

Going Straight in a Sacred Landscape: The Great Hopewell Road

GIULIO MAGLI, Politecnico di Milano, Italy

BRADLEY T. LEPPER, Ohio History Connection, OH, USA

The Hopewell culture built a series of geometric earthworks, among which the Newark Earthworks stand out as the most complex. It has long been suspected that a ceremonial, double-walled straight road connected Newark with the Hopewell Heartland, located in modern Chillicothe. In recent years, evidence for this Great Hopewell Road increased, as well as the awareness that the whole area was a sacred landscape; however, up to now, existing traces of the road have been found only a few kilometers southwest of Newark. In the present paper, a new, comprehensive analysis of this topic is presented, using Airborne LiDAR and satellite imagery combined with the methods of scientific Archaeoastronomy. We propose that the road connected the two centers and investigate its symbolic significance. A coherent picture emerges that strongly points to a unitary project, aimed at making Newark a Hopewell “cosmic” pilgrimage center.

Keywords:

Hopewell culture, Hopewell Archaeoastronomy, Great Hopewell Road.

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1. INTRODUCTION: HOPEWELL CULTURE AND EARTHWORKS

Hopewell refers to an ancient American Indian culture that flourished in midcontinental North America, especially southern Ohio, between about 90 and 430 CE (Seeman and Nolan 2023). The Hopewell culture is characterized by an extensive interaction sphere and by the construction of imposing earthworks mostly along the principal tributaries of the Ohio River in southern Ohio (Lynott 2014). The people lived in scattered communities (hamlets) with little evidence of a political hierarchy, but the construction of huge earthen structures necessitated collective efforts, pointing to a strong cultural memory, a common religion, and a strong commitment to cooperation. The earthworks were connected with the religious world of the Hopewell and are likely to have been pilgrimage centers (Lepper 2024). This is supported by the enormous scale of the earthen enclosures and by accumulations of large quantities of ceremonial regalia made from unusual raw materials brought from widely distant regions without evidence of corresponding quantities of material from Ohio moving in the opposite direction (Lepper 1996; 2016). The overwhelming predominance of a

[^]author's address: Giulio Magli, Department of Mathematics, Politecnico di Milano, Piazza Leonardo da Vinci 32, 20133 Milan, Italy; email: giulio.magli@polimi.it; Bradley T. Lepper, World Heritage Program, Ohio History Connection, 800 E. 17th Ave., Columbus, OH 43211, USA; email: blepper@ohiohistory.org

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religious orientation of these places is also supported by archaeoastronomical studies (Hively and Horn 1982; 1984; 2019; Romain 1998; 2000).

The largest earthworks could accommodate thousands of people and are concentrated in southern Ohio. Many have been lost or nearly lost due to agriculture and the growth of towns and cities, but they were documented in 19th century surveys (Squier and Davis 1848). Among the Hopewell works, Newark (Fig. 1) stands out as the largest complex (Lepper 2004; 2006; 2010; 2016); the Newark Earthworks appear as a comprehensive synthesis of all Hopewell architecture (Lepper 2004). This idea of replicating sacred structures at pilgrimage sites is common to many cultures (Durkheim 1995), and this points to the possibility that Newark was built at a relatively late date, which is supported by the few documented radiocarbon dates that suggest that Newark belongs to the later portion of Hopewell, circa 300 CE (Lepper 1998a, 122, 128).

