Supplementary Material for "Solstice Alignments at Angkor Wat and Nearby Temples: Connecting to the Cycles of Time"

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Introduction

The main text of this article presents data suggesting that solstice alignments were intentionally incorporated into the design of Angkor Wat. Details relevant to four more solstice aligned temples are also included in the main text. The purpose of the present document is to provide detailed assessments for ten additional Angkor temples and a more distant site known as Preah Khan of Kompong Svay. We begin this document, however, with additional commentary regarding the methods employed in the study – especially concerning the use of Google Earth Pro (2018).

Methods

To determine if a structure is aligned to a celestial event, the first requirement is to establish astronomic, or true north relative to the structure. My preference is to rely on ground-based survey data for the structure that I have personally collected and oriented to true north based on multiple solar observations using a total station. However, due to logistics this was not a practical option for the current project.

The next-best alternative is to use LiDAR (Light Detection and Ranging) imagery corrected to true north. LiDAR data for much of the Angkor area have been collected (e.g. Evans *et al.* 2007; Evans *et al.* 2013; Evans 2016). Unfortunately, I do not have access to that data. The École française d'Extrême-Orient (EFEO), Siem Reap Centre explains that, "lidar data for the Angkor area is privately-funded and the IP is therefore tied up among various parties, which makes it unavailable for public dissemination" (EFEO, email communication to author, June 5, 2017).

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Another option is to use aerial or satellite imagery such as provided by Google Earth Pro (2018). This is the option used here. Google Earth Pro shows north as referenced to the WGS84 datum using the Simple Cylindrical Projection. Since meridians in this projection are necessarily oriented to geodetic north, Google Earth imagery is likewise oriented to geodetic north. For all practical purposes, true north and geodetic north can be considered the same. (The difference, known as the La Place correction, varies according to location but is typically less than 30 seconds of arc.) Additionally, however, and simply as an interesting experiment, I compared the azimuth values for earlier measured sightlines tied to solar observations using a total station (Romain 2004, 67) against azimuth data for the same points measured using a computer protractor on the corresponding Google Earth image. As a side note, I prefer not to use the Google Earth Pro ruler for angle measurements as my experience has been that this is not always accurate. I found no discernible difference at map scale between the on-the-ground measurements made using the total station Sun shot method (Wolf and Ghilani 2002, 530) and the computer protractor-measured Google Earth Pro image azimuths. I am confident that for studies such as this, Google Earth imagery allows for accurate horizontal angular measurements referenced to true (or geodetic) north.

The least desirable alternative when making archaeoastronomical assessments is to rely on survey maps made by others. All too often, such maps are problematic in terms of showing true north. Relatively few maps show true north as established by solar or stellar observations. Most use UTM north, State Plane coordinate north, arbitrary grid north, magnetic north (often with no year given for declination value) or north derived from incorrectly applied corrections to magnetic north. None of these "norths" are the same as true north (or geodetic north).

When working with any aerial or satellite imagery, camera tilt and associated relief displacement can be of concern (Wolf and Ghilani 2002, 798–800). It is preferred that the camera be as close to perpendicular to the ground target as possible. The overlapping of photos during the Google Earth image-making process helps minimise this potential problem. Further, Google Earth Pro provides a function that resets the compass to zero and tilt to as close to vertical as the photos allow once a target is centred (View →→ Reset →→ Tilt and Compass). This tool was applied throughout the present study.

Linear dimensions provided in Table 1 (main text) were made using the Google Earth ruler tool. The caveat is that the accuracy of the Google Earth ruler for linear measurements at the scale shown here and at this location is not known. Accordingly, linear measurements provided in Table 1 are intended only to show how the east–west sides of temple structures are, in general, longer than north–south sides.

For the locations assessed in this article, Google Earth Pro provides a series of images taken in different years. The quality of these images in terms of resolution, ground cover and shadow effects differ from year to year. For the present study, the entire series of available photos for each site was reviewed with the best quality imagery selected.

The method used to calculate solstice azimuths relies on the formula (Wood 1978, 61),

$$\cos A = \frac{\sin\delta - \sin\varphi \sin h}{\cos\varphi \cos h} \qquad \text{(SE1)}$$

where *A* stands for the azimuth, *h* is the horizon elevation, φ (phi) represents the latitude of the site, and δ (delta) is the declination of the Sun for the relevant year.

Given that the Angkor area is basically flat, a horizon elevation of 0.5° was used, corrected for refraction (-0.5°) and lower limb tangency (+0.25°) (where lower limb tangency refers to the instant when the bottom of the Sun touches the horizon). Declination values for 1000 AD were determined from Ruggles (1999), cross-checked against Aveni (2001).

Because the Sun rises and sets at an angle to the horizon, horizon elevation affects the rising and setting azimuth values for the Sun. Factors that typically result in other-than-flat horizons include trees, mountains and human-built walls and structures: such obstacles raise the apparent horizon elevation. For Angkor, we do not know if temples were aligned using horizon elevations observed from ground-level locations at the temples or from previously built nearby towers at or higher than the forest canopy. I suspect that solar azimuths were based on observations made earlier at locations other than at each temple, using an essentially flat horizon with the results then applied in a template fashion during the design phase of each temple. Because the azimuths for the solstice sunrises and sunsets change so slowly, due to changes in the obliquity of the orbit, observation and/or calculation dates plus or minus several hundred years from 1000 AD will not result in azimuth differences discernible to the naked eye.

Results

Phnom Bok

Phnom Bok is located 13.9 km northeast of Angkor Wat, on the summit of a 213 m high hill also known as Phnom Bok (Figure S1). The site is one of three hilltop temples built in the early tenth century AD by Yashovarman I (Higham 2001, 65).

