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ARCHAEOASTRONOMY AND LANDSCAPE ARCHAEOLOGY AT CAHOKIA

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Abstract:
The Mississippian-era site of Cahokia was the largest Native American city north of Mexico. Archaeologists have long speculated about possible astronomic alignments and spatial relationships in the layout of its 100+ earthen mounds. In this paper LiDAR imagery, historic documents, ethnohistoric and archaeologic data are used to assess the site relative to astronomic and landscape alignments. New findings show how Monks Mound, Rattlesnake Mound, Powell Mound and others are aligned to the Sun, Moon, and Milky Way. Additionally, these alignments intersect prominent bluffs to the east and southeast that appear to have been used as horizon markers.

Keywords: Cahokia, Monks Mound, archaeoastronomy, Milky Way, Moon

Introduction

Cahokia is a Mississippian-era site located in the state of Illinois, USA, about 17.8 km (11 mi) southeast of the confluence of the Missouri and Mississippi Rivers (Figs. 1 and 2). Cahokia flourished from about 1050-1350 CE. At its height, it was the largest Native American city north of Mexico (Fowler, 1969, p. 1).

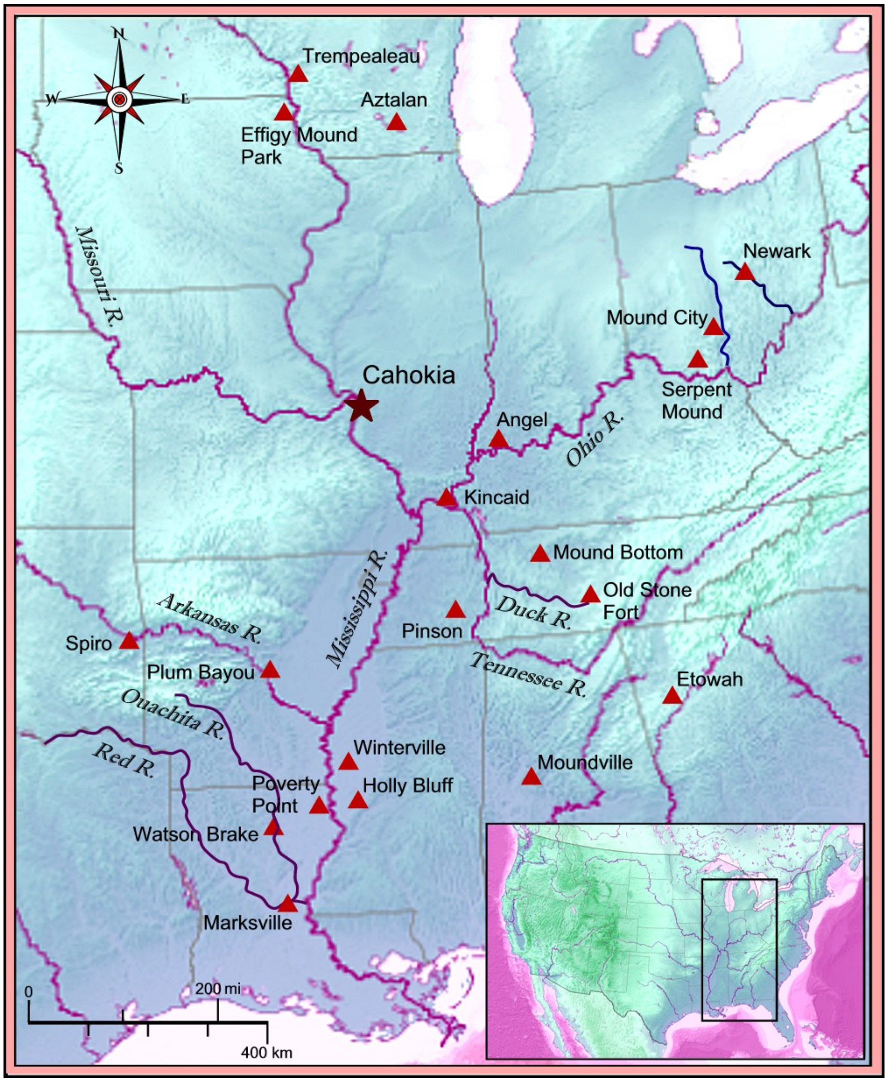

Figure 1. Shaded relief map showing location for Cahokia and selected sites. Base map by Uwe Dedering, CC BY-SA 3.0, Wikipedia. https://en.m.wikipedia.org/wiki/File:Usa_edcp_relief_location_map.png. Annotations by present author.

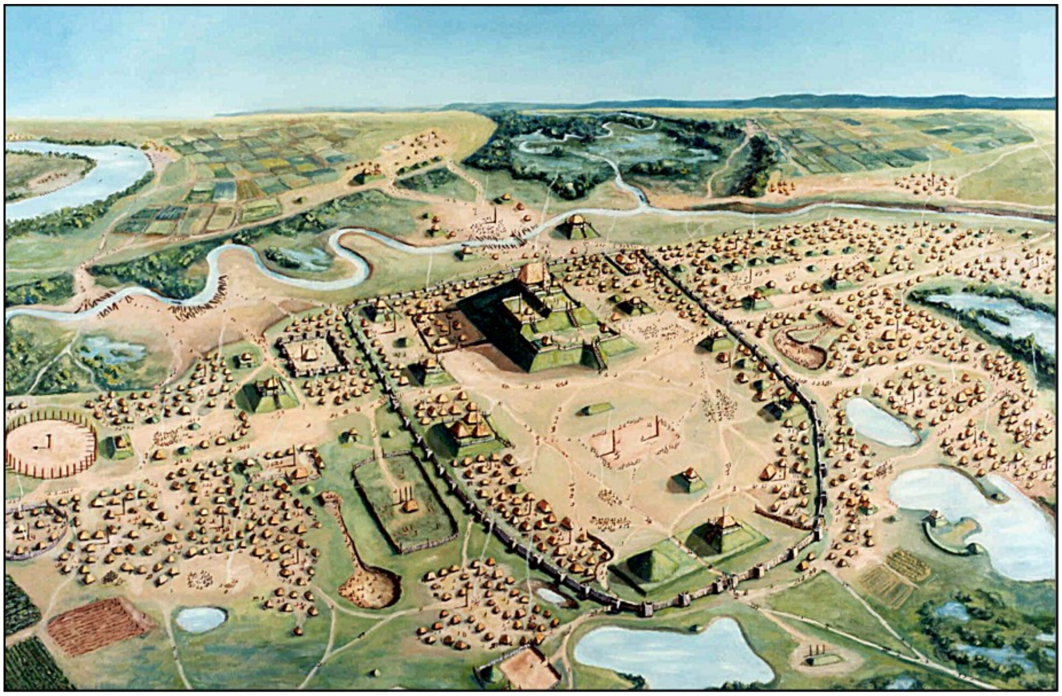

Figure 2. Artist representation of Cahokia. Painting by William Iseminger. Courtesy of William Iseminger and Cahokia State Historical Site.

Additionally, Cahokia has the distinction of having the largest Native American earthen mound north of Mexico — namely Monks Mound as well as more than 100 additional mounds, large and small. If there was an epicentre for the Mississippian culture, then Cahokia was that center and Monks Mound was its centrepiece.

Although much has been written about how Cahokia was located in an area that was well-suited for human habitation, the reasons why the site was situated precisely where it is have not been accounted-for. In this paper I present archaeoastronomic and landscape archaeology data in support of the hypothesis that Cahokia was situated at a unique location where celestial and landscape alignments crossed. At this intersection, Monks Mound was built and from here, nearly everything else followed in terms of spatial layout.

The inspiration for what follows originates with a comment made more than 60 years ago by Warren L. Wittry. Wittry (1927-1995) was an archaeologist and research associate at the University of Illinois-Chicago Circle. He is bestknown for his theories concerning Cahokia woodhenges (Wittry 1969, 1996). Of interest in the present context is an observation he made concerning the bluffs and bluff mounds situated a few kilometres east of Cahokia. According to Timothy Pauketat (2013, p. 107), "on an unpublished sketch made around 1962, [Wittry] considered these to have been used by Cahokians in horizon sightings of rising celestial objects." I never had the pleasure of meeting Dr. Wittry; nor have I seen his sketch. But his remarks were prescient and I believe, correct. Records, however, are sketchy and whatever mounds that were once on the bluffs have been mostly obliterated by suburban development. Nevertheless, sightlines to the bluff knolls can be plotted and as I will show, Cahokia appears to have been laid-out with respect to celestial events aligned to bluff knolls and mounds.

The paper is structured in the following way. A brief overview of the environmental setting for Cahokia is presented. A methods section is next. This is followed by summaries for several mounds and features important to what follows. Next are analyses showing how certain mounds and features are aligned to celestial events and bluff mounds and knolls. Discussion follows. The paper ends with a few concluding remarks.

Background

Cahokia is situated in the American Bottom. This is a flat alluvial floodplain on the east side of the Mississippi River. The area extends for a distance of about 80 miles from around Alton, Illinois, south, to Chester, Illinois (White, et al., 1984, p. 17). Cahokia is situated in the approximate middle of this area, about 9.5 km east of the Mississippi River. This positioned the site for easy river access to most of middle North America — a factor that facilitated trade and contact. To the east the area is flanked by high bluffs that separate the bottomlands from the upland prairie (Fig. 3). Of considerable importance to Cahokia, fresh water flowed from the bluffs. Canteen Creek, for example, originates in the upland area east of Cahokia and after passing through the bluffs, flows through Cahokia between the Monks and

Kunnemann mounds. Another waterway — i.e., Cahokia Creek, flows from the north where it runs along the base of the bluffs catching water from bluff rivulets and joins Canteen Creek just north of Monks Mound. The Collinsville Bluffs directly to the east of Cahokia are about 36 m (118 ft) in height with knoll summits a few meters higher. Bluff knolls provide expansive and impressive views of Cahokia and the surrounding area. Figure 3 shows a section of the bluffs to include several of the knolls considered later.

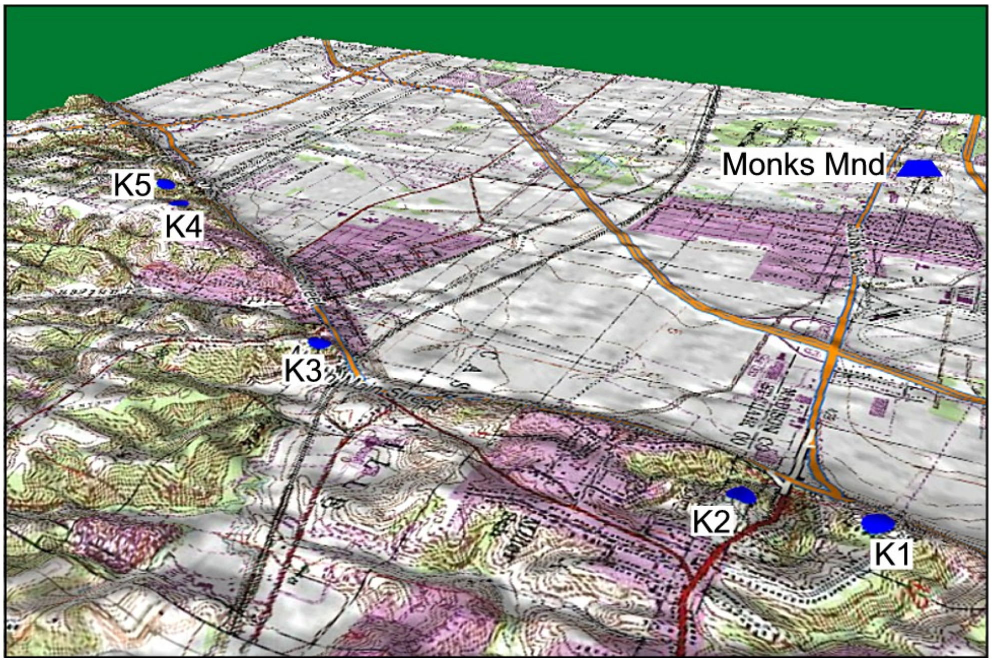

Figure 3. 3D view showing Collinsville bluffs overlooking Cahokia bottomlands. From USGS 7.5-minute series map (1998 Monks Mound, IL quadrangle). 10-foot contour interval. Vertical exaggeration applied. View is looking to the southwest. Locations for knolls 1-5 and Monks Mound as shown. Base map by Terrain Navigator Pro (Trimble, 2023), annotations by the author.

At the time of the Cahokia florescence the climate was ideal for growing crops in the organically rich bottomlands around Cahokia. Corn, or maize was a staple (Cutler and Blake, 1969). The area also included numerous oxbow lakes and wetlands for fishing and hunting (Pauketat, Rees, and Pauketat, 1998). In fact, the second largest lake in Illinois is Horseshoe Lake, 2.6 kilometres to the northwest of Cahokia. Horseshoe Lake covers 10 square kilometres. Before modern drainage, levees, and dams, the lake was considerably larger (Skele, 1988; Fig. 3). Notably, Horseshoe Lake and

Cahokia are in the Mississippi Flyway (White, et al., 1984, p. 32). Hundreds of bird species are found here including migratory ducks and geese. Horseshoe Lake is shallow; however, it is home to a wide variety of fish including largemouth bass, channel catfish, shortnose gar, bluegill and sunfish. Analyses of faunal remains from six Mississippian sites in the Cahokia area found that fish comprised 50% to 75% of the faunal assemblages (Kelly and Cross, 1984, p. 231). White-tail deer were also heavily consumed, and it has been suggested that Cahokians maintained tamed herds (Boles, 2019). In short, the environment around Cahokia was ideal for human habitation. The question that remains, however, is why were the mounds positioned exactly where they are?

As noted, I believe the answer to that question is found in the astronomic and landscape associations for the site. I am not the first to consider astronomy and landscape as related to Cahokia. Among earlier investigators who made significant contributions were Warren L. Wittry, Martha A. Rolingson, P. Clay Sherrod, Melvin L. Fowler, and Nelson A. Reed.

Warren Wittry (1969, 1996), for example, proposed equinox and solstice alignments associated with Cahokia woodhenges (Fig. 4). Based on excavated postholes, Wittry (1996) posited five woodhenges in an area west of Monks Mound. While there is little doubt as to the existence of the woodhenges it remains an open question as to how they were used. One issue, for example, is that while three of the posts in two of the circles align to the solstices and equinox (or east), how should we account for the other dozens of posts that make-up the complete circles? Whatever the answer, discussions about the Cahokia woodhenges got people thinking about Cahokian archaeoastronomy and that alone, was a significant contribution.

Figure 4. View of the fall 2016 equinox sunrise over first terrace of Monks Mound from Woodhenge III center observation post. This structure was reconstructed by William Iseminger (2010, pp. 130–131) based on excavated posthole evidence. Photo by author, 22-September-2016.

P. Clay Sherrod and Martha A. Rolingson (1987, p. 95) also posited solstice and equinox alignments for Cahokia. Sherrod and Rolingson (1987, p. 96) were tentative in their posited solstice sightlines. However, they made a stronger case for an equinox alignment extending across nine mounds from Mound 44 which is west of Monks Mound, through a small mound on the southwest corner of the first terrace of Monks Mound (Fowler's Point) to Mound 27 on the east side of the site. Surprisingly they never clarified any distinction between their equinox sightline and the cardinal directions of east-west, although they did show a north-south sightline crossing their equinox line (Sherrod and Rolingson, 1987; Fig. 23).

Melvin L. Fowler is well-known for his excavations of Mound 72 and his incredibly useful volume that plots nearly every known mound at Cahokia (Fowler, 1989, 1997).