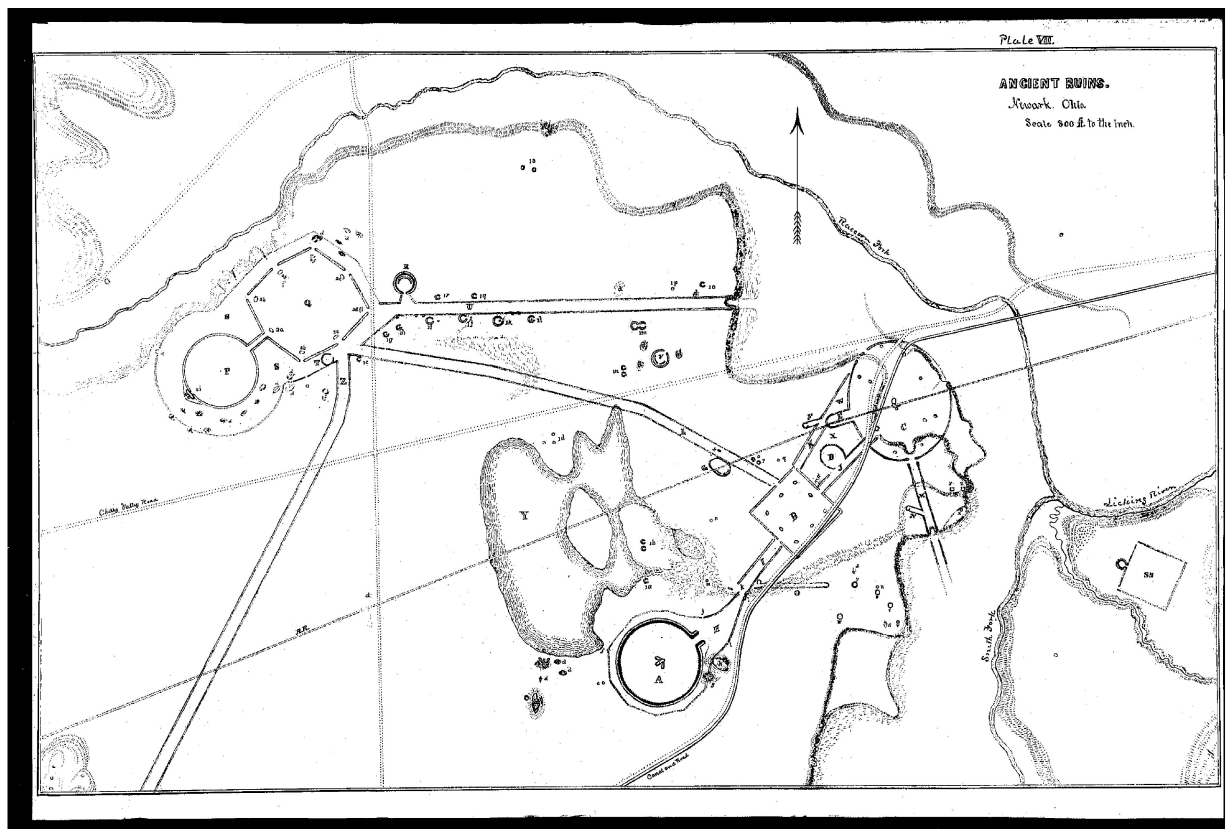


Figure 1. Map of the Newark Earthworks by James and Charles Salisbury, 1862 (Courtesy of the American Antiquarian Society).

The collection of geometric enclosures at Newark includes the Great Circle – a 370 m wide circle endowed with an interior ditch and 2.4 m high walls, the so-called Observatory Circle with a diameter of 321 meters, and the Octagon. The Octagon is an 8-sided polygon with sides averaging 189 m in length, although one of the walls originally was shorter by 9.2 m and appears to have been lengthened by well-intentioned restorers in the historic era (Hively and Horn 1982, S7). There are openings at

each corner of the Octagon, and there is a parallel walled corridor leading into the Observatory Circle. The combined Octagon Earthworks has an axis of symmetry that bisects the Observatory Circle and Octagon, and passes through the parallel-walled corridor.

Other structures at Newark include the Wright Square; and an ellipse surrounding a number of large and small, conical and loaf-shaped burial mounds—the Cherry Valley Ellipse, but these have been almost entirely obliterated. Until recently, Newark was almost overlooked in Hopewell studies, mostly because archaeologists focused on burial practices and offerings, and Newark’s burial mounds had been leveled without systematic study during the early 19th century (Lepper 2016).

To the southwest of Newark, the most impressive concentration of earthwork sites is in the vicinity of modern Chillicothe, usually considered the Hopewell core or “heartland” (Fig. 2). A circle – octagon structure is present in the site called High Bank Works. Although considerably reduced by a long history of agriculture, it still can be clearly traced.



Figure 2. Map of the earthworks in the area of Chillicothe by E.G. Squier and E. Davis (1848). High Bank Works is located along the east bank of the Scioto River near the lower right corner of the map, while Hopeton is close

to the meander of the river, north of Chillicothe. The Steel Works is represented by the two small circles west of Chillicothe on the western margin of the map.