Archaeastronomical assessment finds all four solstice azimuths incorporated in the design of Phnom Bok. In Figure S1, points A and B are the points of origin for these alignments. The points of origin conform to the design plan shown in Figure 6a (main text), without *gopura*s. Of the four posited solstice alignments, the summer solstice sunset alignment is the least accurate. The ideal summer solstice sunset azimuth (solid line) misses the corner of the structure (dashed line) by about 1.0°.

Phnom Krom

Phnom Krom is situated about 15 km southwest of Angkor Wat. The temple pyramid is situated on a 116 m high hill overlooking the Angkor plain and Tonle Sap Lake (Figure S2a). Phnom Krom is the one of the three hilltop temples built in the early tenth century AD by Yashovarman I (Higham 2001, 65).

All four solstice azimuths are incorporated in the design of Phnom Krom. The solstice alignments follow the design shown in Figure 6a (main text). Figure S2b shows the align-

FIGURE S1. Google Earth image of Phnom Bok with solstice azimuths plotted.

ments. They extend from points A and B through the corners of the complex. Although not visible in the aerial photo, floor plans and descriptions (Glaize 1948, pl. XXVII; Laur 2002, 298, 300) document *gopura*s at points A and B. Today only fragments of these structures remain. Of the four solstice alignments, the summer solstice sunset alignment is the least accurate. In this case, the ideal summer solstice sunset azimuth (solid line) misses the corner of the structure by about 0.75°.

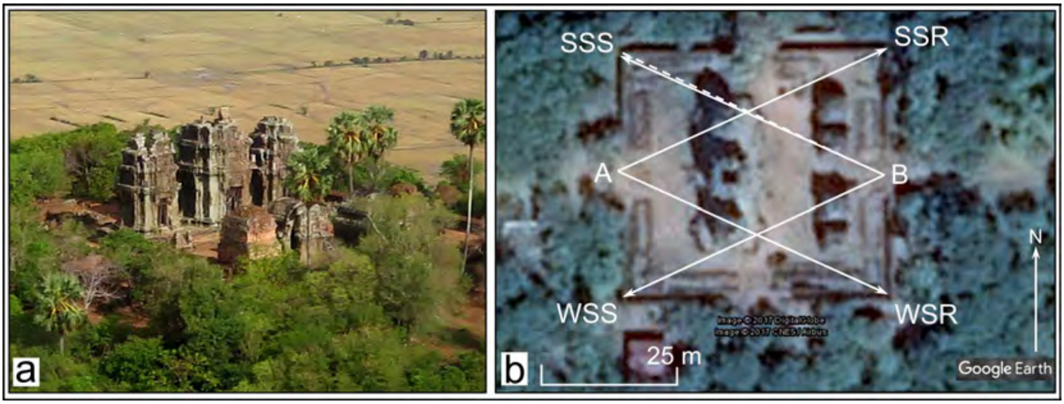

FIGURE S2. a. Aerial view of Phnom Krom from the northeast (photograph by author); b. Google Earth image of Phnom Krom with solstice azimuths plotted (lat. 13.285477º, long. 103.812340º, eye alt. 109 m, imagery date 20 November, 2013).

Banteay Srei

Banteay Srei (Figure S3) is located 23 km northeast of Angkor Wat. It was built in the mid-tenth century AD during the rule of Rajendravarman II (Higham 2001, 80). The temple was devoted to Shiva. A linga is located in the central tower.

Unfortunately, the satellite imagery for this site is fuzzy. Still, it is of sufficient quality to allow a fairly reliable archaeoastronomical assessment. That assessment shows all four solstice azimuths incorporated in the design. The design follows the plan shown in Figure 6a (main text), with solstice azimuths originating at *gopura* entrances along the minor axis. In Figure S3b, these structures are identified as points A and B.

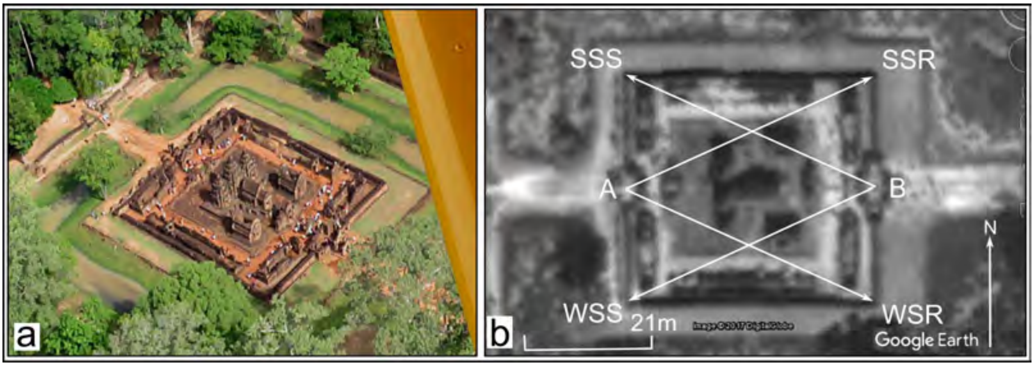

FIGURE S3. a. Aerial view of Banteay Srei from the southeast (photograph by author); b. Google Earth image of Banteay Srei with solstice azimuths plotted (lat .13.598950º, long. 103.963014º, eye alt. 92 m, imagery date 26 October, 2012).

Ta Keo

Ta Keo (Figure S4) is located 4 km northeast of Angkor Wat and is dedicated to Shiva. The temple was built in the late tenth to early eleventh century AD under the rule of Jayavarman V (r. 968–1001 AD) (Higham 2001, 66). The temple pyramid is surrounded by a moat and two walls. The centre pyramid has three levels.

Interestingly, the centre pyramid is offset to the west of the centre of the outer enclosure walls (Laur 2002, 249). This allows for multiple solstice alignments to be incorporated in the design. Figure S4 shows these alignments. The outermost set of solstice azimuths have their origins at *gopura*s at points A and B. Additional parallel solstice lines extend from other *gopura*s situated along the minor site axis.