One of the most insightful of the early Cahokia investigators was Nelson A. Reed (1927-2018). Based on measurements between the east and west edges of the third and fourth terraces, Reed, et al. (1968, p. 146–147) initially reported that the orientation of Monks Mound is offset by 6º east of true north. Reed (1969, p. 33; 2009, p. 62) later amended that value to 5º. According to Reed (2009, p. 62): “The builders of the Cahokia site accepted the 5-degrees-east-of-north alignment of Monks Mound and used this pole [F78], or its many predecessors on earlier building stages, as center point of reference.”

In the same article, Reed (2009, p. 72–80) suggested an association between Monks Mound and the Milky Way Path of Souls. As discussed elsewhere (Langford, 2007a, 2007b), the Milky Way Path of Souls was believed by many tribes across the Eastern Woodlands and Plains, to be the path, trail, or road that souls of the dead travelled in order to reach their final destination which was the Land of the Dead. This path, or trail was visible in the night sky as the Milky Way.

This story will figure prominently in the pages that follow and has been discussed in detail as it relates to Cahokia, elsewhere (Romain, 2021). Briefly, however, I have suggested that Rattlesnake Causeway was a metaphoric representation of the Milky Way Path of Souls and further, that Rattlesnake Mound was a portal to the Path of Souls. At summer solstice, at nightfall, the site axis, Causeway and minor axis of Rattlesnake Mound point to the southern end of the Milky Way.

Methods

Three sets of celestial and landscape alignments are considered here: 1) a cardinal/equinox alignment; 2) alignments to the moon’s maximum south rise; and 3) alignments to the Milky Way. The features involved are Monks Mound, Powell Mound, Rattlesnake Mound and Rattlesnake Causeway. The celestial alignments extend between mounds and to bluff knolls designated K1 – K6. There are other celestial-landscape alignment combinations and a couple of additional alignments that will be briefly mentioned; but what is presented below in Figure 5 seems to have been central to the layout of the site.

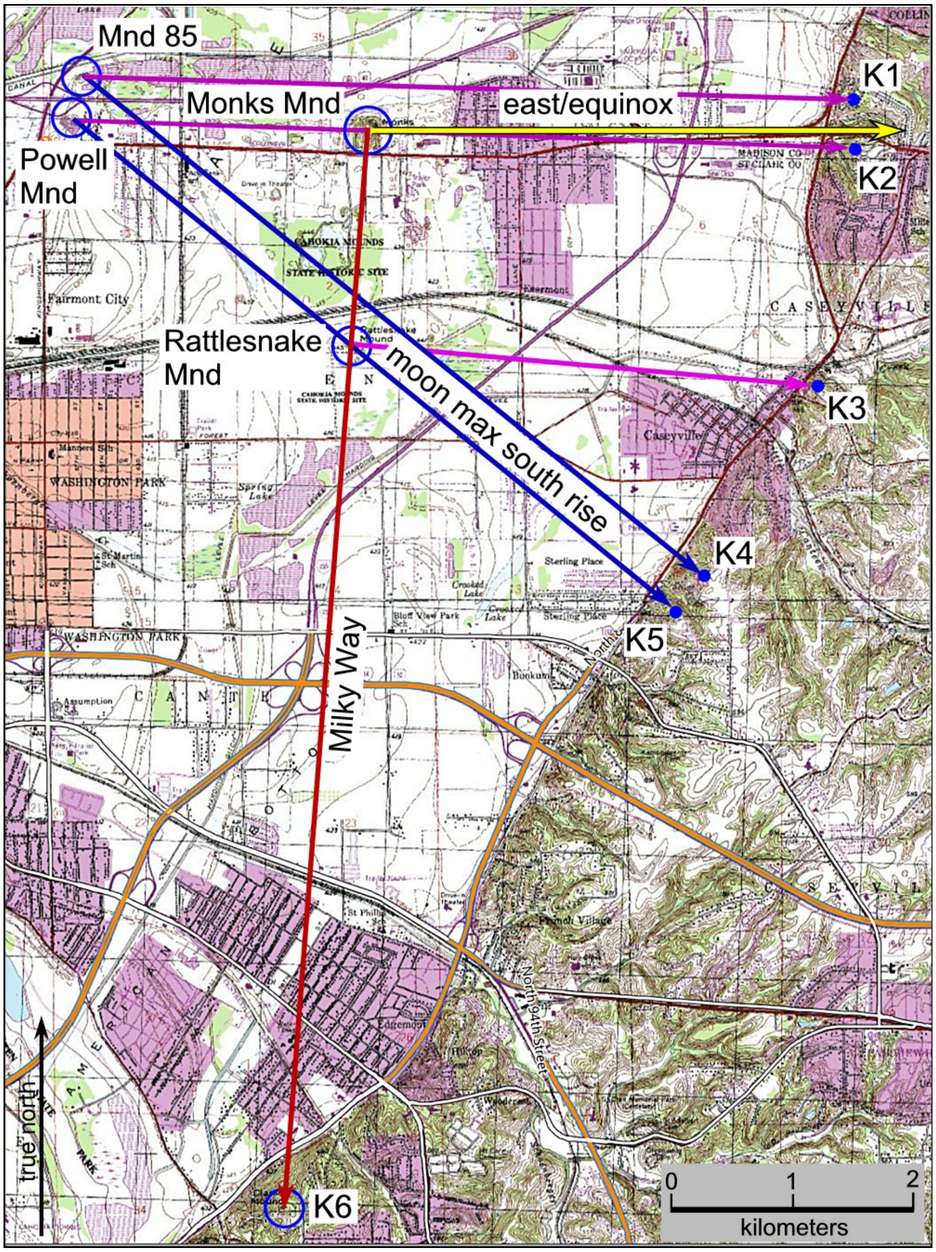

Figure 5. USGS 7.5-minute series map (1998 Monks Mound and French Village quadrangles) showing Cahokia area with selected sightlines plotted to bluff knolls. Map merge and annotations by author. Yellow line is to cardinal direction/equinox; purple lines are bottomland mound to bluff knoll sightlines; blue lines are lunar alignments. Red line is Milky Way alignment.

Before proceeding, it may prove useful to explain certain of the methods involved. Astronomic azimuths were calculated according to the formula (McCormac, 1983, p. 345):

$$\cos A = (\sin \delta - \sin \varphi \sin h) / (\cos \varphi \cos h)$$

where, *A* stands for the azimuth, *δ* (delta) is the declination for the sun (1000 CE), *h* is horizon altitude, and *φ* (phi) represents the latitude of the site. In this formula, horizon altitude refers to the vertical angle of the distant horizon relative to a flat plane, measured in degrees. Declination values were obtained from Ruggles (2015; Table 31.3). Horizon altitudes were calculated using elevation data from a digitized version of the USGS 7.5-minute series map for the area (Monks Mound, Illinois quadrangle) (Trimble, 2023). Corrections for refraction (Wood, 1978; Fig. 4.5) were applied before entering the *h* values into the main formula. Calculations were made for upper and lower limb tangency. For the Moon an additional correction of +0.95º for parallax was applied.

In the above calculations, horizon altitude is a major factor. As the horizon altitude increases or decreases due topography and vegetation cover, the apparent rising and setting azimuth for a celestial body will vary accordingly. For the analyses herein, calculations were based on ground level elevations at backsight locations. In other words, the assumption is that Cahokian sky-watchers made their observations and plotted their sightlines before the mounds were built. There are available options for determining horizon altitude by computer program (e.g., Kosowsky, 2012; Smith, 2012). However, where mounds or modern features block sightlines (as is often the case here) my preference is to make the calculations using the formula:

tan z = VD/HD

where, VD means vertical distance, HD means horizontal distance, and

VD = C - A

where, C is the foresight location (highest elevation), and A is the backsight location (lowest elevation). (Where the observer's backsight location is a significant distance from the foresight location then a correction for the earth's curvature of the earth is needed [Wolf and Ghilani, 2002, pp. 75–76]. At the distances involved here that correction does not need to be applied.) To account for the presence of tree growth in the direction of the distant horizon, 24 m were added to highest contour interval shown on the topographic map for the foresight location.

There are a number of uncertainties in the calculations. For example, there are uncertainties relating to horizon altitudes (e.g., unknown distant tree heights as well as clearing distances in area of backsight locations). And the refraction correction used here is a mean value at presumed standard conditions Wood (1978; Fig. 4.5). (For further discussion see Gough, 2018; Schaefer and Liller, 1990.) Additional uncertainties relate whether upper limb, lower limb, or center tangency for the Sun and Moon was used as the visual reference by ancient skywatchers. For these reasons posited alignments should be understood as accurate to ±0.5º . Also, intermediate calculations were carried-out to multiple decimal places to minimize rounding errors. Final results, however, are rounded to tenths of a degree.

When comparing position data using different applications it is useful to know that by default, some programs use digitized United States Geological Survey (USGS) maps that are often referenced to the older NAD27 datum. NAD27 is different from the datums used by Google Earth and LiDAR acquisitions. Google Earth uses WGS84. LiDAR acquisitions may use WGS84, or other datums. Latitude and longitude coordinates for a given benchmark will differ depending on the datum. This difference is known as datum shift and it can be tens of meters. Terrain Navigator Pro (TNP) used herein allows the user to choose between NAD 27 and WGS84 (and other datums). That feature was applied as needed in order to ensure congruence between maps and imagery.

Further, it is the case that the accuracy of a posited sightline to some extent depends of the ability of the user to accurately connect the control or reference points. Factors that can affect that include visual acuity, screen resolution and even line width. Given these complicating factors, in several instances I used Vincenty’s inverse formula to calculate azimuths between points. The Vincenty inverse formula uses inputted latitude and longitude (with choice of datums) for two locations and calculates the azimuth between them (see e.g., https://geodesyapps.ga.gov.au/vincenty-inverse).

There is an important qualification regarding alignments to bluff knolls. As viewed from Cahokia it would have been difficult, or even impossible, to see the K1 – K6 knolls, especially at night. Although they are several meters in height, they are nevertheless not high enough to be readily silhouetted or distinguished against the horizon and tree line. It is likely that fires were used to identify the knolls from a distance. As discussed later, there is documented evidence for fires associated with two of the known bluff mounds. Modern-day building and clearing on most of the other bluffs precludes finding further evidence.

As the point sometimes gets overlooked, it is worth repeating that what follows is based on the presumption that the mound locations, alignments and relationship between mounds were established and laid-out on the ground before major construction. Once marker posts, small mounds, or other identifiers were placed at relevant locations, the construction of large mounds could proceed over decades without affecting the underlying relationships.

Mound and Feature Summaries

Monks Mound (Mound 38)

Monks Mound (Fig. 6) is the largest mound at Cahokia; and as noted, the largest Native American mound north of Mexico. It covers approximately 6 ha (15 acres) (Collins and Chalfant, 1993, p. 319).

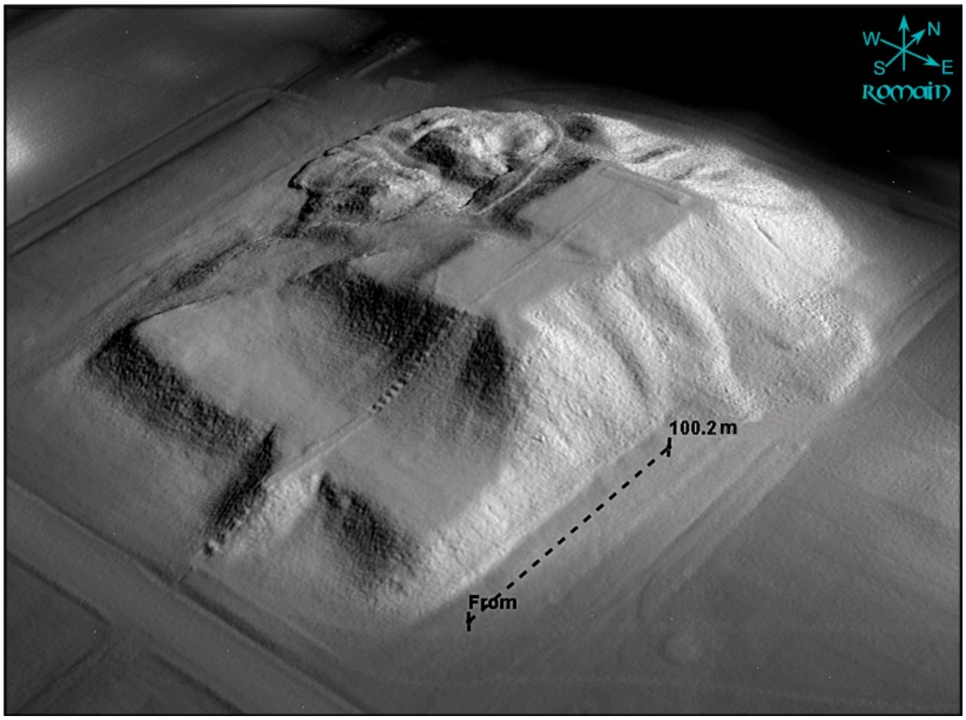

Figure 6. Oblique LiDAR view of Monks Mound from southeast. No vertical exaggeration. Image from LiDAR data courtesy of Indiana University, Department of Earth and Atmospheric Sciences.

It is difficult to give precise dimensions for Monks Mound due to significant slumping. Episodes of slumping occurred soon after construction as well as more recently to include major slumping in 2007 (Schilling, 2013, p. 15). This has resulted in considerable slope wash and a scalloped appearance along the base. Using the 130 m contour line as base, however, LiDAR assessment finds the north-south length of the mound is about 293 m (to south end of ramp leading to the first terrace); while the east-west width is about 247 m. Again, measuring from the 130-meter contour elevation, the height of the mound is about 28 m.

Slumping of Monks Mound, especially on the west side of the mound has caused uncertainty as to how many terrace levels the mound has. Some investigators believe the western slumpage was once part of the next higher terrace. Others consider the area as a separate terrace. For present purposes, Reed's (2009; Fig. 3) interpretation is followed and can be described as follows. The first terrace is the large terrace extending across the base of the mound facing south. This terrace had a platform mound on its southwest corner. Excavations by Benchley (1975) revealed several house-like structures within the platform mound. Further, Benchley (1975, p. 20) found five Historic period burials in the upper level of the platform mound.

Again, following Reed (2009; Fig. 3), the second terrace is the next higher. This terrace had a small conical mound on its southeast corner.

The third terrace forms the summit of Monks Mound. It is on this terrace that a large ‘spirit house’ and the F78 pole structure were located. The house structure measured 28.9 m east-west and 13.5 m north-south (Reed, 2009, pp. 34–46). A final layer of earth capped the structure.

Coring of Monks Mound identified a 6 m (20 ft) thick layer of “black highly organic clay material” at its base (Reed, et al., 1968, p. 142). The source for this muck was likely the Eldelhardt Meader immediately north of the mound (Reed, et al., 1968, p. 145; Reed, 2009; Schilling, 2013, p. 311). As Schilling (2010, p. 316; 2012, p. 311) suggests, this layer of muck could have represented the primal earth retrieved by the Earth-Diver in many Native American stories. If that is the case then the concept may have precedent in earlier Hopewell earthworks (e.g., Hall, 1979, p. 260; Romain, 2000, pp. 191–195). In any case, excavations and core samples indicate that mound construction likely took place rapidly, albeit in stages. According to analyses of the radiocarbon data by archaeologist Timothy Schilling (2013, p. 23): “Construction could not have occurred before A.D. 1050”.

Based on excavation findings, it was Reed’s (2009, p. 61) opinion that “The First Terrace and hence the Ramp were clearly an addition to the mound after completion of the Second and Third Terraces…” Schilling (2013, p. 19, Table 4) is of the same opinion: “…the main part of the mound, north of Terrace 1, was built first, followed by a series of caps on the summit and the addition or extension of Terrace 1…”. If true, that would place the F78 pole feature (discussed later) in an even more central location relative to the shape and perimeter of the mound than is currently the case.