The circle is identical to Newark's in dimensions. The octagon is smaller, but the overall design is the same, with the unique difference being in the orientation: the main axis of the High Bank structure is oriented orthogonal to Newark's. Both at High Bank and at Newark, alignments to the lunar standstills have been documented (Hively and Horn 1982; 1984) and those of Newark have been further confirmed by more recent research (Mickelson and Lepper 2007). In particular, the main axis of Newark and thus the longitudinal (i.e., that orthogonal to the principal) axis of High Bank is oriented to the maximal northern standstill of the Moon (Fig. 3). Of course, the presence of these alignments does not mean these earthworks were intended as astronomical observatories in the modern sense, but rather as "cosmic centers" where the celestial cycles were symbolically linked with the renewal of the Hopewell life.



Figure 3. The Moon rising at its nearly northernmost point on the eastern horizon in alignment with the Octagon Earthworks. The image was taken in 2007 (Photo by Timothy E. Black/Newark Earthworks Center).

The Newark and High Bank octagons are unique among Hopewell earthworks in terms of their geometry and astronomy. Their connections strongly suggest a special link between the two, despite the considerable distance between them. The aim of the present paper is to examine – within a comprehensive framework – the proposition that Newark and Chillicothe were not just symbolically linked, but also physically connected by a remarkably straight, parallel-walled road, or "Great Hopewell Road" (GHR).

Despite the double walls, Hopewell roads had a predominantly ceremonial – rather than defensive or utilitarian – character. Indeed, although most of the least-cost route between Newark and Chillicothe falls close to the projected route of the GHR, there were no centers of even remotely equivalent

significance between the Newark Earthworks and the dense cluster of earthworks around Chillicothe (Price 2006; Lepper 2024). Furthermore, as we shall see, there is the distinct possibility that the route and its final target (Newark) were conceived of together.

The GHR proposition was originally advanced by Lepper (1995; see also (Lepper 2024)) building on historical documents, especially the Salisbury map (Fig. 1), an associated manuscript, and aerial imagery available at the time (see Section 3.1 for details). In the present paper, we combine methods of satellite imagery analysis and archaeoastronomy to advance the argument that the road extended to the Scioto River at Chillicothe. Among the lines of evidence we consider are symbolic aspects, connected with the possible use of astronomy in the design and construction of the road. The evidence strongly points to a unitary project, with Newark interpreted as a Hopewell “cosmic” pilgrimage center.

2. METHODS

The methods used in the present paper are those of modern, scientific archaeoastronomy (Ruggles 2015; Magli 2020) combined with remote sensing archaeology (Parcak 2015). Archaeoastronomy must include close collaboration with archaeology to propose and/or assess the validity of any technical observations (such as, for instance, the possibility that alignments do not occur by chance). Therefore, all our results and proposals here are double-checked for plausibility within historical and archaeological contexts. Most of our measurements and observations have been obtained through a careful analysis of satellite imagery provided by Google Earth Pro (GEP), which is an instrument of choice for many remote sensing archaeological investigations (Parcak 2019). GEP has been recently used in a variety of applications, such as to study activities that threaten archaeological sites (Parcak 2015) or cognitive aspects of Chinese and Japanese imperial projects (Magli 2019; Baratta and Magli 2021; Baratta et al. 2022).

In our case, what is crucial is to measure azimuths. This measure depends on the accuracy of geographical north, which is referred to by the ruler instrument of the program. One of the authors has had, in the past, several occasions to verify in the field (thus, with direct measures) the impressive accuracy of the program’s compass, while importing satellite images in processing programs (e.g., plugging Google Earth Engine in AutoCAD may introduce errors). As far as the horizon is concerned, in the study area of the present paper, it is usually flat or nearly flat; regardless, when necessary, the elevation profile function has been used to establish horizon heights. The resolution of the images used is very good: GEP does not furnish it directly, but it is possible to obtain it from the original producer, and it turns out to be around 30 cm for the study area. Thus, the unique errors come from the rectification of azimuthal images made by the program (which is negligible for the range of distances under study here) and from the intrinsic error in positioning the program ruler, which can be estimated as $\pm 1/2^\circ$.

In combination with GEP, the authors also used Airborne LiDAR data. Airborne LiDAR is a laser-based radar, which targets the earth surface and creates an elevation model measuring the time for the reflected light to return to the receiver. Data for Ohio were kindly provided by the State Department of Administrative Services. These data (furnished as tiles of point clouds) have been imported in Qgis and resampled into raster tiles. We used GEP to georeference the point clouds and simplify

comparison with satellite data. High-resolution Airborne LiDAR data are currently available only for Licking County, covering about 15 km of the projected course of the road from Newark.