Of the 12 posited solstice alignments at Ta Keo, most are accurate to within 0.5°. The exception is the longest of the three winter solstice sunset lines. Shown in Figure S4, the ideal solstice azimuth (solid line) misses the corner of the structure by about 0.75°.

Baphuon

Baphuon (Figure S5) is situated 3.6 km northwest of Angkor Wat, within the greater Angkor Thom enclosure. The temple was built in the mid-eleventh century AD by Udayadityavarman II (r. 1050–1066 AD) and is dedicated to Shiva (Petrotchenko 2014, 138).

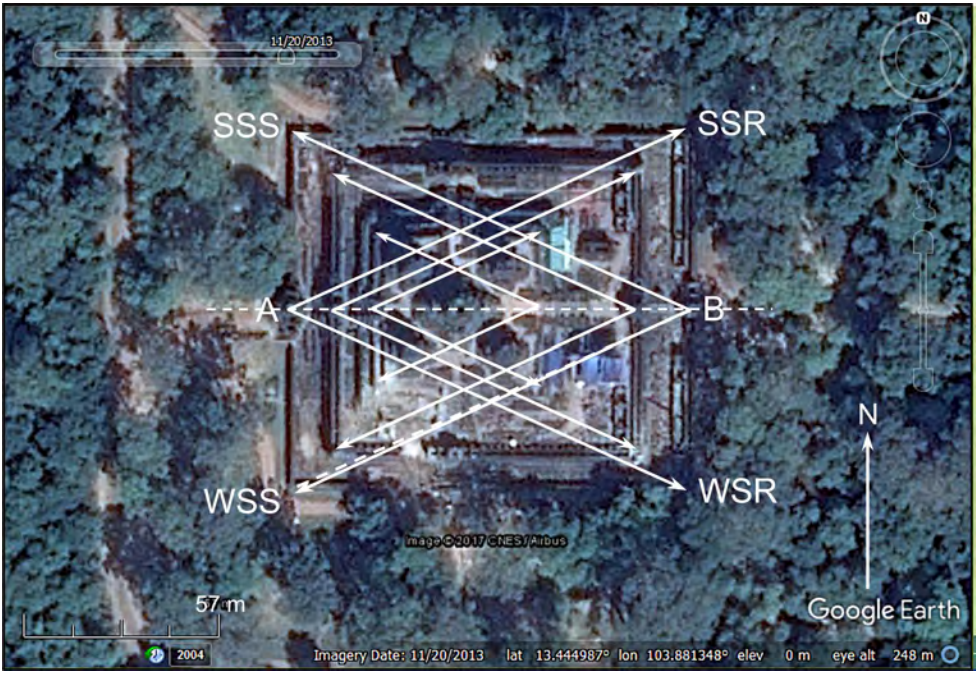

FIGURE S4. Google Earth image of Ta Keo with solstice azimuths plotted.

The complex features a multi-level pyramid. Archaeastronomical assessment finds all four solstice azimuths incorporated in the structure. Solstice alignments originate at *gopura*s situated along the minor axis. In Figure S5, these *gopura*s are at points A and B.

One of the interesting things about Baphuon is that the outer enclosure is skewed from the cardinal directions by 0.5–1.0° (east–west enclosure wall = 0.5° skew; north–south enclosure wall = 1.0° skew). That said, and as shown by the dashed line in Figure S5, however, the inner pyramid is accurately oriented to the cardinal directions with the result that the solstice azimuths accurately intersect their corner targets.

Ta Prohm

Ta Prohm (Figure S6) is located 3.5 km northeast of Angkor Wat. It was built in the early twelfth century AD by Jayavarman VII (r. 1181–c. 1220 AD) (Higham 2001, 122), and Petrotchenko (2014, 182) explains that the temple was dedicated "to the memory of his mother, venerated […] in the likeness of Prajnaparamita, the mother of all Buddhas".

Ta Prohm is surrounded, and to a large extent covered over, by dense forest (Figure S6). Unfortunately, this tree cover precludes astronomical assessment. Of interest, however, is that from what can be seen of the walls, it is clear that the orientation of the complex is skewed by several degrees from the cardinal directions – not every Angkor temple is oriented north–south and east–west. As discussed below, some sites are oriented toward phenomena other than cardinal and/or solstice directions.

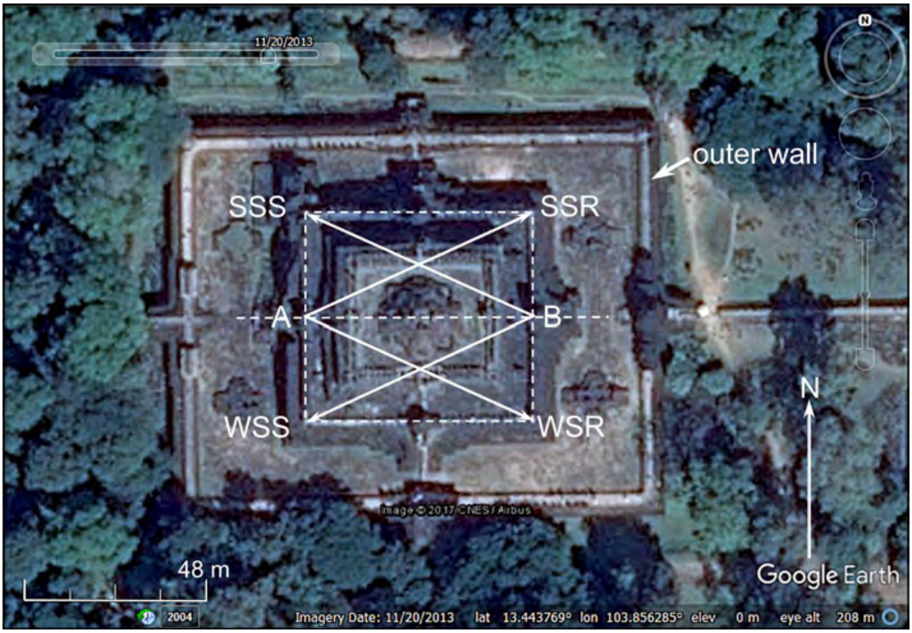

FIGURE S5. Google Earth image of Baphuon with solstice azimuths plotted.