Southeast Mound

This was a small mound situated in the southeast corner of the second terrace of Monks Mound (or third terrace if one prefers that interpretation of terrace levels — e.g., Pauketat, et al., 2023, p. 254.) An early report (deHass, 1869, p. 296) states the 10-ft (3 m) high mound was removed in 1831. According to deHass (1869, p. 296), the property owner uncovered "human bones, stone implements and weapons, vases of unburnt earthen-ware, etc." Recent geophysical surveys at the mound location found evidence for two circular buildings, possible circular wall trenches, and a "large anomaly, up to a meter wide…near the center" (Pauketat, et al., 2023, p. 251). Pauketat, et al. (2015, p. 25) believe this mound was the axis mundi for Cahokia.

Rattlesnake Mound (Mound 66)

Rattlesnake Mound (Fig. 7) is a large ridge-topped mound at the southern-most extent of Cahokia. At its base and measuring from the 128 m contour line, the mound measures about 133.7 m (438.6 ft) along its longitudinal axis, 61 m (200 ft) across its width, and about 7.7 m (25 ft) in height.

Limited excavations and coring into the mound were made in 1927 by Jay L. B. Taylor, chief engineer for Warren K. Moorehead (1929).

The mound gained its name due to the large numbers of rattlesnakes that congregated on the mound during heavy rains while the mound was being excavated (Taylor in Moorehead, 1929, p. 70). As a result of the excavations, a very visible unfilled trench still extends across the width of the mound.

Excavation revealed that the mound was comprised of a bluish black "gumbo"-like soil typical to the area under the plow zone as well as levels of yellow sand (Moorehead, 1929, p. 69). The mound was not totally excavated. Even so, it is estimated that "the remains of at least one hundred fifty burials had been found" (Taylor in Moorehead, 1929, p. 74). The burials were bundled long bones and crania. Most of the long bones were oriented parallel to the minor axis of the mound, others were orthogonal to that axis and a few northeast to southwest. The minor axis of Rattlesnake Mound extends along an azimuth of 185º — which is the azimuth for the main Cahokia site axis.

Figure 7. View of Rattlesnake Mound (number 66). Photo courtesy of Cahokia Mounds State Historic Site.

Rattlesnake Causeway

Rattlesnake Causeway (Fig. 8) is a raised earthen feature roughly 800 m (2,625 ft) in length, 18 m (59 ft) wide and between 0.5–1.5 m (1 1/2–5 ft) in height (Baires, 2014, p. 6). It extends from near Fox Mound (mound number 60), south to Rattlesnake Mound (mound number 66). In the late 1800s a railroad spur was built on the causeway. Remnants of the railroad construction are visible today in LiDAR DEMs (Fig. 8). Radiocarbon dating finds that "the causeway was constructed at the onset of Cahokia's 'Big Bang'...." Baires (2014, p. 9) — that is to say, ca. 1050 CE. The Causeway intersects Rattlesnake Mound at its center. Several small mounds surround Rattlesnake Mound.

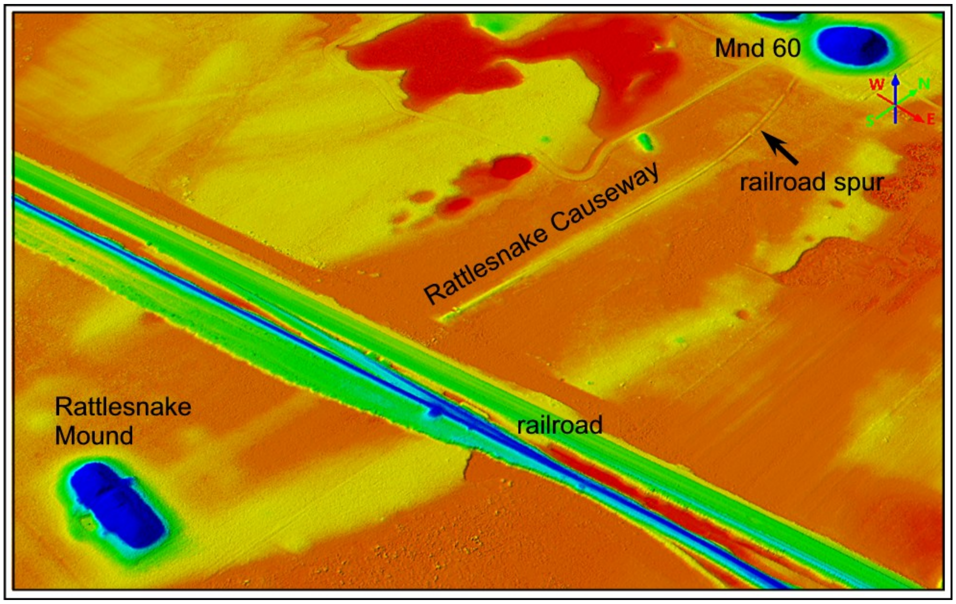

Figure 8. LiDAR image showing Rattlesnake Causeway. Highest elevation in blue, followed by yellow, orange and red. LiDAR data courtesy of Indiana University, Department of Earth and Atmospheric Sciences.

Powell Mound (Mound 86)

The Powell Mound (Fig. 9) is named after William Powell — the farmer responsible for levelling the mound so he could expand his fields. The destruction by steam-shovel took place during December 1930 and January 1931.

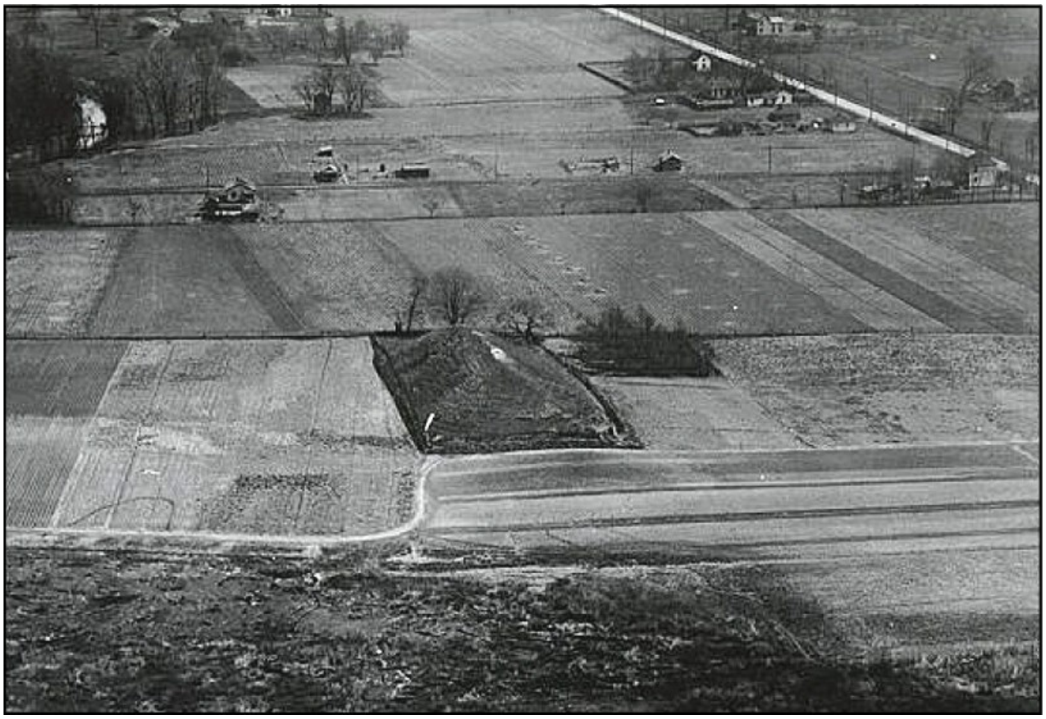

Figure 9. Aerial view of Powell Mound from the northwest. Collinsville Road shown in upper right, Cahokia Creek upper left. Photo taken in 1922 by Lieut. G. W. Goddard, U.S. Army Air Service. From Crook, 1922; Figure 12.

Originally the Powell Mound was one of the largest at Cahokia. According to Moorehead (1929, p. 84), who measured it before destruction, the mound was 310 feet (94.58 m) long, 170 feet (51.8 m) wide and 40 feet (12.2 m) in height. Powell Mound is referred to as a “ridgetop” mound due to the way it came to a long narrow ridge at its summit. Human burials were noted during destruction of the mound — although we will never know how many since the remains were dumped into a truck and hauled away.

Because it has been levelled, the significance of the Powell Mound is often overlooked. In addition to marking the furthest west extent of the site (making it a liminal location and especially suitable for burials), the mound was massive. Moorehead (1929, p. 84) said this: “In my opinion, the Powell Mound is the most imposing member of the Cahokia group, Monks Mound being so large and so heavily timbered as to pass for a natural feature of the landscape, and No. 66 [Rattlesnake Mound] being too low and long and too obscure in location to attract special attention.”

Given that today the Powell Mound is mostly gone (except maybe for a few square meters of its base) in order to accurately establish its location, size, and orientation it is necessary to rely on historic maps, records and the very few existing photographs.

We are fortunate to have the mound's location documented by Warren K. Moorehead (1929, p. 84). Using the township range system, Moorehead (1929, p. 84) described its location as follows: "From the southwest corner of Sec. 34, T. 3 N., R. 9 W., Madison County, Illinois, Stn. 15, minor axis, bears N. 79º 30' E., three hundred four feet, thence North 25º E., six hundred seventy-five feet." As shown by Figures 10a and 10b, when the Moorehead bearings and distances are plotted they terminate at a mound feature shown on U.S. Geological Survey (USGS) 7.5-minute series topographic maps. That feature is the Powell Mound.

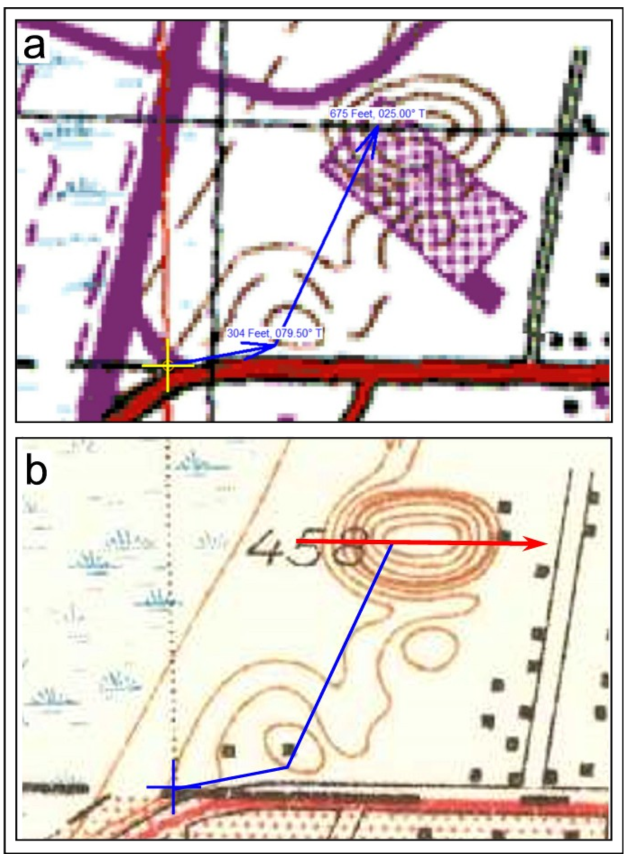

Figure 10a. Enlarged detail of 1985 USGS quadrangle map (St. Louis, Missouri-Illinois) with azimuth and distance as given by Moorehead (1929, p. 84) plotted from intersection of township section and range lines to the Powell Mound. Yellow cross shows point of origin, blue lines show azimuths (converted from bearings).

Computer plotted using Terrain Navigator Pro (Trimble, 2023). Large purple rectangle shows location of modern construction.
Figure 10b. Same plot as shown in Figure 10a using less visually cluttered 1935 USGS quadrangle map (Illinois-Monks Mound). Red arrow indicates 91º azimuth for mound axis as given by Moorehead (1929, p. 84).

Worth mentioning is that by 1985 and 1935 — which are the dates for the USGS map details in Figures 10a and 10b, the mound had already been largely destroyed. In 1968, what remained of the mound was further “reduced to a height of three feet as a result of grading adjacent to the construction of the Gem store” (Bareis, 1975, p. 15). Perhaps the 1935 map is based on a survey made before the mound’s destruction. Or as often happens, a new USGS map edition will continue to use data from older maps. That appears to have been the case here. The USGS 7.5-minute series maps show the mound before destruction with that representation carried forward. According to Moorehead (1929, p. 84) the longitudinal axis for the mound extended along a quadrant bearing of S. 89 E. This is equal to an azimuth of 91º (True).

Monks Mound Cardinal-Equinox Alignment

It may be that the sightline extending east from Monks Mound (Fig. 5, yellow line) was the baseline for much of what followed. Viewed from ground level at the presumed center of where Monks Mound was built and assuming a clear field of view, an observer looking toward the distant bluffs would have seen the Sun rise due east framed by two bluff knobs each having a mound (Fig. 11). That sunrise would have occurred on the dates of the astronomic equinoxes — e.g., 14-March-1000 CE at 18:15 EDT and 17-September-1000 CE at 08:35 EDT (Stellafane, 2021).

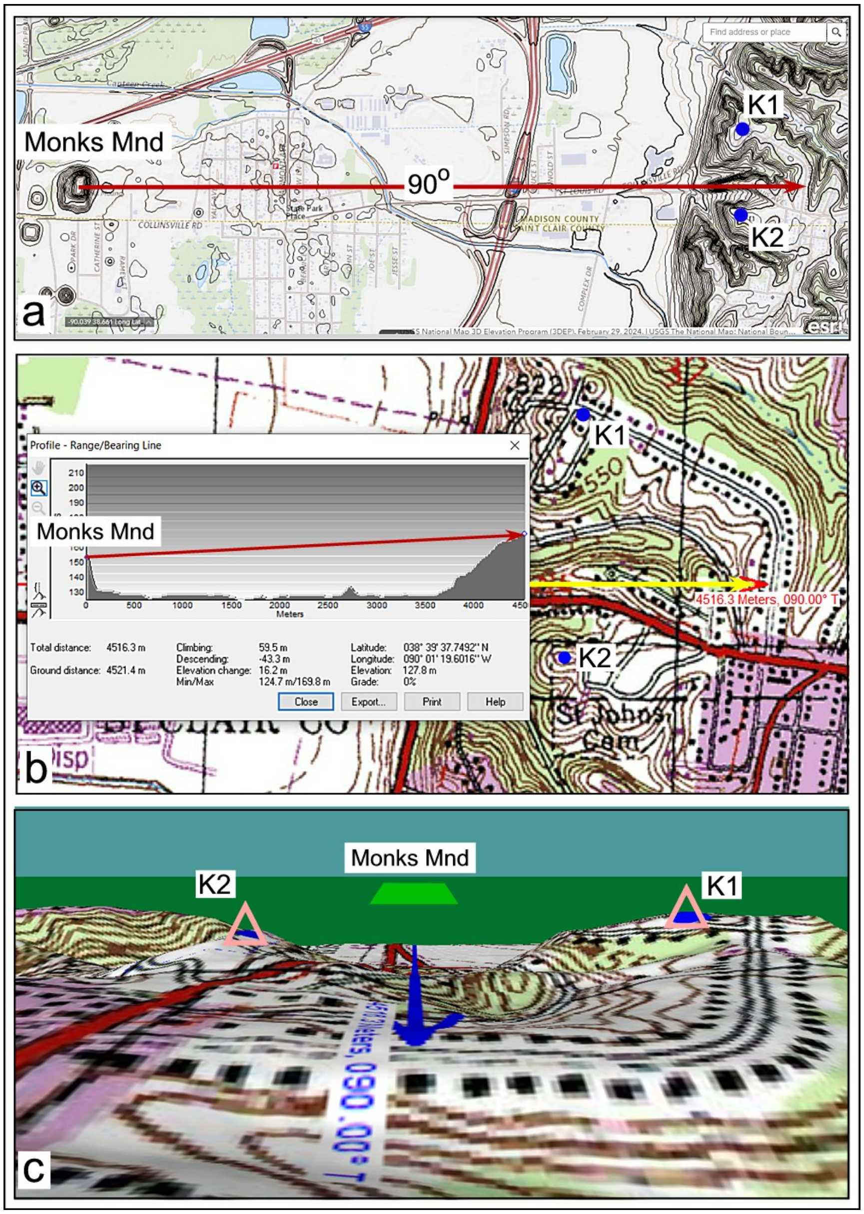

Figure 11a**.** USGS contour map showing Cahokia area with 90⁰ degree azimuth (red line) plotted from Monks Mound. Map from USGS National Map 3D Elevation Program, image date 29-February-2024. https://apps.nationalmap.gov/viewer/
Figure 11b. Enlarged detail of USGS 7.5-minute series map (Monks Mound quadrangle) showing 90⁰ degree azimuth plotted from Monks Mound (yellow line). Inset shows profile view (red line). Maps rendered by Terrain Navigator Pro (Trimble, 2023).
Figure 11c. 3D enlarged detail of USGS 7.5-minute series map (Monks Mound quadrangle) showing how the 90⁰ degree azimuth from Monks Mound (blue line) intersects east ridge and is framed by K1 and K2. View is from the east looking toward Monks Mound. Map rendered by Terrain Navigator Pro (Trimble, 2023). Annotations by the author.