The simulations of the sky during the Hopewell period were obtained using Starry Night Pro 7 and Stellarium 24.4, programs that produce highly accurate and reliable astronomical simulations. Declinations have been calculated using the program @Getdec, kindly provided by Clive Ruggles.

With a careful use of these scientific instruments, we believe that the data we obtained are accurate. However, our ability to achieve the goals of this project is constrained by what David Swaim (2024, 18) has termed the “contingency of evidence”:

“That is, in the historical sciences, the evidence that we have at our disposal is itself very much a contingent matter ... This is true in several senses: first, the evidential material we have to work with is just what the world conspires to deliver. ... Further, the relative quality of the evidence where we happen to find it is essentially a contingent fact. ... Finally, that we are in a position to uncover and analyze the relevant evidence is contingent” (2024:118).

Therefore, we must be willing to extrapolate based on incomplete information. As Swaim further states, “... historical science is necessarily speculative” (Swaim 2024, 120).

3. OLD AND NEW EVIDENCE FOR THE GHR

3.1 Existing evidence

In 1820, Caleb Atwater proposed that the parallel walls beginning at the southeastern opening into Newark’s octagonal enclosure might be found to extend from Newark to another monumental earthwork at least thirty miles [48 km] distant, writing: “Such walls having been discovered at different places, probably belonging to these works, for ten or twelve miles (16 to 19 km) at least” (Atwater 1820, 129). Interestingly, Atwater also expressed his conviction, based on “an attention to many hundreds of these works, in every part of the west which I have visited, that their authors had some knowledge of astronomy” (Atwater 1820, 237). Atwater’s claims were forgotten after Ephraim Squier and Edwin Davis claimed, in 1848, that these parallel walls extended only two-and-a-half miles [4 km], which suggested that they terminated at Ramp Creek (Squier and Davis 1848, 67). In 1862, however, James and Charles Salisbury corroborated Atwater’s claim by following the walls for “some 6 miles [10 km] over fertile fields, through tangled swamps and across streams, still keeping their undeviating course” (Salisbury and Salisbury 1862, 21). They did not, however, trace the parallel walls to their termination, but suggested that, “its course if continued would lead near Circleville & Chillicothe, where there are extensive ruins” (Salisbury and Salisbury 1862, 21). Later, the road was documented through aerial photographs in the pioneering works of Warren Weiant, Jr. and Dache Reeves (Weiant 1931; Reeves 1936).

More recently, Lepper examined aerial photographs and conducted local surveys of suspected traces of the GHR (Lepper 1995; 1996; 1998a; 2024). Based on these data, and analogies with similar road networks in Chaco Canyon and the Yucatan Peninsula, Lepper proposed that the road did indeed connect the Newark Earthworks with the cluster of similar earthworks centered on modern Chillicothe, running straight for some 90 km. This is the proposition that we analyze in the present

paper. The existence of the road has been securely established up to Ramp Creek and, based on historic accounts, for at least six miles (10 km) south (Salisbury and Salisbury 1862). Additional investigations related to the GHR have been made by Pederson (1999), Simpson and Kvamme (2001), Price (2006), Romain and Burks (2008), Schwarz (2016), and Davis (2023).

3.2 New Airborne LiDAR data

Airborne LiDAR data for the area of the Newark Earthworks and the well-documented section of the GHR north of Ramp Creek have been analyzed by Romain and Burks (2008). The first to use Airborne LiDAR data to search for new traces of the road has been archaeologist Jamie Davis in 2023. His results are so far unpublished, but he has publicly shared his imagery. He identified four proposed remnants of the Great Hopewell Road located south of Ramp Creek. To securely identify features visible with Airborne LiDAR with possible traces of the ancient road, we have independently performed a similar analysis using Qgis-based instruments and background satellite map data. One of these sets of walls turns out to be close to and in alignment with a remnant “pavement” of limestone identified by Schwarz (2016, 21–23) as a possible trace of the GHR, strengthening the probability that it is, indeed, a physical signature of a section of the GHR. The southernmost segment of the GHR so far identified with Airborne LiDAR imagery is located 12.8 km southwest of the octagon (39°57'19" N, 82°31'14" O) (Fig. 4 and Fig. 5).