FIGURE S6. a. Ta Prohm entrance gopura (photograph by author); b. Google Earth image of Ta Prohm.

Preah Khan

Preah Khan (Figure S7) is located 5.4 km north-northeast of Angkor Wat. It was built in the twelfth century AD by Jayavarman VII (Higham 2001, 125). The temple complex includes Brahmanical and Buddhist elements.

The complex is quite large. The rectangular wall surrounding the interior buildings, for example, is roughly 700 × 800 m. Figure S7b shows the centre temple area. In a largerscale view, a moat can be seen surrounding the centre temple area. The centre temple complex shown in the figure is skewed counterclockwise from the cardinal directions by 1.0°. The east and west walls are a bit difficult to see clearly in the Google Earth image; however, it appears that only the solstice sunrise azimuths are reflected in the design. In Figure S7b, these azimuths originate at point A.

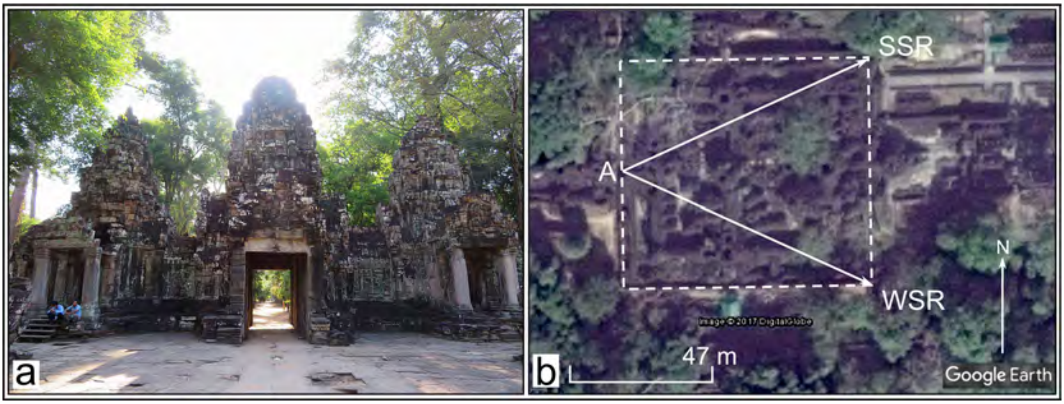

FIGURE S7. a. View of Preah Khan entrance *gopura* (photograph by author); b. Google Earth image of Preah Khan with solstice azimuths plotted (lat. 13.462575°, long. 103v.871663°, eye alt. 205 m, imagery date 29th January, 2013).

Bayon

Bayon (Figure S8) is located 3.3 km north-northwest of Angkor Wat. It is situated at the centre of the Angkor Thom enclosure. Jessup (1997, 115) refers to the temple as "the microcosmic center of the city of Angkor Thom". Bayon and the Angkor Thom enclosure were built in the late twelfth / early thirteenth century AD by Jayavarman VII (Higham 2001, 121). The temple is Buddhist and is famous for the many large faces sculpted on its towers (Figure S9). The faces look out to the cardinal directions. They may represent Jayavarman VII manifested as Avalokitesvara, the Buddhist bodhisattva of compassion.

Archaeastronomical assessment shows all four solstice azimuths incorporated in the design of Bayon. The design follows the plan shown in Figure 6a (main text), with solstice alignments originating at *gopura* entrances. These *gopura*s are on the minor axis of the site at points A and B in Figure S8b.

Bayon is a challenging site to assess, as some exterior walls are oriented to the cardinal directions while others are not. For example, the east half of the southern wall is skewed counterclockwise from east by about 1.5°. A similar situation is found with the west-facing north–south wall. On the other hand, the minor axis across the site is accurately aligned east and west. The end result is that three plotted solstice azimuths miss their corner targets by 0.75°. The misses are, however, within the limits of what was earlier decided upon as an "alignment"; that is, to within 1.0° (see main text).

That said, and as suggested by Magli (2017, 6), the likely reason for the skewed orientation of this complex was to facilitate viewing of the equinox sunset. The slight deviation in orientation allows for the equinox sunset to be viewed over the centre lotus tower from the east side of the complex. As the equinox Sun sets, its azimuth changes slightly to the north as it loses altitude to where it appears balanced on the tip of the centre tower. As explained by Magli (2017, 5),

> the beautiful hierophany of the sun suspended just above the mountain temples at the equinoxes was very probably intended as a materialization of the connection of the temple itself with the heavens, since it brings about a match between the zenith in the sky and the cardinal directions on the ground.

Given the very ornate east–west causeway that leads into Bayon, it may be that processional movements along this causeway were timed to the equinox hierophany.

The combination of solstice and equinox alignments at Bayon brings to mind that, at Angkor and indeed, cross-culturally, simultaneous alignments to different celestial and/or topographic phenomena is not uncommon. As discussed earlier, both solstice and equinox alignments are found in the design of Angkor Wat. Similarly, further afield, simultaneous solstice and cardinal direction alignments are found in the design of certain medieval Chinese monumental structures (Romain 2017). At Angkor, while solstice alignments seem intended to symbolically link structures to the solar cycle, additional and simultaneous equinox or cardinal direction alignments seem intended for observational purposes and/or to accommodate movements in and out of structures along cosmologically significant axes.