Concerning the bluff mounds, Dr. J. F. Snyder (1909, p. 74) a local physician and avocational archaeologist had this to say: “On the crest of the bluffs three miles directly east of the great mound there were formerly situated two “sugar loaf” mounds overlooking, on opposite sides, a wide ravine formed by a small rivulet that cuts its way at that place through the bluffs in its course from the higher lands beyond.” These and most of the other bluff mounds have been levelled by housing developments. And Snyder can be forgiven if measurement finds that the bluffs are actually 2.5 mi (4069 m) east of Monks Mound. Notably, however, the 1904 USGS topographic map for the area shows the rivulet Snyder referred to — thus confirming the mound locations K1 and K2 in Figure 12.

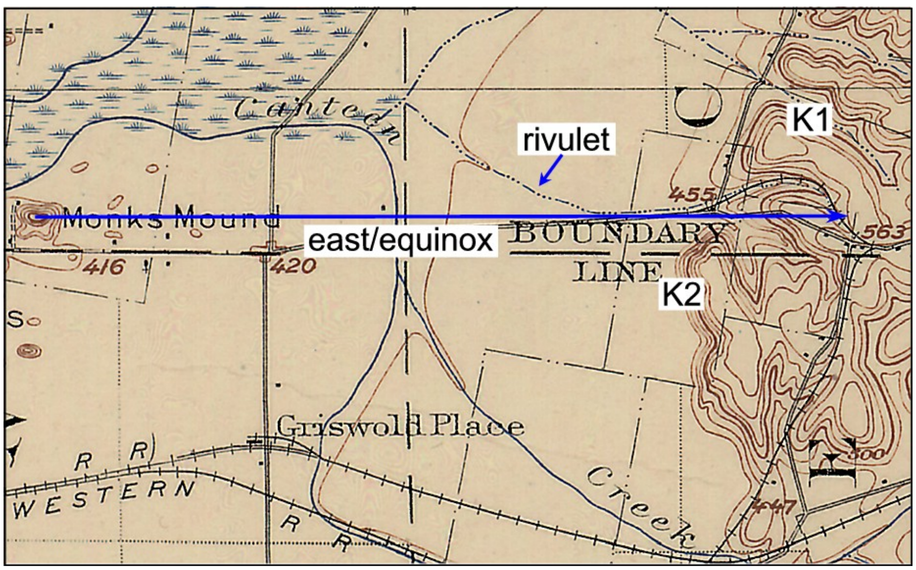

Figure 12. Enlarged detail of 1904 USGS 7.5-minute series map (Missouri-Illinois Saint Louis quadrangle, reprinted in 1925). Annotations by author. https://maps.lib.utexas.edu/maps/topo/missouri/pclmaps-topo-mo-saint-louis-1903.jpg

According to Cyrus Thomas (1894, p. 133), the southernmost of these mounds “formed a landmark for some miles around.” Reporting on his excavation of the mound Thomas (1894, p. 133) said this:

> At the depth of about 12 feet a layer of ashes, nearly an inch thick was disclosed, and a foot below this, another layer of ashes, a foot or more in thickness. Excepting some thin, flat pieces of sandstone, there were no relics nor other remains, not even a portion of bone. Below the ashes

> the earth showed the effect of heat for a few inches but seemed to be the undisturbed surface of the bluff.

Of special importance is that Thomas made note of extensive ash beds in the mound. Even if the mounds were not silhouetted against the dawn sky, fires on the bluffs and/or mounds would likely have been visible from Monks Mound marking where the Sun would soon appear.

The age of the bluff mounds is not known. There are mounds in the general area that date from Mississippian times back to the Archaic (Munson and Harn, 1971). It might make for an interesting scenario, however, if these two mounds pre-dated the Cahokia florescence. That would establish a temporal link between Cahokia and their ancient past.

The intriguing question is whether the 90^0 azimuth from Monks Mound to the ridge line represents an orientation to the cardinal direction of east or is it an equinox alignment? Before addressing that question, it is important to define the term *equinox*.

As explained by John Steele (2021, p. 35), “In modern astronomy, an equinox is defined as the moment at which the sun crosses the celestial equator. At that moment, the sun will have a declination of 0º”. There are other ways, however, of defining or determining the equinox. For example, *equinox* can be determined by: 1) noting the spatial mid-point between solstice rise or set positions on the horizon; 2) counting “the half-way point in time between the two solstices and aligning upon sunrise or sunset on that day”; 3) determining “the day on which sunrise and sunset occur in exactly opposite directions”; or 4) noting the day “on which the length of time from sunrise to sunset is the same as that from sunset to sunrise” (Ruggles, 1997, p. S45).

Each of these equinox-finding methods has inherent observational difficulties (Ruggles 2017, pp. 128–129). For example, with reference to establishing the equinox by noting the spatial mid-point between solstice rise or set positions, only in cases where the horizon is flat will the sun rise or set at an azimuth of 090º or 270º. Nevertheless, there is a growing body of evidence suggesting that equinoxes were known to some ancient peoples. These cultures had culturally-specific ways of establishing the equinoxes — some spatial and some temporal (see e.g., Beer, et al., 1961, Table 1; Belmonte, et al. 2020; Boutsikas, 2021, p. 207; Gullberg, 2020, p. 308; Hannah, 2009, pp. 147–155; Magli, 2017; Plofker, 2009, pp. 90–91; Romain, 2022; Steele, 2021, p. 46).

At Cahokia, the matter is not easily resolved because there is no clear evidence for Mississippian recognition of the equinoxes as contrasted to cardinal alignments. As to the horizon, the east horizon altitude as viewed from the base of Monks Mound is about 0.5º. Once the refraction correction of -0.5º is applied, the horizon altitude is 0.0º. Thus, for the sightline in Figures 11a-11c we are left with the possibility of either a cardinal direction or spatial equinox alignment. On the date of the astronomic equinox, as viewed from the base of Monks Mound the lower limb of the Sun was tangent to the horizon at an azimuth of 90.2º. Upper limb tangency was at 89.8º, so those further refinements are not especially helpful in distinguishing between the equinox azimuth and east.

It might be argued that since the 90º azimuth from Monks Mound does not intersect any identified mound or marker on the bluff ridge, maybe the posited sightline is fortuitous. There are several points, however, that argue against that. First, it could be that a sunrise marker on the ridge has been overlooked and/or built over by the housing development now occupying the ridge. Also worth recalling is that Thomas found beds of ashes in mound K2 — one of the flanking sunrise mounds. No cremation or other burial remains were found. If not for cremations or burials then perhaps the fires were intended to mark the approximate anticipated sunrise location during early dawn hours, or in some other way symbolically associated with sunrise.

What also makes the posited alignment from Monks Mound intriguing is that as Figure 5 shows, near-parallel sightlines drawn from Mound 85 and the Powell Mound intersect K1 and K2, respectively. The observation that these sightlines are close to parallel suggests that the mound builders were aware of K1 and K2 and perhaps situated Mound 85 and the Powell Mound relative to those knolls and mounds. The Mound 85 to K1 sightline extends along an azimuth of about 91.0º, while the Powell Mound to K2 azimuth is about 92.25º.

As to Mound 85, very little is known about it. It is shown on USGS topographic maps about 360 m northeast of the Powell Mound. As scaled from an older document known as the Patrick map, Fowler (1997, p. 156) gives its dimensions as 70 m by 30 m and about 3 m in height. According to Fowler (1997, p. 156), “A slight rise in elevation is about all that can be seen today. This is a small remnant of this once massive mound.”

Recognition of a cardinal east/equinox sightline extending from the base of Monks Mound to the east ridge seems likely. And as demonstrated by the orientation of the Monks Mound building structure discussed below, the east/equinox direction continued to be important after the mound was built.

Specifically, excavations on the third terrace by Reed (2009, p. 65) found posthole evidence for a large building with a fence or palisade (Fig. 13). Schilling (2013, p. 25) explains that this “was the largest Mississippian building ever built.” Exactly how the structure was used is not known. Suggestions include council house, residence for a chief or priestly elite, and charnel temple. Whatever its use, as shown by Figure 13 the structure was oriented to the cardinal directions to include east.

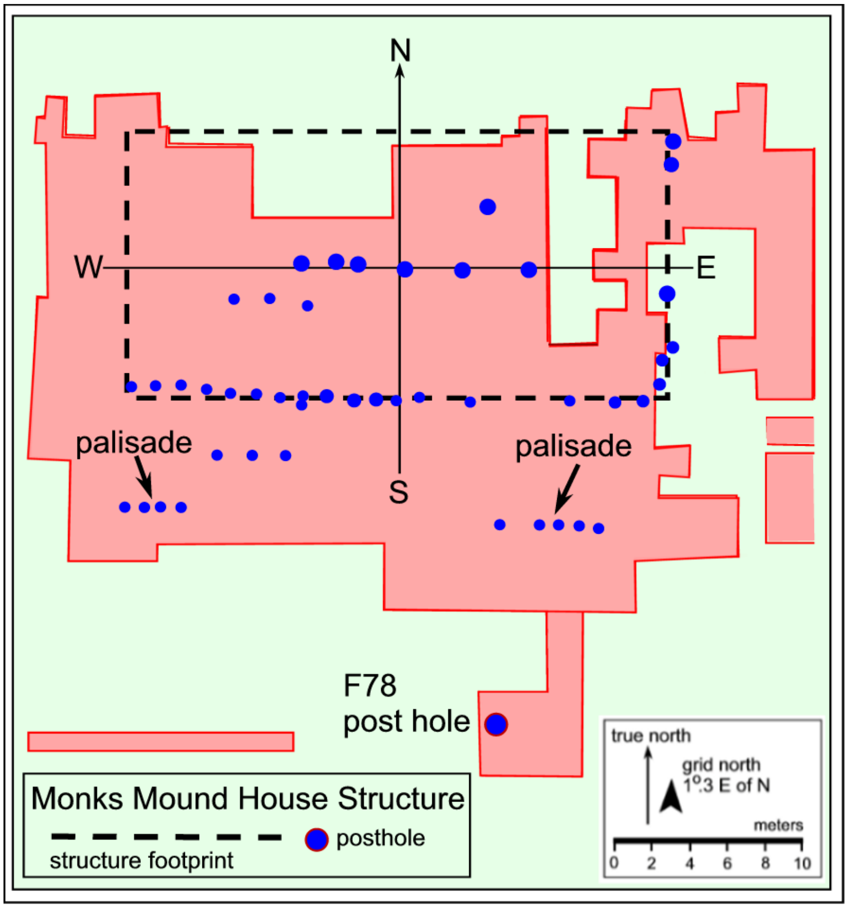

Figure 13. Simplified footprint of building on Monks Mound third terrace. Excavation units in light red, outline of structure shown by dashed line, postholes in blue. Redrawn by the author after Reed, 2009; Fig. 38.

Support for the cardinal/equinox alignment also comes from a feature found in front of the building structure (Figs. 13 and 14). Known as F78, this was a large and deep post hole. Excavation found the post hole was 3.5 m in depth and 1 m in diameter (Reed, 2009; Fig. 8). Reed (2009, p. 75) noted that it was the deepest posthole found at Cahokia.

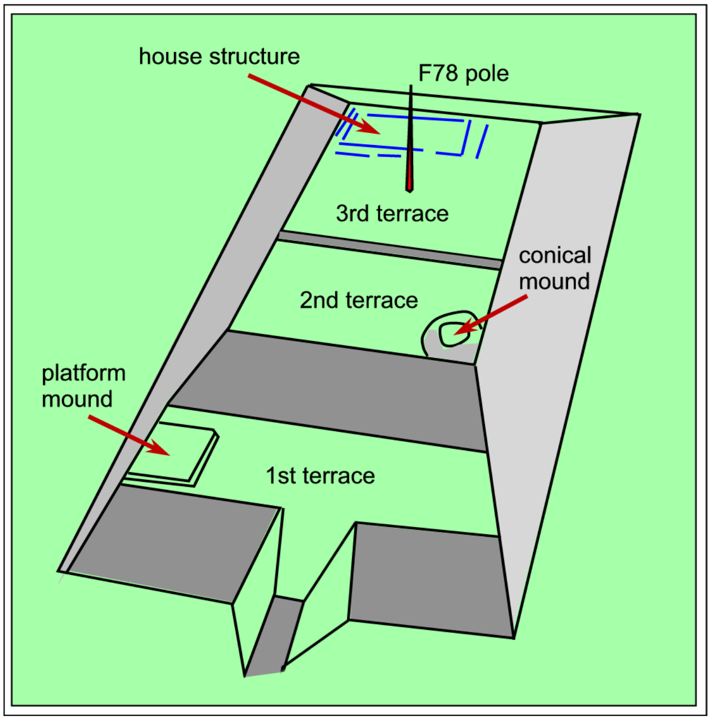

Figure 14. Schematic plan of Monks Mound as it might have originally appeared. Drawing by the author after Reed 2009; Fig. 42.

In what follows it will be suggested that the F78 post marked the axis mundi for Cahokia. To begin with, however, it is useful to consider how the location for the F78 post relates to the east horizon. Of course, the excavated posthole has long since been filled-in and covered-over. And there are other difficulties establishing its location. Published plans of the excavations are to different scales. And the original site datum (0-0) set by James W. Porter in 1964 was arbitrarily situated “southwest of mound” (Reed, 2009, p. 8). Those were days before the use of GPS for surveying. Worse yet, the resulting excavation grid and map were incorrectly oriented because “an error was made in compensating for magnetic declination (Fowler, 1997, p. 57). For the present study, therefore, to locate F78, a combination of maps and data were used. The end result is likely accurate to ± 2 m.