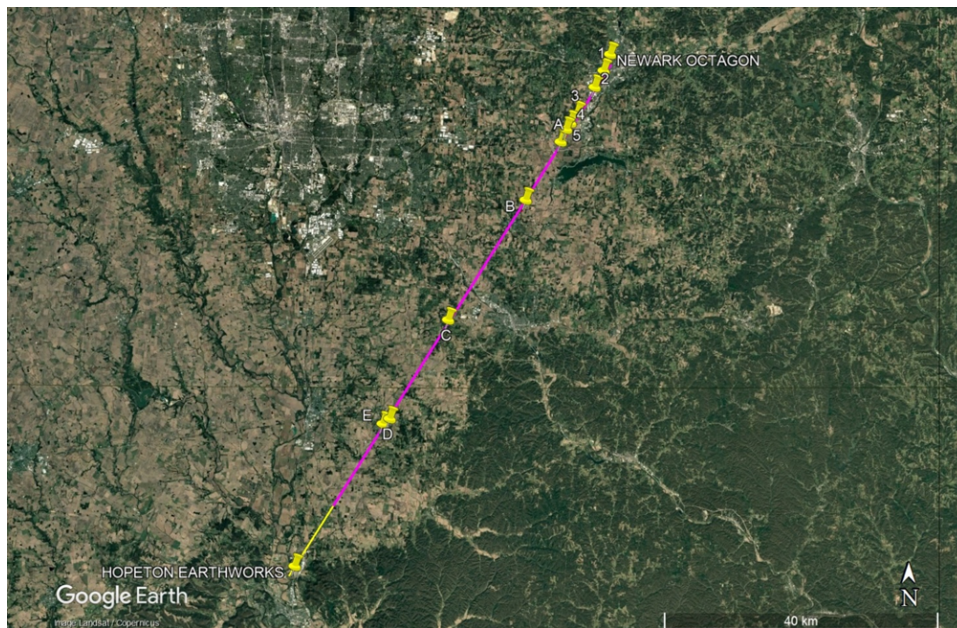


Figure 4. Comprehensive map of the results of the present paper. The projected course (88 Km in total) of the Great Hopewell Road is shown in yellow from Hopeton to Kingston and in magenta from Kingston to the Newark Octagon. Letters A to D denote features which are likely due to road remnants, visible on satellite images. Numbers 1 to 5 denote traces visible on Airborne LiDAR images (Image courtesy GEP; editing by the authors).



Figure 5. Close-up of Fig. 4 showing the position of the projected course with respect to the Airborne LiDAR identified segments (Image courtesy GEP; editing by the authors).

Unfortunately, as mentioned previously, high-resolution Airborne LiDAR imagery for Ohio does not yet extend south of Licking County.

3.3 New satellite data

To extend our analysis of the possible extent of the GHR, we used GEP, projecting the course of the GHR farther to the southwest. In the literature, there are three estimates of the azimuth: considering the direction which points from Newark to Chillicothe, Magli (2009) proposed 211.5° , Lepper (1998b, 130) proposed 211° , while Romain and Buchanan (2015) proposed 210.5° .

We have re-examined all the images available, made use of a direct measure obtained in the field by one of the authors, and integrated all this with our new data. We determined that the best fit, and therefore the most likely azimuth, is $212^\circ 20'$. We then used this value to trace the projected course on GEP all the way southwest to Chillicothe, inspecting a band a few hundred meters wide and looking at several different historical GEP images of the same areas (the reason being essentially the differences in the seasons when the images were taken, and consequent differences in vegetation and crop growth). This analysis revealed several interesting features (Fig. 4).

The course proceeds in flat land and avoids crossing Sugarloaf Mountain (a high-relief feature located slightly north-east of Chillicothe). We have found many linear features oriented parallel to the projected course to within 1° or less. Among these features there are paved (asphalt) roads, agricultural roads, and forest borders. In addition, we identified what appear to be parallel walls close to Lancaster-Newark Rd NE (apparently ancient, although based solely on the imagery it is impossible

to claim that it is Hopewell), which can be followed at azimuth $\approx 38^\circ$ for some 6 km towards Newark and corresponds to an old electric wire perhaps traced with the help of the existing feature (Fig. 6).