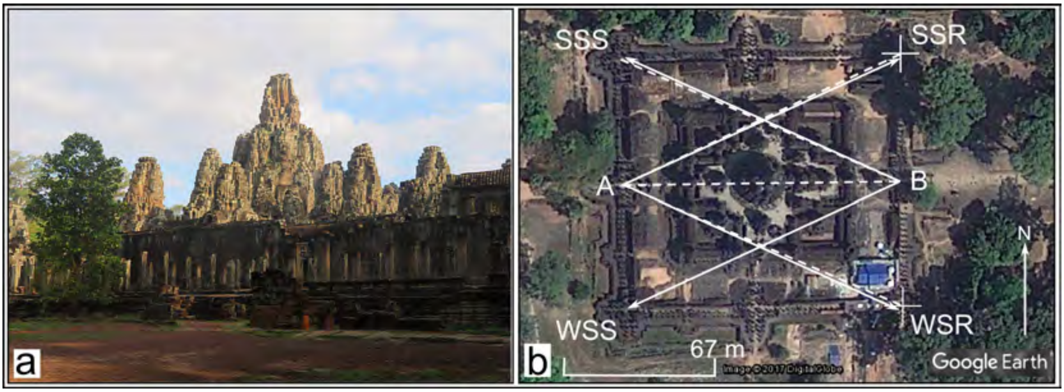

FIGURE S8. a. View of Bayon (photograph by author); b. Google Earth image of Bayon with solstice azimuths plotted (lat. 13b.441811°, long. 103b.859577°, eye alt. 292 m, imagery date 2nd March, 2010.

Banteay Samre

Banteay Samre (S10a) is located 10.5 km northeast of Angkor Wat. No inscriptions reveal when the temple was built, but based on its architectural style, the consensus of opinion is that Suryavarman II was the temple's sponsor in the mid-twelfth century AD (e.g. Freeman and Jacques 2003, 164; Jessup 2004, 158).

The site is unusual in that it does not incorporate solstice or equinox alignments as found at other temples. Rather, the diagonal axis of the inner temple at Banteay Samre points directly to the centre of Phnom Bok, a tenth-century AD temple described above and located 3.8 km northeast (Figures S10b and S11b).

FIGURE S9. Sculpted faces at Bayon looking out to cardinal directions (photograph by author).

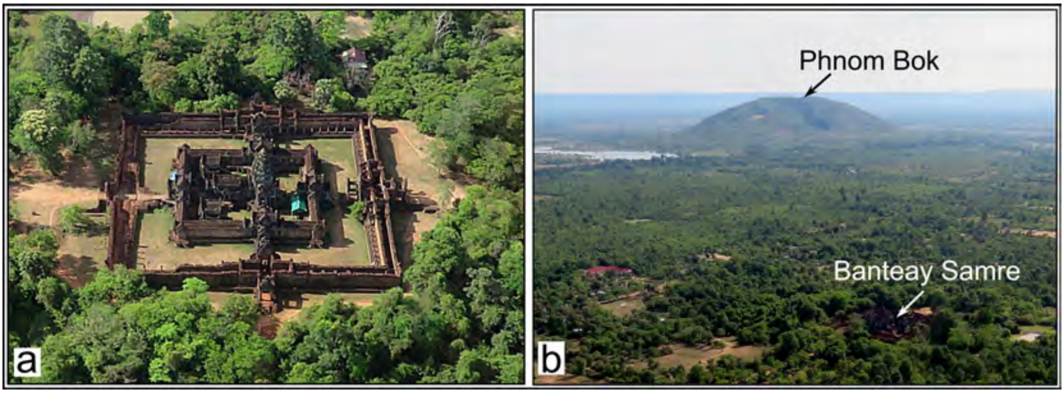

FIGURE S10. a. Aerial view of Banteay Samre from the north (photograph by author); b. aerial view showing location of Banteay Samre relative to Phnom Bok (photograph by author).

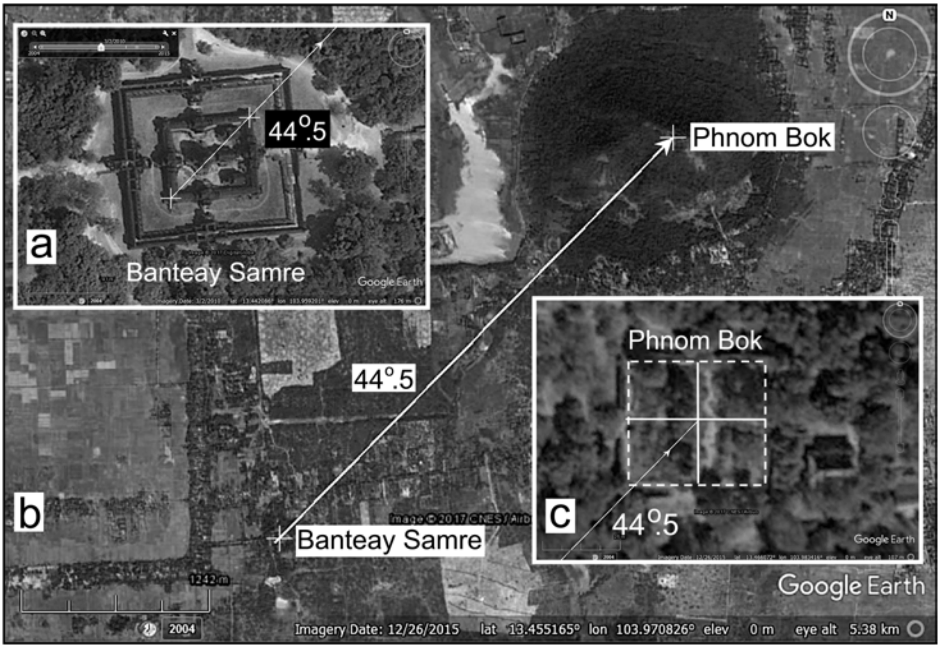

FIGURE S11. a. Detail of Banteay Samre showing 44.5° diagonal axis of inner enclosure; b. Google Earth image with 44.5° azimuth from Banteay Samre plotted; c. detail showing how 44.5° azimuth plotted from Banteay Samre intersects centre of Phnom Bok temple.