The first map used was a contour map of Monks Mound made by Mikels Skele (1988, p. 55) of the Illinois Historic Preservation Agency (IHPA). The IHPA map shows the entire mound and excavation units (Fig. 15a). It appears derived from an aerial photogrammetric map made by the University of Wisconsin-Milwaukee (Fowler 1997; Fig. 4.11). The map is useful; but it is too small to show F78 itself. Reed (2009; Fig. 21), provides a large-scale contour map showing F78 plotted on a 50 m x 55 m section of the site grid; but that map does not show the feature relative to the entire mound. Importantly though, Reed (2009, p. 9) gives the grid coordinates for F78 as N203.91/E185.12.

Knowing the grid coordinates for F78 and with reference to Figure 15a, the first step was to plot F78 on the IHPA map. To do this the map was imported into TurboCAD (IMSIDesign, 2024) with the CAD drawing scale set to the IHPA map scale. Grid coordinate data for F78 were then plotted by computer input. Next the map was rotated clockwise by 1.26º to correct grid north to true north. (Correction value per by Fowler 1999; Fig. 1.3). Four control markers (blue crosses) were added so the map could be georeferenced. Next, the IHPA map was added as a layer over a LiDAR contour map (Fig. 15b) so that the blue crosses on the IHPA map matched corresponding features on the LiDAR image. For Figure 15c the IHPA map layer and blue markers were removed, leaving only the red coordinates lines for F78 with a black control marker added to that location. From the F78 control marker in Figure 15c, a 90º line was drawn across to Figure 15d which is a digitized USGS topographic map detail (Terrain Navigator Pro) showing the east ridge (with datums for LiDAR and USGS digital map set to WGS84). A blue marker dot was placed where the 90º line intersects the ridge. As shown by the computer-generated information next to the blue marker in Figure 15d, the marker is at latitude 38º 39’ 38.5” N. Likewise, as indicated by the data in the lower left of Figure 15c, the black marker and F78 post are at 38º 39’ 38.5” N. Thus, the F78 post is due west of the ridge marker and I believe, established a backsight for the east/equinox alignment. If the F78 post had been positioned north or south of where it was, then the alignment would not have worked, or at least it would not have been so accurate. In other words, the sunrise location on the bluff ridge dictated the location for F78.

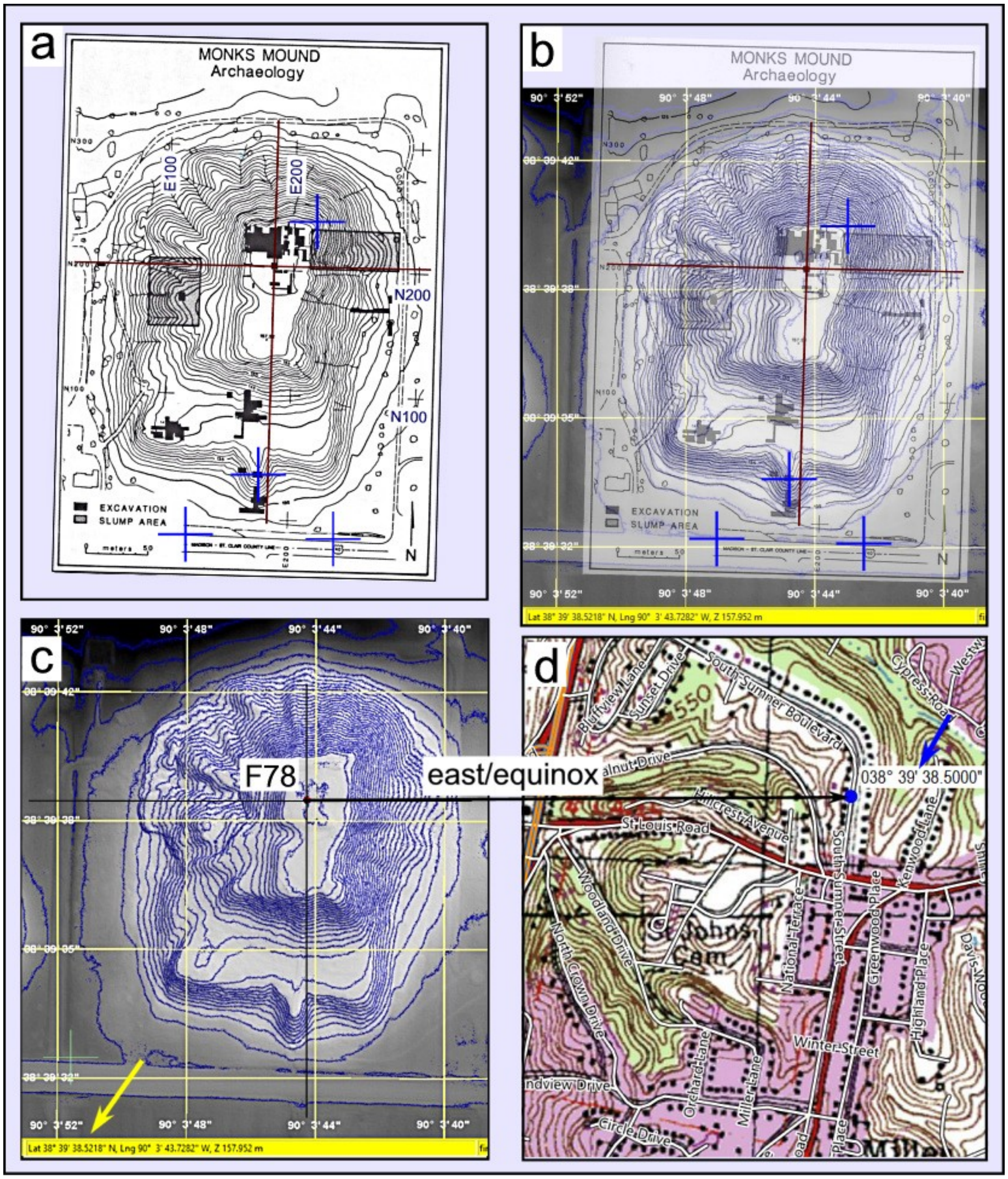

Figure 15a. Monks Mound contour map by Mikel Skele, Illinois Historic Preservation Agency (IHPA). Courtesy of Illinois Historic Preservation Agency. Map corrected to true north with annotations by present author. Red lines plotted per coordinate data for F78. F78 is at intersection of red lines. Blue crosses added by present author for georeferencing.
Figure 15b. IHPA map added as a layer over LiDAR contour map (1 meter contour interval). Red cross shows location for F78. LiDAR data courtesy of Indiana University, Department of Earth and Atmospheric Sciences.
Figure 15c. LiDAR contour map with IHPA map removed leaving red cross with added marker pin showing location for F78. LiDAR data courtesy of Indiana University, Department of Earth and Atmospheric Sciences.
Figure 15d**.** Sightline drawn from F78 due east. Blue dot shows where the line

intersects east ridge. Base map by Terrain Navigator Pro (Trimble, 2023), annotated by author.

As a cross-check I also plotted the F78 coordinates on a control point survey map made in 1973 by consulting engineer and surveying firm, Flagg, Scheibal and Sherbut, Edwardsville, IL. (Fig. 16). At map scale there was no discernable difference between the IHPA and control point survey maps for F78.

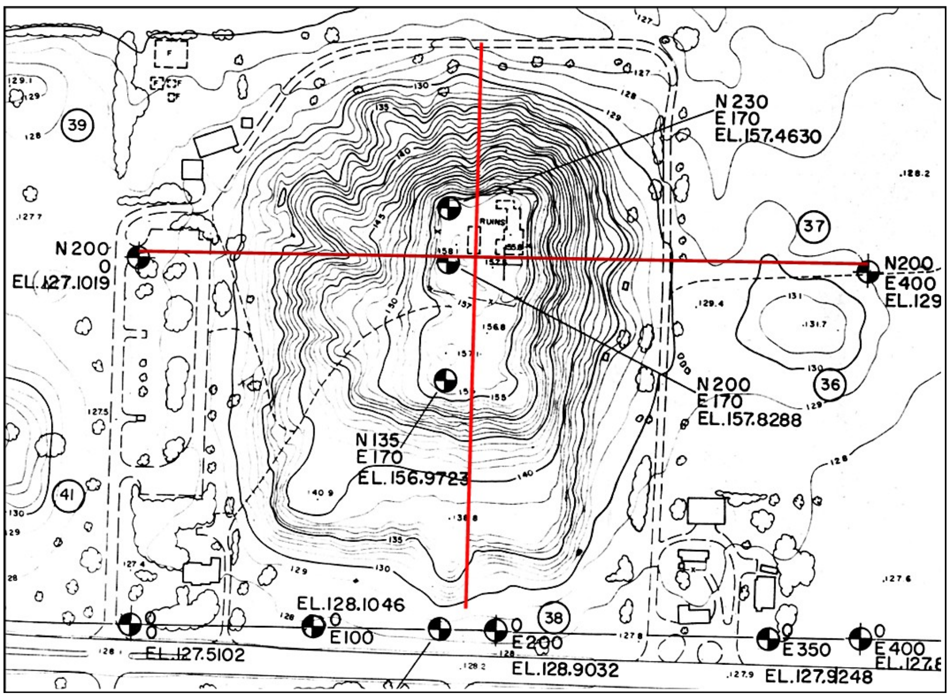

Figure 16. Control point survey map made in 1973 by Flagg, Scheibal and Sherbut, Edwardsville, IL. Red lines plotted by present author intersect at F78. Map courtesy of William Iseminger and Cahokia State Historic Park.

A follow-up question relates to the azimuth for sunrise as viewed from F78 given that the summit of Monks Mound is 19 m higher than the base where initial calculations were presumably made from. As viewed from the F78 higher elevation, on the date of the astronomic equinox, the Sun’s upper limb tangency was at 89.8º while lower limb tangency was at 90.2º. Center of the Sun would have been at 90º.

In short, in answer to the question as to whether the 90º sightline from Monks Mound represents alignment to a cardinal direction or equinox, I would suggest that as a practical matter it was, in a sense, both. What I mean is that whether a due east or equinox alignment, it was the Sun that gave meaning to the sightline(s), by whatever name. If, Cahokians recognized the spatial equinox then the fact that that sightline was coincident with east would simply have made the hierophany more significant.

Monks Mound to Rattlesnake Mound and the Milky Way

For several decades conventional wisdom has been that the Cahokia site axis is skewed clockwise by about five degrees from true north. This assessment was and continues to be, reasonable, given that mound edges are difficult to distinguish making both edge and center to center azimuths between mounds less than certain. As Pauketat, et al. (2023, p. 254) recently pointed out "…the orientations of the Cahokia's Precinct's central rectangular pyramids in their final form remain true to the 005-degree axis…" The significance of the 5º site axis is that its reciprocal — i.e., 185º, points to the Milky Way.

Specifically, there is a temporal window when the 185º site axis, Monks Mound, Rattlesnake Causeway, and minor axis of Rattlesnake Mound all point to the Milky Way and Milky Way Path of Souls. That time is just after sunset, at nightfall, on the summer solstice. At that time, the Milky Way rises out of the northeast horizon, arcs across the eastern and southern sky and plunges to the horizon at an azimuth of about 185º.

For example, Figure 17 shows a computer planetarium simulation of the night sky as viewed from along Rattlesnake Causeway, looking south, at nightfall, on the night of the 1050 CE summer solstice. In 1050 CE summer solstice occurred on 16-June (https://stellafane.org/misc/equinox.html). Sunset was at 19^h, 21^m (local standard time); and nightfall occurred at 21^h, 25^m (local standard time). The same view would apply for several hundred years preceding and following the 1050 CE date. (Nightfall is when all the stars that can be seen with the naked-eye become visible. That happens after sunset, when the Sun is 18º below the horizon (Bowditch, 2017 [1802], Table 1316).

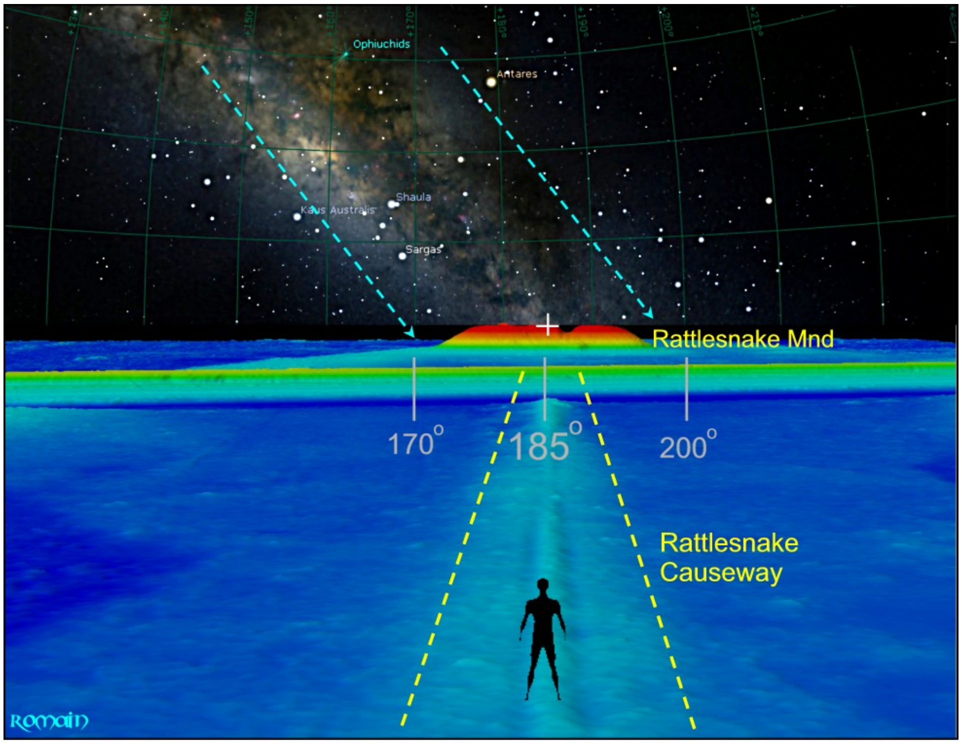

Figure 17. Computer simulation (Stellarium ver. 0.19.3) showing how the Milky Way was aligned to Rattlesnake Causeway at nightfall on summer solstice, 1050 CE. Image combines LiDAR DEM with Stellarium screen shot. Atmospheric visualization turned off to better show Milky Way. What appears to be a notch in Rattlesnake Mound is a trench that Warren K. Moorhead left unfilled after excavation in the 1920s. Green line is east-west active railroad embankment. LIDAR data from State of Illinois, Geological Survey, Prairie Research Institute.

The simulation in Figure 17 shows that the trajectory of Rattlesnake Causeway intersected the Milky Way near the center of the star band, near the Dark Rift. Viewed from the north end of the Causeway, the east-west width of Rattlesnake Mound closely matches the lateral spread of the Milky Way. Indeed, that correspondence may help explain the orientation of Rattlesnake Mound's longitudinal axis which is orthogonal to the 185º azimuth.

Notably, the edges of the Milky Way are fuzzy. At its south end, where it meets the horizon, its width is about 20º. This means there is an azimuthal range that a ground feature like the Causeway might point toward and still be considered Milky Way aligned. The Milky Way also appears to move from east to west across the southern horizon as the Earth rotates.

As a moving target with fuzzy and broad boundaries the Milky Way does not present a specific alignment point; but rather, a spatial corridor and temporal window. From this it might follow that, if the Causeway was used to direct or guide the deceased to the Milky Way Path, then movement from this world to the next could happen within a range of azimuthal and temporal parameters. This would allow mortuary ceremonies involving movement of the dead along the Causeway to Rattlesnake Mound for burial or reburial, during an extended time frame rather than at a specific moment in time.

As to timing of the Milky Way alignment at summer solstice, there is little doubt that Cahokians were well-aware of the solstices. Preliminary LiDAR analyses suggest summer solstice sunset alignments between several mounds. Woodhenge II and III have post holes at summer and winter solstice rise locations relative to center posts (Iseminger, 2010, p. 128). At the nearby St. Louis Mound Group, there are multiple solstice alignments (Romain, 2023). And there are multiple solstice alignments at the Angel site in Indiana (Romain and Herrmann, 2022).

