010



Fig. 2: The orientation of Avenue of the Dead as seen on satellite image by © Google Earth; direction 15.5 deg to the east from astronomical north. The Pyramid of the Moon on the north end of the Avenue, Citadel on its south-east edge. This orientation has astronomical explanations (Aveni, Malstrom, Šprajc, see the text). Note the river (from east to west, crossing the Avenue) has been regulated (into a canal) in accord with the rectangular plan of the city.

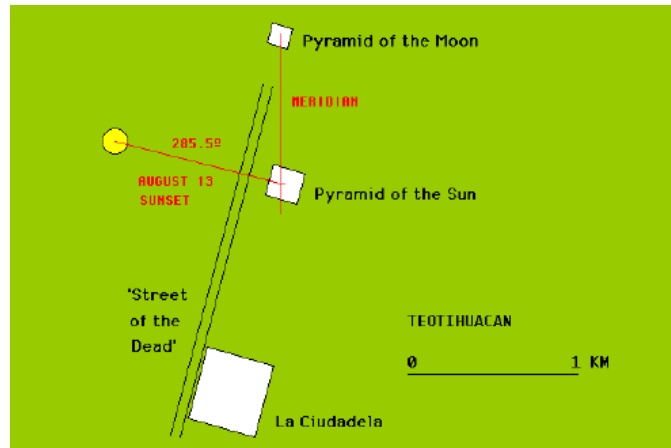


Fig. 3: On astronomical orientation of Teotihuacan, to Malström's hypothesis [3]. The Sun sets directly opposite the Pyramid of the Sun - azimuth of the sunsets is 285.5deg on 13 August and 20 April.

Fuson hypothesis

Pyramids and other buildings are oriented with respect to the actual direction to the north magnetic pole in the epoch of their construction or last reconstruction. Due to the changing direction in time to the north magnetic pole with respect to the pole of rotation of the Earth (astronomical north), which only changes very slightly itself, the orientation of the buildings constructed at different times also changes with time. Thus, there should be a clear correlation between age and orientation of the buildings. This is the core of Fuson's hypothesis [5], supported by discovery of Olmec's lodestone compass in San Lorenzo (dated to 1000 - 1200 BC) [6]. Unfortunately only one actual compass has been found so far (at that Mexican site).

The question whether the changing orientation of buildings in Mesoamerica through time has a correlation with changes of the deviations of the magnetic compass (paleomagnetic declination) has been answered positively by Klokočník et al [7]. This correlation was established for many (not all) tested localities in Mesoamerica based on many on-site measurements. Also Charvátová et al [8] discovered similar positive correlation for chinese „pyramids“ (tombs) in Xi'an and Luoyang provinces of central China, using satellite images on Google Earth (no terrestrial measurements). Note that it does not mean any „teleconnection“ between these two civilizations. It is important for us. Now we consider our results in [7] from Mesoamerica and in [8] from China encouraging enough that we can extrapolate to Teotihuacan although we originally believed that its orientation was astronomical.

Paleomagnetic declinations for Mexico

The Fuson's hypothesis can not be tested without relevant knowledge of the paleomagnetic pole position as would be observed at the locality investigated, valid for a given time (Fig. 3 in Klokočník et al [7]). In other words, we need the paleomagnetic declinations relevant to the given place and date. They are available from worldwide spherical harmonics models for the Earth's magnetic field, e.g. Korte et al [9], which provide global (but inevitably smoothed

data) or from the data gathered specifically for the area of interest. The latter is what we prefer and have for Mexico thanks to Dr Harald Böhnel from Mexico. For a comparison with other data sources and more information about the paleomagnetic data see [7] and references in it.

Fig. 4 shows the paleomagnetic declination changes for Mexico for the interval 0 - 4000 BP (before present) or 2000 AD – 2000 BC. The positive declination means clockwise deviation from astronomical north to east, as in Fig. 2. Changes of direction to the magnetic north are significant and can be rapid, as happened between 500 BC and 100 BC or in 900-1100 AD for Mesoamerica, compared to the situation valid for the “pyramids” for China, in [8].

Orientation of Teotihuacan with magnetic compass?

If one can rely upon the paleomagnetic declinations (Fig. 4), if information about the “Olmec compass” in [6] is correct, and if archaeologists do not have serious objections to our timing of the orientation of an “oldest” version of the Avenue of the Dead, i.e. in the time interval 300 - 500 BC (Böhm, 2010, priv. commun.), then we can explain the orientation 15.5 deg east of astronomical north by the use of a magnetic compass (Fig. 4). The directional precision of this compass might reach 1 degree, no more. The directional difference “15.5 vs 16.5 deg” then looks insignificant (or related to two slightly different epochs). Once the orientation was given, it was kept during all subsequent improvements and reconstructions (of the structures along the Avenue). Accepting the Fuson hypothesis we do not need any complicated astronomical explanation of the grid layout at Teotihuacan.