One might be inclined to dismiss this inter-site alignment as fortuitous. However, the occurrence of other inter-site alignments at Angkor suggests that sometimes, these alignments were intentional. Magli (2017, 10) provides two convincing cases: Bayon to Banteay Samre and Phimeanakas-Baphuon to Bakheng. However, there are more. The relationship between Angkor Thom and Bakong provides another example.

Angkor Thom

Angkor Thom (Figure S12c) is an enormous walled enclosure built during the twelfth century AD by Jayavarman VII (Laur 2002, 131). The site encloses 9 sq km including the royal palace, the Bayon and Baphuon temples and other structures.

The massive enclosure is further surrounded by a wide moat, and five ornate gates provide access. Four of the gates are situated on the site's major and minor axes. The fifth gate, the so-called "Victory Gate", is located north of the minor axis, through the east wall. The gates are famous for their giant stone faces which, like those of the Bayon temple, look out to the cardinal directions.

Maps and descriptions of Angkor Thom (for example, Laur 2002, 131) tend to represent the enclosure as a cardinally aligned square. In actuality, however, the north–south axis of Angkor Thom is skewed about 2° west of true north and the enclosure is not a square. Ground survey by the EFEO (cited by Petrotchenko, 2014, 245) found the following lengths: north wall 3089 m, south wall 3050 m, west wall 3038 m and east wall 3030 m.

Given the precision of architectural design demonstrated elsewhere across the Angkor area, there is no doubt that the offset orientation and less-than-perfectly-square shape of Angkor Thom were deliberate. A possible explanation follows.

Bakong was either the first, or one of the first, major temple mountains built in the Angkor area (Laur 2002, 307). Notably, the southeast to northwest diagonal of Bakong extends along an azimuth of 313° (Figure S12a). When this azimuth is extended across the landscape it intersects Angkor Thom (Figure S12b); indeed, it intersects the centre of the Bayon temple at the centre of Angkor Thom. Moreover, the same line also defines the southeast to northwest diagonal for Angkor Thom (Figure S12c). In other words, the diagonal axes of Bakong and Angkor Thom are both oriented to an azimuth of 313°; and the azimuth between the two sites is also 313°. The centre-to-centre distance separating Bakong and Angkor Thom is 17 km.

That these correspondences in azimuth were intentional is suggested by a feature known as the Yasodharapura road or causeway (Fletcher *et al.* 2008, fig. 1). This feature, which likely served as both a road and a way to direct the flow of water (Higham 2001, 65, 122; Fletcher *et al.* 2008, 662; Kummu 2009, fig. 3), linked the Angkor Thom and Phnom Bakheng areas to the Bakong area. Remnants of this feature are visible in aerial photographs. Importantly, as Figure S12b shows, the feature extends parallel to the 313° line between Angkor Thom and Bakong.

Angkor Thom was built hundreds of years after Bakong, and it is intriguing to speculate that by orienting Angkor Thom to the older structure Jayavarman VII perhaps intended to reference his historic or genealogic connection to the founding of the Angkor Empire vis-à-vis Bakong, presumably considered by him to be the first major temple mountain and the genesis for all that followed. Briggs (1951, 61) points out that, beginning in the ninth century AD, "kings ruling at that time began to make out long genealogies, connecting themselves with the various dynasties which ruled Chenla and Funan [names used by Chinese cartographers for pre-Khmer areas of Southeast Asia]". Moreover, and with specific reference to Jayavarman VII, "[h]is genealogy, given in inscriptions of his reign traces his descent […] to […] Svayambhuva Kambu and the apsara Merā, fabled founders of the race" (Briggs 1951, 209). According to this foundation story, the Khmer Empire began when Prince Kambu invaded and conquered the Nāga people and married the *apsara* (spirit) daughter of the Nāga king. According to inscriptions contemporaneous with his reign, Jayavarman VII apparently considered himself directly related to the founding of Angkor, and the physical alignment of Angkor Thom to Bakong is consistent with this narrative.

The Angkor Thom enclosure does not directly incorporate solstice alignments, which are precluded by its particular shape and orientation. Rather, the shape and orientation of the Angkor Thom enclosure appears intended to facilitate the alignment with Bakong. That said, though, it should be recalled that the Bayon temple, situated at the centre of Angkor Thom, *is* solstice-aligned. Accordingly, if Angkor Thom with Bayon at its heart are considered as one complex, then it can be argued that the complex is in fact solstice-aligned. Similar configurations occur elsewhere at Angkor wherein the innermost temple is solstice-aligned but surrounding enclosure walls are not (for example, Baphuon, Banteay Srei).