Following Reed, it is suggested that the F78 post on Monks Mound was the axis mundi for Cahokia. Given the coordinate data for F78, it is of interest to know how that feature relates to the site axis and Milky Way. Likewise it will be useful to consider the “summit mound” on the southeast corner of the third terrace as that has alternatively been posited as the axis mundi for Cahokia (Pauketat, et al., 2023, pp. 254).

Figure 18 shows the two sightlines plotted. One sightline is from the F78 post location to Rattlesnake Mound; the second is from the southeast corner mound (SEM) to Rattlesnake Mound. Feature F78 was computer plotted by inputting the latitude and longitude coordinates (WGS84) obtained earlier from Figure 15c into the ‘create marker’ function of the LiDAR application. The same thing is true for the southeast mound (SEM) location and summit center for Rattlesnake Mound (RMS). There is a difference of about one degree between the two azimuths. As viewed from the north end of the Causeway, or SEM or F78, a one degree difference would not have made a significant difference in the appearance of the Milky Way relative to Rattlesnake Mound. Again, this is because the Milky Way is about 20º wide and there is nothing that definitely identifies its center.

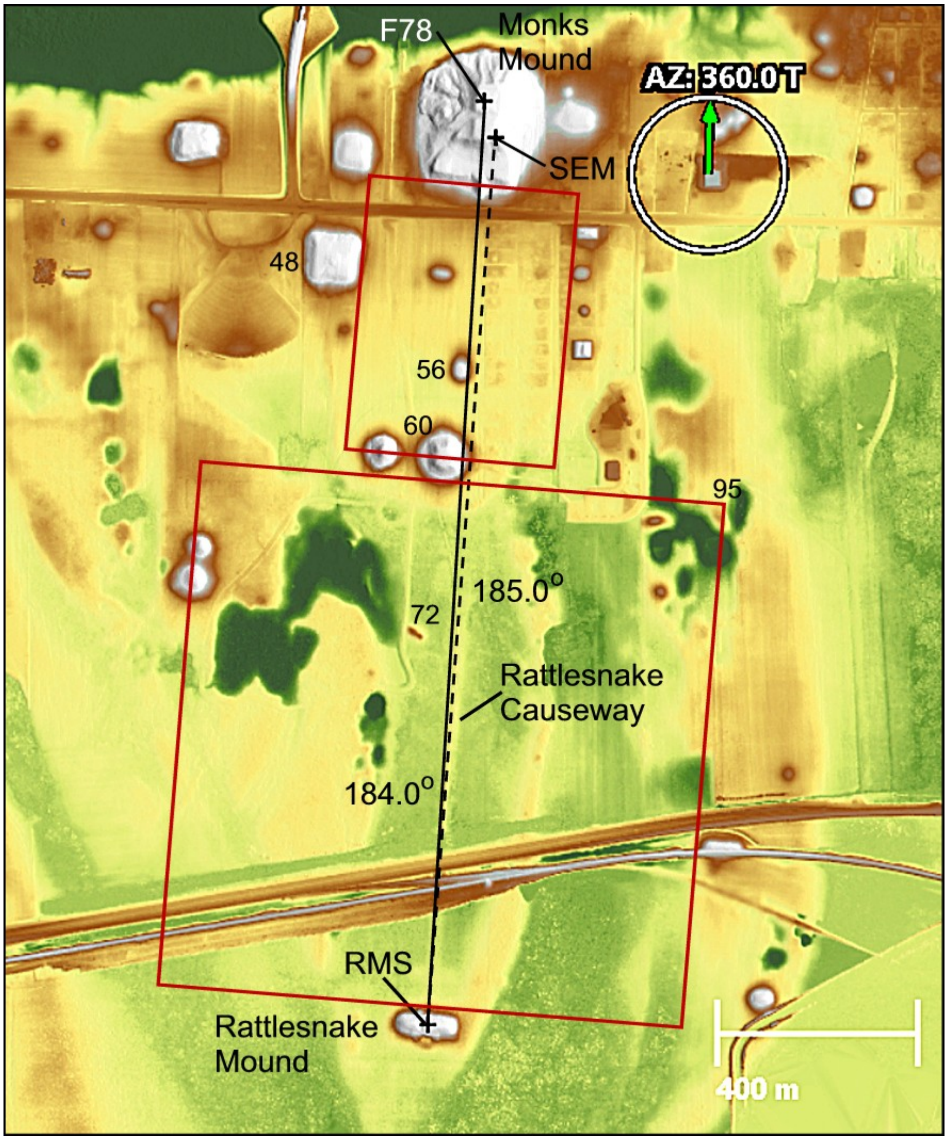

Figure 18. LiDAR DEM showing sightline from F78, through front ramp, along west edge of Rattlesnake Causeway, to center of Rattlesnake Mound summit (RMS). Dashed line shows sightline from southeast corner mound (SEM) along Rattlesnake Causeway to Rattlesnake Mound summit (RMS). No vertical exaggeration. LiDAR data courtesy of Indiana University, Department of Earth and Atmospheric Sciences.

There is no doubt that the southeast corner mound location and the SEM – RMS sightline were important as that sightline coincides with the azimuth for

Rattlesnake Causeway. However, what makes the SEM location and its features unlikely as the site axis mundi is that: 1) unlike F78 (which was massive posthole presumably used to support a ≈20 m vertical pole), no center post hole was found at the SEM location. In fact, quite the opposite. According to Pauketat, et al. (2023, p. 254), the SEM location was a sweat lodge; 2) the SEM location is nowhere near the north-south, or east-west center of Monks Mound (regardless of how badly the mound has slumped); 3) as Figure 18 shows, the SEM – RMS sightline fails to bisect the site to the degree of accuracy that the F78 sightline does; and 4) with the F78 pole in position, evidence of its role as the axis mundi would have been repeatedly witnessed by Cahokians when lightning struck the F78 summit post.

With regard to this last point, as an experiment, excavators of the F78 feature placed an 11 m long pole in the post hole. Within days and for months afterward, the pole was struck by lightning (Reed, 2009, p. 75). Figure 19 shows an artist's depiction of a lightning strike event on the F78 post. There is no doubt that the same thing would have happened in Mississippian times. Arguably, lightning strikes established a dramatic and unmistakable connection between the Upperworld and This World. Given its central location and visible connection between realms, it seems likely that the F78 post marked the axis mundi for Cahokia.

Figure 19. Artist’s depiction of lightning strike on F78 center post, Monks Mound. Illustration by Herb Roe, originally commissioned by present author, reproduced here under license from Herb Roe.

Indeed, as shown by Figure 20, and as viewed from F78, the Milky Way would have been an impressive sight as it lined-up with the major site axis and plunged into the Lowerworld, marked by Rattlesnake Mound.

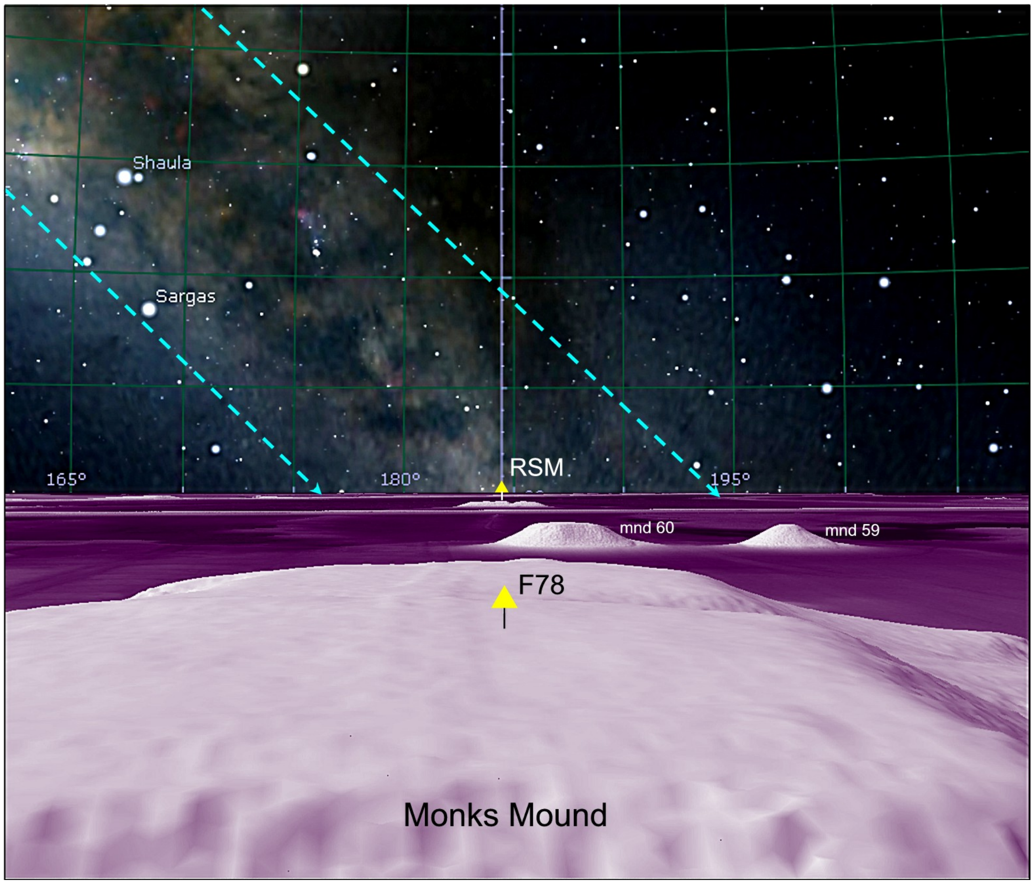

Figure 20. Computer simulation showing Milky Way and Rattlesnake Mound as viewed from F78 axis mundi on summit of Monks Mound. F78 vertical line is 2 m in height. Center of Rattlesnake Mound is at marker RSM. View is at nightfall on summer solstice, 1050 CE. Image combines LiDAR DEM with Stellarium (ver. 0.19.3) screen shot. Atmospheric visualization turned off to better show Milky Way. LIDAR data courtesy of Indiana University, Department of Earth and Atmospheric Sciences.

Rattlesnake Causeway and the Bundle Burials

In an earlier paper it was suggested that Rattlesnake Mound was a portal to the Otherworld for souls of the deceased (Romain, 2021). In this scenario Rattlesnake Causeway was a terrestrial metaphor for the Milky Way Path of Souls leading from the center of Cahokia directly to Rattlesnake Mound (Baires, 2017; Romain, 2021). Recall that in many indigenous stories, the Milky Way Path of Souls was the 'road' that souls travelled in order to reach their final destination, which was the Land of the Dead (Lankford 2007a, 2007b). No less than 150 individuals in bundle burials were found in the limited excavations of Rattlesnake Mound — the purported Milky Way portal.

Additionally, however, it appears that the Rattlesnake Mound burials were placed in a very special location within the mound.

A detailed top-view plan showing the location for the Rattlesnake Mound burials was made by Taylor when he excavated the mound in 1927; but that plan was not published until several years ago by Pauketat and Barker (2000; Fig. 10). The Taylor plan shows 35 separate interments (each consisting of multiple individuals) situated in a concentrated area. Assessment of Taylor's published plans places the burials about one-third of the way up the southern slope of Rattlesnake Mound (positioned away from central Cahokia and facing the Lowerworld wetlands). Notably, the burials were positioned a few feet west of, as well as directly on, the mound's minor axis. Recall that the mound's minor axis coincides with the azimuth for Rattlesnake Causeway — both of which point to the Milky Way and Milky Way Path of Souls (Romain, 2021).

In fact, as Figure 21a shows, if Rattlesnake Causeway were to be extended into Rattlesnake Mound, then the bundled burials would be situated well within the lateral boundaries of the Causeway.

An important piece of information is provided by Taylor concerning the physical context of the burials. Specifically, Taylor (in Moorehead, 1929, p. 72) said:

> Careful examination of the surrounding soil immediately after these burials were discovered and before the rain softened it failed to disclose any visible evidence that it had ever been disturbed. So far as could be ascertained, the earth in which these bones lay did not in any wise differ in color, texture, or formation from that in the immediate vicinity, and if a trench or individual pits had been dug to receive the burials, all evidence of such outlines had been obliterated.

The implication is that the bundled burials were placed on an early mound surface before being covered over by layers of earth that eventually rose to the height of the mound we see today. Taylor (in Moorehead, 1929, p. 71) states that the first human remains were found in section 15-C at a depth of

26 ft below the benchmark datum, or about 3.2 ft (1 m) above the base of the mound.

As part of her dissertation research, Sarah Baires (2017, p. 108) excavated Taylor's trenches and in fact, went a bit deeper. Surprisingly, Baires found a trench-wall structure about 1 m below the original level of the burials. Using this information, the position of the burials and building can be plotted. Figures 21 and 22 show the results.

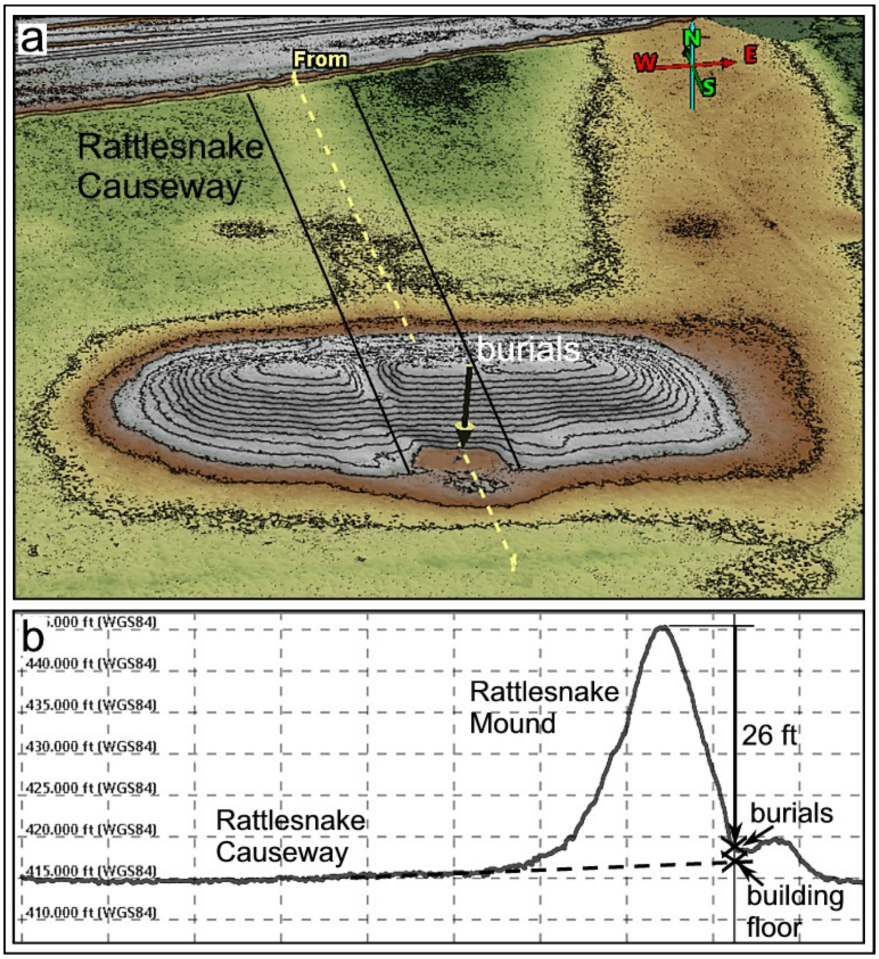

Figure 21a. LiDAR image showing relationship between Rattlesnake Causeway and bundle burials. Cursor shows location for burials. Dashed line shows center line of Rattlesnake Causeway, solid black lines show Causeway width. Cursor shows location of burials.
Figure 21b. LiDAR profile showing location for bundle burials at the end of projected Rattlesnake Causeway.