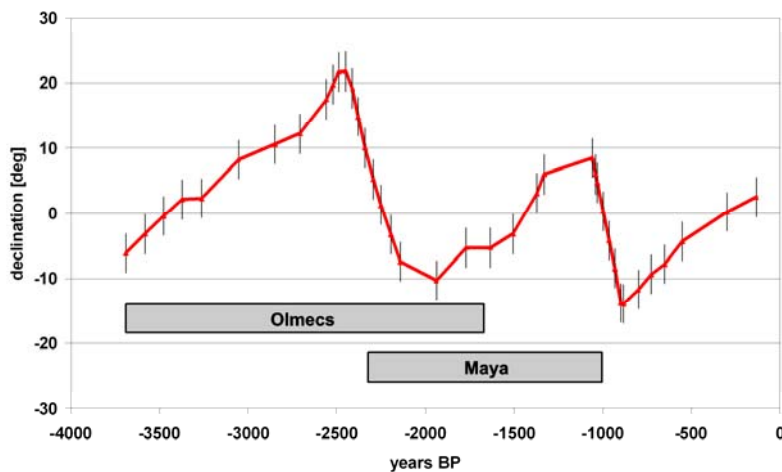


Fig. 4: Paleomagnetic declination for Mexico according to Böhnel (2006), priv. commun. [7]. Precision is expressed by the error bars. Note significant changes of the declination in time intervals 500 BC - 100 BC or in 900 - 1100 AD. Note as a warning also that local anomalies of the paleomagnetic declination (which may reach few degrees) cannot be recorded by this curve and thus remain unknown. This curve yields two possibilities for the age of the Avenue of the Dead, namely approx. 400 BC and 600 BC (when the declination was 15-16° east); we selected the younger date.

Water in Avenue of the Dead?

Dwelling quarters, water reservoirs, canals, canalization were an integral part of the Teotihuacan metropolis. Everybody can detect some constructions concerning water for example in s/c Grupo Viking and inside the Avenue of the Dead itself, namely in its southern part between pyramid of the Sun and Ciudadela, on surface and beneath it.

Fig. 5 shows the northern bank at the first reservoir, Fig. 6 the channel (water conduit) to the first reservoir, then Fig. 7 shows the next dam and Fig. 8 connecting channel between the first and second basins, with a “turning” to the Viking group. Figures 9 and 10 show examples of ruins of buildings (water spa?) in the Viking group nearby. Figs. 11 and 12 show further reservoirs in the south direction, this time with a central island each. Note green grass inside the reservoirs. Water is now in shallow depth here. It is also possible to watch some constructions beneath the surface and a mud under surface (depth about 1.5 m) in some places.

We present our provocative speculation how it might look like with the system of water reservoirs hypothetically filled with water, Fig. 13, with water running in the north-south direction throughout the connecting conduits. The water level in the system might be easily regulated. What is still missing in our imagination is the source of water, a spring or river providing sufficient amount of water (from Cerro Gordo on the northern side?). No doubts that specialists know or will find the relevant answer. As we know the idea of the water reservoirs “inside” the Avenue shown on Fig. 13 has not been presented yet in open literature.



Fig. 5: A bank of the first (most northern) reservoir in the Avenue of the Dead (close to Pyramid of the Sun), and northern side (steps) of the first reservoir.

Fig. 6: A tunnel (channel, conduit) under the first bank leading water to the first reservoir.
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Fig. 7: Next dam, this is between 1st and 2nd reservoirs;

Fig. 8: Next conduits with a branch to the Viking group.



Figs. 9 and 10: Ruins of Viking group near Avenue of the Dead. Was here water and was this a part of spa?



Figs. 11 and 12: Further reservoirs in the southern direction on Avenue of the Dead, with artificial “islands”(?).
Note green grass; now water is here in depth ~1-2 meters.



Fig. 13: Satellite image from Google Earth showing southern part of Avenue of the Dead, added in blue color are possible water basins. A general view, hypothetical reconstruction.

No. 1 corresponds to Fig. 5, No. 2 to Fig. 8, Nos. 3 and 4 to Figs. 9 and 10, No. 5 to Fig. 11 and No. 6 to Fig. 12.

Conclusion

An alternative hypothesis to astronomical hypotheses about the orientation of the Avenue of the Dead (and consequently of the whole Teotihuacan) has been formulated. We claim that the orientation was done by means of a magnetic compass (in frame of a “cosmic geomancy”). The arguments come from [5] - [8] and are supported by the recent paleomagnetic data (Fig. 4). The assumption is that the oldest choice of the orientation of Avenue of the Dead was from about 400 BC (then it dictated the layout of the whole Teotihuacan metropolis). We also note about possible “water management” in the Avenue and its surrounding – our imagination about the water reservoirs, dams (banks) and conduits is depicted in Fig. 13.

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