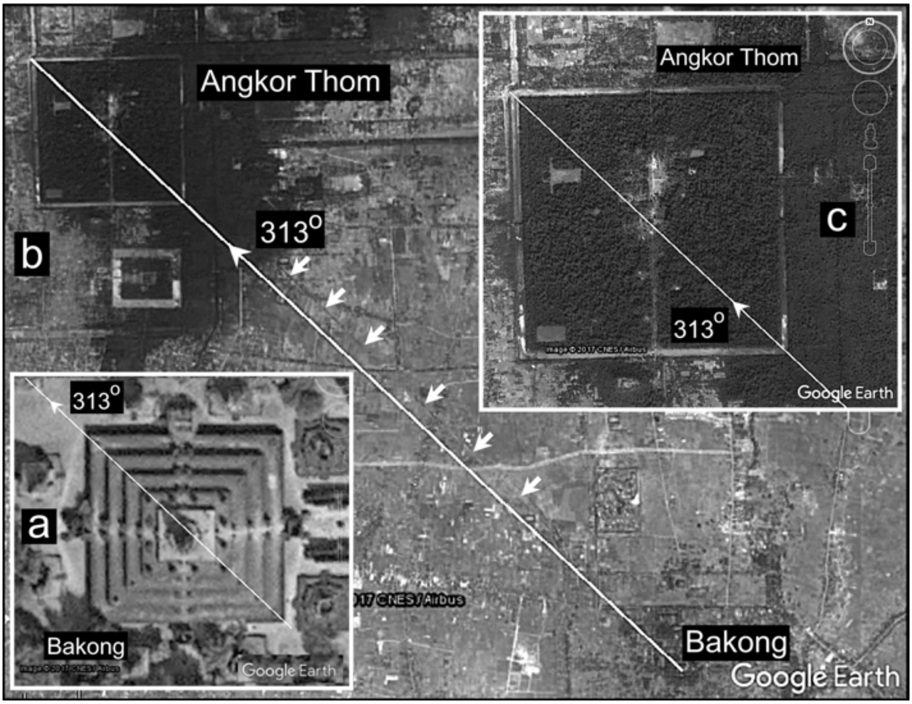

FIGURE S12. a. Google Earth image of Bakong with azimuth of diagonal axis plotted; b. Google Earth image showing how Angkor Thom is located on an azimuth of 313° as measured from the centre of Bakong (centre-to-centre distance separating the two features is 17 km), white arrows show remnants of road that extended between the two areas; c. Google Earth image of Angkor Thom showing how the 313° azimuth defines the diagonal of the enclosure.

Preah Khan of Kompong Svay

A bit further afield, but also demonstrative of a likely inter-site alignment scheme, is the relationship between Preah Khan of Kompong Svay, two nearby mountains and Angkor Wat.

Preah Khan of Kampong Svay (Figure S13) is located about 96 km east of Angkor Wat. Indications are that it was built in stages between the late tenth and early thirteenth centuries (Hsieh *et al*. 2016, 38). What stands out about the site is its size, which dwarfs both Angkor Wat and Angkor Thom. Figure S13 shows the relative sizes of these monuments.

Magli (2017, 13) suggests that Preah Khan of Kompong Svay is aligned to the Moon's maximum north rise, and points out that a line extending due west from the entrance into Preah Khan of Kompong Svay's inner enclosure intersects the centre of Angkor Wat (see also Groslier 1973, 118; also referenced in Hendrickson and Evans 2015, 4). My own measurements find this plotted azimuth is accurate to within 0.1° (Figure S14a). Given that the two sites are separated by 96 km, this alignment, if intentional (and it probably is), is quite remarkable.

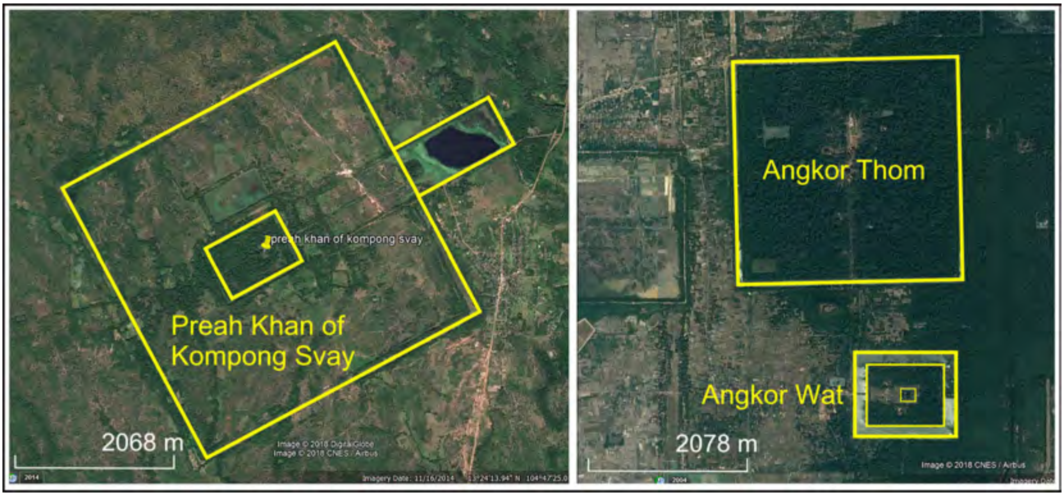

FIGURE S13. Size comparison between Preah Khan of Kompong Svay, Angkor Thom and Angkor Wat.

That said, there is no reason to think that these are the only alignments at Preah Khan of Kompong Svay. Indeed, in support of the intentionality of the above-mentioned inter-site alignments between Banteay Samre and Phnom Bok and also between Angkor Thom and Bakong, it is found that the diagonal axis of Preah Khan of Kompong Svay points to two important mountain locations (Figure S14b).

The first mountain location is Phnom Dek, also known as "Iron Mountain". Iron Mountain is described by Hendrickson and Evans (2015, 2) as "one of the richest iron oxide deposits in Cambodia", and they add that Preah Khan of Kompong Svay remains the only Khmer temple complex with evidence of iron metallurgy inside its walls. As noted in the main text of the present article, iron production was one of the driving forces behind the success of the Angkor Empire. Appropriately, the diagonal axis of Preah Khan of Kompong Svay points directly to Iron Mountain, 31 km distant.