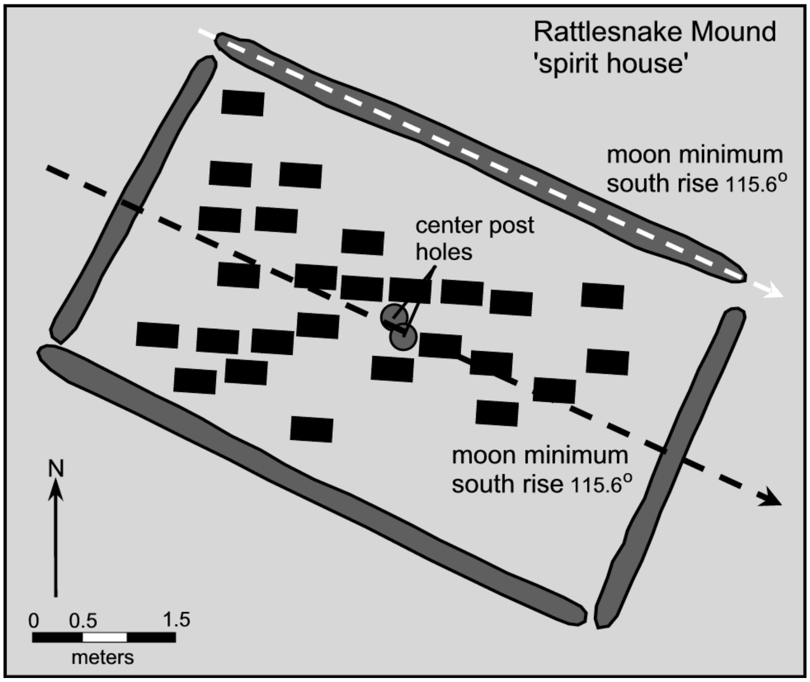

Figure 22. 'Spirit house' structure at base of Rattlesnake Mound as revealed by excavated wall trenches. Black rectangles represent bundle burials. House structure redrawn after Baires (2017; Fig. 4.5), bundle burials following Taylor (in Pauketat and Barker, 2000; Fig. 10). Lunar sightlines calculated and plotted by present author.

As to orientation, Baires (2017, p. 110) sought to associated the spirit house with the winter solstice rise. The problem is that the orientation of the building (i.e., 112º – 114º) is nowhere near the solstice azimuth of 120º. The structure is, however, oriented to the Moon's minimum south rise to within ± 0.5 º (1000 CE, horizon altitude = 1.1º, corrected for refraction, lower limb tangency, and parallax) (Fig. 22). The ± 0.5º qualification results from Baires's (2017, p. 110) use of a magnetic compass for determining azimuths for the structure's walls, which she then corrected to true north using a magnetic declination value of 1.15º West for June 2011. The NOAA (2023) declination calculator for July 2011 at that location shows a declination of 0.89º (Enhanced Magnetic Model [EMM]). The difference in declination values does not materially affect the posited lunar alignment. However, it is worth noting for future investigations.

We may never know with absolute certainty, but I suggest the following scenario. From the center of Cahokia, persons could walk south along Rattlesnake Causeway, walk across the surface of Rattlesnake Mound which was still less than 1.2 m (4 ft) in height and place the dead on a trajectory of the Causeway that terminated inside the mound, and within the spirit house structure. At this stage Rattlesnake Mound was likely a low platform mound as indicated by LiDAR imagery showing an elevated area surrounding the ellipse-shaped mound (Fig. 21a). At some point, after the bodies had decomposed, the bones were gathered into bundles, the spirit house was decommissioned by disassembly and covered with a layer of earth. The collected bundles were then placed on top of the decommissioned structure, with another layer of earth covering everything. Over time the mound was built higher in stages, eventually resulting in the height we see today. (A similar instance of burials being placed on top of a decommissioned 'spirit house' is found in mound 72, see Fowler, et al., 1999, Fig; 6.2).

The order of events might be argued; but the important point is that the Rattlesnake Mound burials were not only placed within what has been described as a mound 'portal' to the Otherworld, the dead were also physically positioned on the terrestrial equivalent of the Milky Way Path of Souls, with an added cross-orientation to the Lowerworld Moon.

Rattlesnake Mound to K6

The story does not end, however, with orientation of the F78 and major site axis to Rattlesnake Mound and the Milky Way. If the sightline is extended from the center of Rattlesnake Mound it will intersect a bluff knoll, 7.2 km to the southeast (Figs. 23a and 23b). I noted the bluff knoll alignment years ago (Romain, 2015, p. 34, note 3). What I did not know at the time, but as pointed out recently by Pauketat, et al. (2023, Fig; 16), is that two mounds were at that location. The larger of the two is known as Clark's Mound. Its age is unknown. Fortunately, a benchmark showing the location for the mound is found on USGS topographic maps for years 1998 (and 1904) (Fig.

23b). And, Moorehead (1923; Fig. 6) shows the mound relative to the benchmark just noted (Fig. 23d, below).

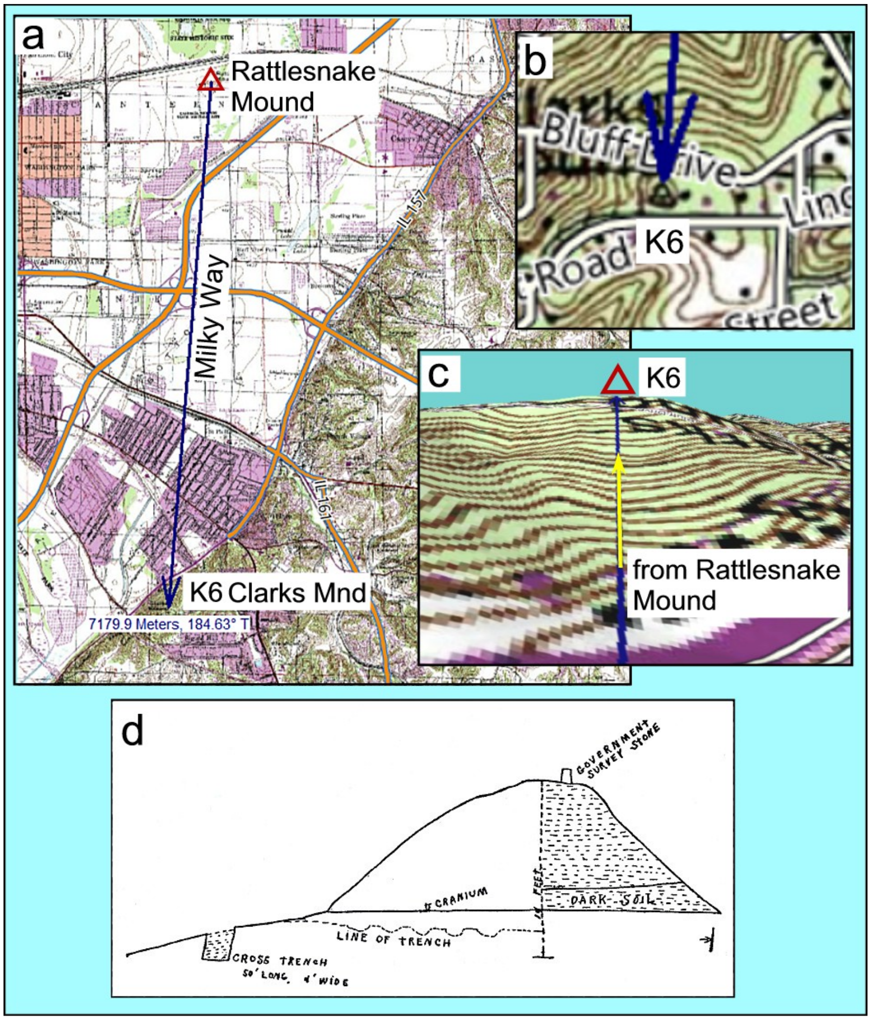

Figure 23a. USGS topographic map detail (1998 Monks Mound, IL quadrangle) showing azimuth from Rattlesnake Mound to Clarks Mound. Base map by Terrain Navigator Pro (Trimble, 2023). Annotations by author.
Figure 23b. Enlarged detail of USGS topographic map showing USGS benchmark (small triangle) on K6 bluff.
Figure 23c. Enlarged 3D detail of USGS map showing location for Clarks Mound and azimuth from Rattlesnake Mound.
Figure 23d. Sketch made by Moorehead (1923; Fig. 6) documenting ‘government’ benchmark.

Even though aligned to the Milky Way, at night and from the distance of Rattlesnake Mound, or F78, Clark’s Mound would not have been visible, unless fires were set on the mound. Notably, there is evidence for the use of fire. According to Moorehead (1923, p. 32):

> Persons frequently called our attention to two mounds on Signal Hill. These command a view of the American Bottoms and in an air line are some four miles south of the largest tumulus — Monks. We secured permission to excavate from Judge J. D. Sullivan, both structures being in his yard. The largest one when viewed and measured from its base, is a low conical mound, 10 feet in height, some 90 feet in diameter, nearly circular at the base line.

At the base of the mound and dug into the ground surface Moorehead (1923, p. 32) found “bowl-like depressions” ranging from 12 inches to 5 feet 2 inches in diameter. The depressions had been “cleaned out” but still contained remnants of ashes mixed with charcoal as well as broken stone and bone tools, pottery shards, shell and bone beads, a fragment of quartz crystal, another of hematite, and animal and bird bones. It was Moorehead’s impression that the pits were used as hearths or for cremations and then cleaned-out and filled-in with a dark-coloured soil, with the mound erected over it. On Moorehead’s (1923; Fig. 6) sketch (Fig. 23d herein) he notes a “cranium” — so apparently human remains were in fact found in the mound.

Rattlesnake Mound to K3

As Figures 18 and 21a show, Rattlesnake Causeway intersects Rattlesnake Mound in an orthogonal manner. This means that while the minor axis of Rattlesnake Mound is 185º, the longitudinal axis is 95º (Fig. 24b). When the 95º sightline from Rattlesnake Mound is extended, it intersects a mound on a prominent knoll (K3) on the bluff overlooking Cahokia (Fig. 24a). Very little is known about the mound. One of the few mentions of it was by Illinois Geological Survey geologist Morris M. Leighton. Leighton (1923, p. 93) described the mound thusly: “In the mouth of Canteen Creek Valley, are terrace remnants with a summit reaching the 480-foot level on the point of a spur where an Indian mound, 20 feet or more in height is situated. Many flint chips occur in the soil….”

In an earlier report McAdams (1887, p. 45) makes note of a “mound on the bluff opposite East St. Louis.” The K3 location is indeed opposite from north

East St. Louis. The reference is brief, but McAdams states that in this mound he found a human burial with a copper headdress and large frog effigy pipe.

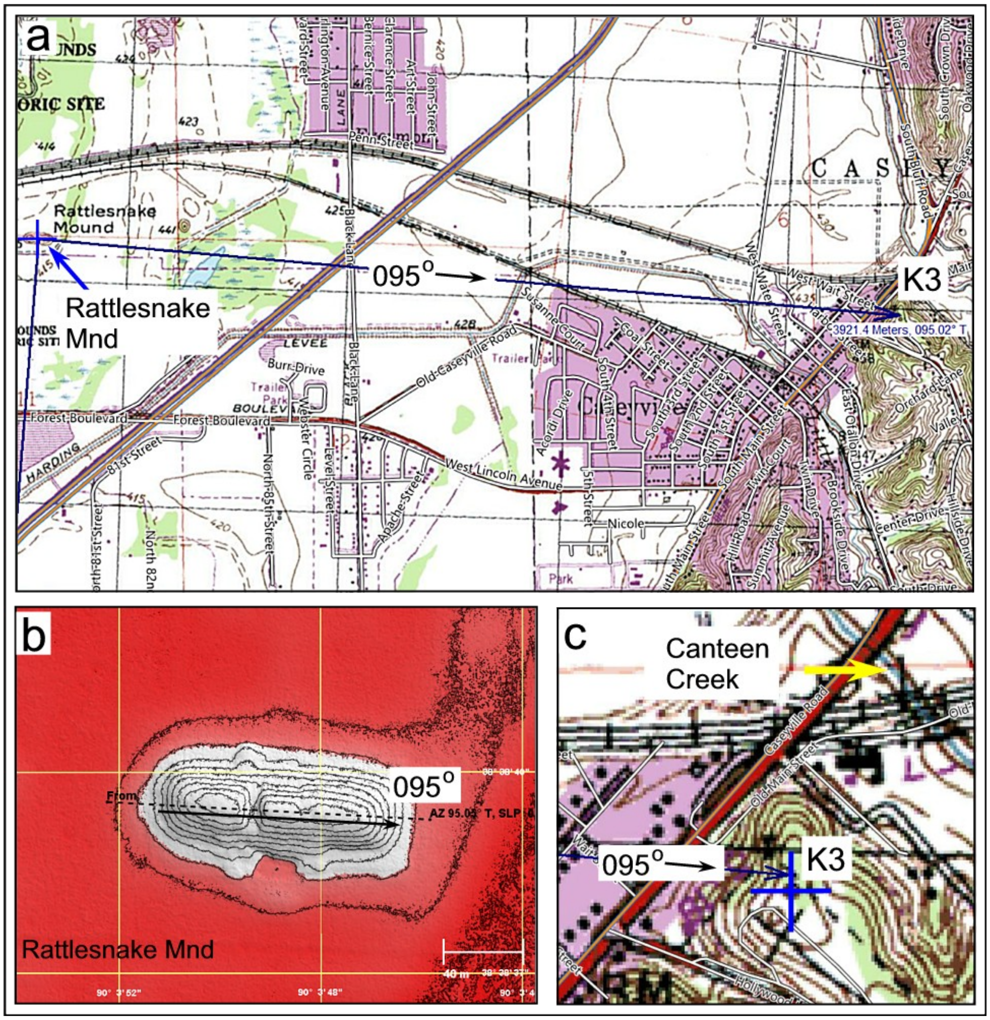

Figure 24a. USGS topographic map detail (1998 Monks Mound, IL quadrangle) showing azimuth from Rattlesnake Mound to K3. Base map by Terrain Navigator Pro (Trimble, 2023). Annotations by author.
Figure 24b. LiDAR view of Rattlesnake Mound. No vertical exaggeration. 1 meter contour interval. LiDAR data courtesy of Indiana University, Department of Earth and Atmospheric Sciences.
Figure 24c. Enlarged detail of USGS map showing K3 bluff, azimuth from Rattlesnake Mound and Canteen Creek.

In addition to the mound, what distinguishes the K3 promontory is that it marks the location where Canteen Creek exits the upland area (Fig. 24c). From this location Canteen Creek flows northwest, passing to within a few hundred meters north of Monks Mound and then on to the Mississippi River.

For Cahokians, Canteen Creek provided a source of fresh flowing water unlike the standing water that mostly surrounds the site. Today, Canteen Creek is a hardly more than a trickle. Before modern changes to the landscape, however, the watercourse was considerably larger. Thus Rattlesnake Mound points to an important landscape location.

From a cosmological perspective, it may be relevant that the source for Canteen Creek are multiple springs in the area of Troy Junction, Illinois, about 10 km to the northeast. If as suggested elsewhere (e.g., Hudson, 1976; Reilly, 2004; Simek, et al., 2021) rivers or watercourses were believed to be conduits to the spirit world or Lowerworld because of how they rise from underground sources, then it would be consistent for the longitudinal axis of Rattlesnake Mound to point to such a portal. Perhaps the Milky Way portal was not the only way to the Otherworld.