The second mountain feature that Preah Khan of Kompong Svay is oriented to is the Mount Kulen hill-plateau. Importantly, Mount Kulen is the major source of flowing water for Angkor. Moreover, Mount Kulen was where Prince Jayavarman II was declared the first king of the Angkor Empire (Higham 2001, 59): this event took place at either the Rong Chen Temple or the Royal Palace (Jessup 1997, 103). Both structures are now in ruins, but both are located near the terminus of the 207° azimuth originating at Preah Khan of Kompong Svay (Figure S14a).

The orientation of Preah Khan of Kompong Svay through its diagonal axis to the two most important mountains in the Angkor area is probably not coincidental. Indeed, similar site alignments to mountains are not unknown in the cross-cultural literature (see e.g. Romain 2018). Given that, the likelihood that the earlier-discussed inter-site alignments for Banteay Samre and Phnom Bok and for Angkor Thom and Bakong were intentional is increasingly plausible. All three sets of inter-site relationships share the use of diagonal lines to point to important locations. Ultimately, though, the implication is that more than one alignment protocol was at work at Angkor. It appears that solstice, equinox, zenith Sun and topographic alignments all played significant roles in the orientation of temple structures.

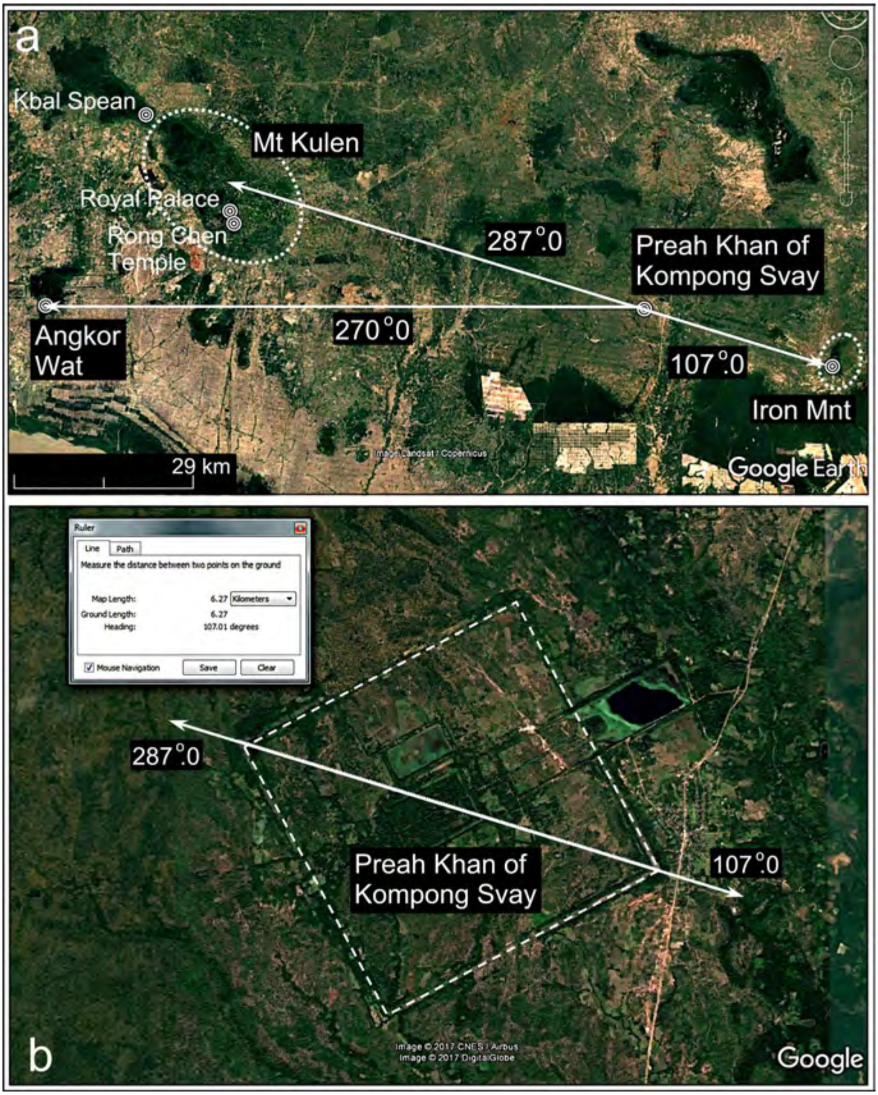

FIGURE S14. a. Annotated Google Earth image showing relationships between Preah Khan of Kompong Svay, Angkor Wat, Iron Mountain and Mount Kulen; b. Annotated Google Earth image showing the reciprocal azimuths for the diagonal axis through Preah Khan of Kompong Svay.

Concluding remarks

Here, astronomical assessments suggestive of intentional solstice alignments incorporated into the design of seven Angkor temples have been presented, supplementing similar findings reported for five temples in the main text, including Angkor Wat. As documented in Table 1 (main text), the total number of solstice-aligned Angkor sites identified in the present study is 12.

In addition to solstice-aligned sites, several compelling instances of inter-site alignments were identified. These inter-site alignments involve Banteay Samre and Phnom Bok, Angkor Thom and Bakong, and Preah Khan of Kompong Svay and two mountain locations with historic significance.

The above data suggest that Angkor temples were linked to the Sun through a sophisticated combination of solstice, equinox and zenith Sun alignments. Zenith alignments along the vertical axes of lotus temple towers established an *axis mundi* for each temple. Where visible equinox alignments occur (e.g. Angkor Wat, Bakong), processional movements along east–west avenues might have been timed to the equinoxes for maximum hierophanic effect. Based on the evidence provided above, solstice alignments were an important part of Angkor temple design. As also explained in the main text, however, solstice alignments were probably not for observational purposes. Rather, they seem to have been for symbolic purposes – presumably intended to link the temples to the dynamic aspect of the solar cycle.

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