Powell to Rattlesnake Mound Lunar Alignment

The next alignment considered extends between the Powell and Rattlesnake mounds. The year 1001 CE was a lunar maximum year. Other maximum years around the time of the Cahokia florescence were 1020 CE, 1039 CE and 1057 CE. In what follows we will be concerned with the Moon's maximum south rise. This refers to the most southern point on the horizon that the Moon will rise over the course of its 18.6-year cycle (i.e., maximum south declination). Important to know is that the southern maximum moonrise is not a one-time event. Maximum south moonrise appears in very nearly the same location a couple of times during months around its precise time of maximum declination. Figures 25a and 25b, for example, show the maximum south rise azimuth for the Moon observed from Powell Mound for two months during 1001 CE. On both dates the moonrise was at 128.9º.

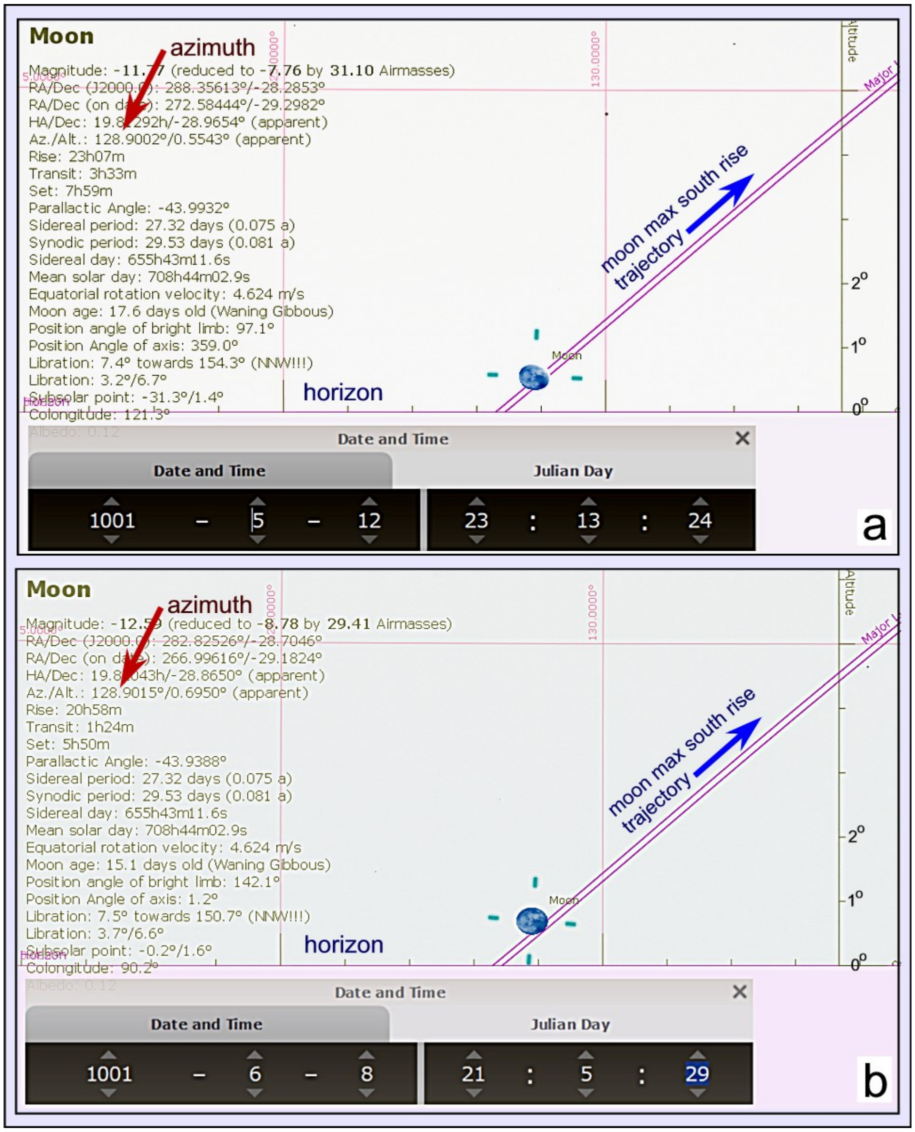

Figure 25a. Stellarium (Zotti, et al., 2021) computer planetarium view of the night sky and Moon on 12-May-1001 CE as viewed from Powell Mound.
Figure 25b. View of night sky and Moon as viewed from Powell Mound on 8-June-1001 CE. No refraction correction. Sky color reversed to better show details. ArchaeoLines Plug-in by Georg Zotti enabled. Annotations by author.

Using the formulae noted earlier it is likewise found that in the year 1001 CE, the Moon reached its maximum south rise at an azimuth of 128.9º (h = 0.9º corrected for upper limb tangency, mean refraction and parallax). If the azimuth is calculated using lower limb tangency the azimuth is 129.4º. As shown by Figure 26a, the azimuth between the Powell Mound and Rattlesnake Mound is 128.8º. Depending then on whether moonrise was considered to occur at upper or lower limb tangency, the sightline extending between Powell and Rattlesnake Mounds was aligned to the moonrise to within either 0.1º or 0.6º. The Moon rises rapidly, however. In five minutes, it rises more than one-half degree in vertical altitude. So, without going too far into the weeds regarding tangency, it can be said that as viewed from Powell Mound, moonrise was in alignment with Rattlesnake Mound.

Consistent with the alignments already discussed, it is also the case that if the Powell to Rattlesnake Mound lunar alignment is extended, it intersects knoll K5 to the southeast (Figs. 26b and 27).

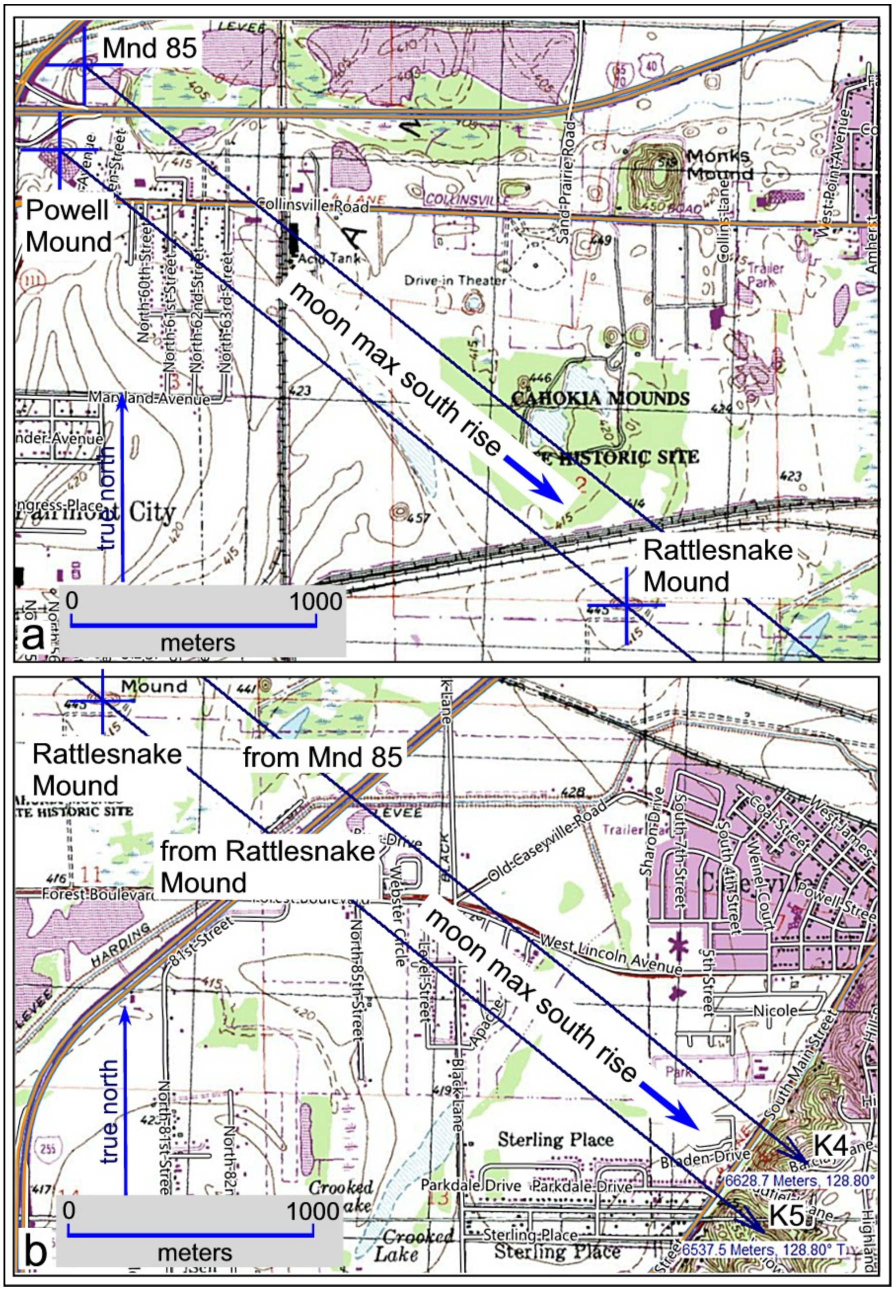

Figure 26a. USGS 7.5-minute series map (1998 Monks Mound, IL quadrangle) detail with Moon maximum south rise azimuths plotted from Powell Mound, Mound 85 and Rattlesnake Mound toward bluff knolls K4 and K5. Due to map scale azimuths continued in Figure 26b.
Figure 26b. Continuation of map and azimuths from Figure 26a. Annotations by author.

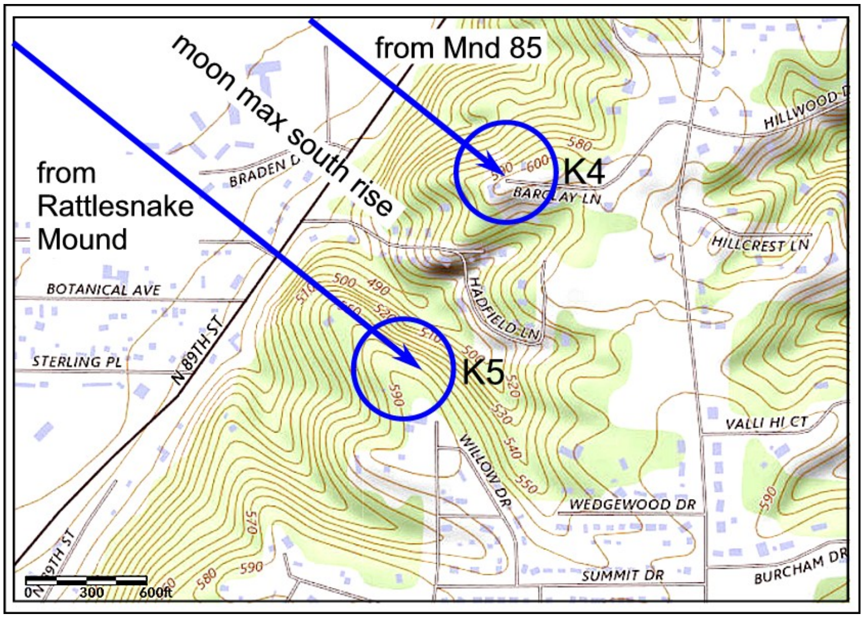

Figure 27. Map detail showing locations for K4 and K5 with lunar azimuth plotted. Base map from USGS National Map: National Boundaries Dataset, 3DEP Elevation Program, ArcGIS Online (Esri, 2024). Annotations by author.

Given that the east bluff has numerous knolls along its length it might be argued that the intersection of the extended Powell to Rattlesnake sightline to a bluff knoll is fortuitous. What makes that argument unlikely, however, is that, as was the case for the east/equinox alignment, there is another sightline that runs parallel to the first. This sightline extends between Mound 85 and knoll K4 (Figs. 26a, 26b, 27). The azimuth for that sightline is 128.8º. In effect we have a double lunar alignment. If one could see the bluff knolls (or fires at those locations) from Rattlesnake and/or Powell during moonrise, for a few moments the Moon would have appeared framed by K4 and K5.

These are not the only lunar alignments at Cahokia. As noted earlier, the spirit house in Rattlesnake Mound was lunar oriented. And, as discussed elsewhere (Romain, 2015, Fig. 4.6), the spirit house in Mound 72 was oriented to the Moon’s maximum south rise. As documented by Fowler, et al. (1999), hundreds of individuals were buried in Mound 72.

In the Cahokian world, the Moon was associated with night, death, fertility, water, and rebirth (Emerson, 1989, 2015; Emerson, et al., 2000; Pauketat, 2013, 2017, 2023; Romain, 2015, 2021). It is appropriate therefore that the

Powell, Mound 85 and Rattlesnake mounds would be associated with the Moon, especially at its furthest south location.

Looking the other way, from the bluffs, it is seen that Mound 85 and the Powell Mound were positioned at the intersections of their respective alignments to knolls K1, K2, K4, and K5 (Fig. 5). In other words, intersecting celestial azimuths seem to have determined the locations for Mound 85 and the Powell Mound.

Discussion

Intersecting azimuths appear to have established the location for Monks Mound (Fig. 5). Most likely, the axis mundi location for Monks Mound was established at ground level prior to the mound being built. Once identified on the ground that axis mundi location continued to be recognized as the mound was increased in size with the F78 post marking the original center location – but now at the summit of the mound. As Reed (2009, p. 75) noted, F78 "was placed at the middle, east-west, north-south of the Third Terrace"; and for Cahokians, "this post was considered the center not only of Cahokia but also of the world…." (Reed, 2009, p. 62).

The intersecting alignments involved a sightline from Monks Mound to the cardinal direction of east, coincident with the equinox sunrise and framed by two bluff mounds. The other sightline is to where, on the night of the summer solstice, the Milky Way meets the horizon, marked by Rattlesnake Mound and a bluff mound. The location where these sightlines crossed memorialized the symbolic center for Monks Mound and axis mundi for the site. From this intersection nearly everything else at Cahokia followed. Monks Mound was a center place where earth and sky met.

I have suggested that Monks Mound was an axis mundi for Cahokia, connecting the Upper World, Lower World, and This World (Romain, 2016, 2018). However, there may be more. What if Cahokia and Monks Mound in particular were believed to be not only an axis mundi, but also a genesis point, metaphorically speaking? There is a certain symmetry in visualizing the Sun shining on Monks Mound at sunrise, bringing warmth and activating life within the dark earth muck that comprised the primordial base of the mound. Continuing the scenario, the orientation of Monks Mound and the site axis provided a directional corridor and anticipated the Milky Way Path that people would eventually follow to their final destination — i.e., Land of the Dead. In this admittedly speculative interpretation, for Cahokians, perhaps Monks Mound represented not only an axis mundi connecting realms, but also the cyclic beginning and end of life.

Conclusion

In the preceding pages archaeoastronomic analyses, historic documents, ethnohistoric data, LiDAR imagery, and computer planetarium simulations were used to show how certain mounds were aligned to the Sun, Moon, Milky Way and landscape features. The triangulation of these independent and multiple data sets supports the idea that Cahokia was intentionally laid-out so it entangled earth, sky, and water. Indeed, there appears to have been an effort to connect solar, lunar, stellar, and life cycles. Also accounted for by reference to the Milky Way was the anomalous 5º skew of the site from the cardinal directions. This alignment in particular provided a time and direction for souls of the deceased to cross to the Milky Way Path. The combination multiple interlocking astronomic alignments tied to prominent landscape features makes Cahokia one of the most sophisticated and complex earthwork sites in the world.

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