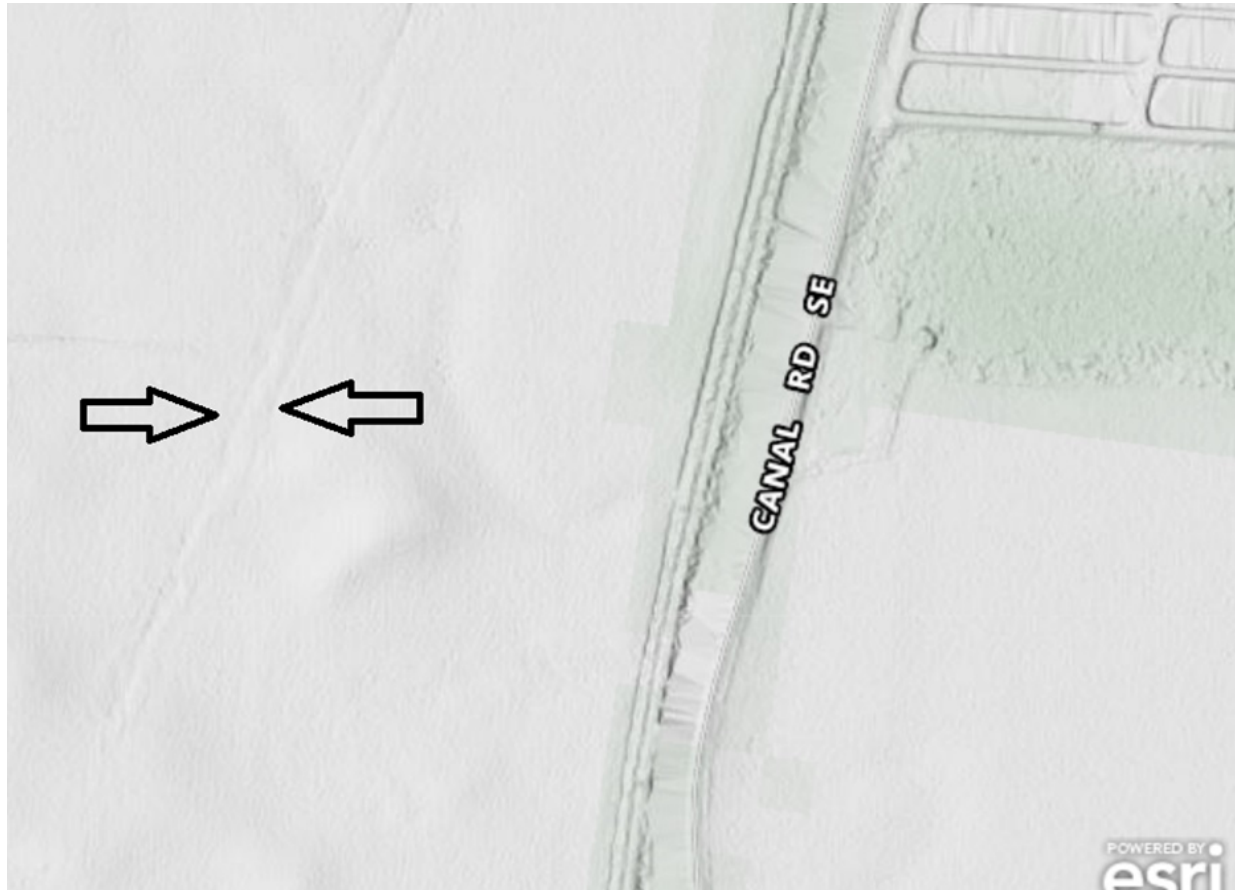


Figure 6. Traces of a (probably) ancient road composed by parallel walls visible on Airborne LiDAR images (Image courtesy Ohio State Administration; editing by the authors).

These orientations do not correspond to the survey lines established by the modern division of the lands, which is based on a grid a few degrees east of north, along which run the majority of the streets. This is a strong hint to the possible presence of “fossil” traces of ancient roads, as occurs for instance in the study of Roman centuriations (Magli et al. 2014).

Among the most convincing features concerning the road, there is a 3.5 km section of the paved road leading north-east from Kingston, some 21 km north-east of Chillicothe. This road crosses neatly the regular division of the lands (Fig. 4) and if extended to the north-east for as much as 60 km it almost matches the southernmost known remnants of the road with an impressive accuracy. The distance between the actual course of the road and the projected one is around 180 meters, which corresponds to a difference in azimuth of less than 10 arcprimes (Fig. 7).



Figure 7. A close-up of figure 5 near point 5 of the map. The southernmost remnant of the road visible on Airborne LiDAR (highlighted in black) is overlaid on the corresponding GEP image. The projected course from Kingston (magenta) passes within some tens of meters from the remnant (Images courtesy Ohio State Administration and GEP; editing by the authors).

There are also agricultural roads and borders oriented to the GHR, as well as a 1.8 km section of the railway that runs to the west of Sugarloaf Mountain before entering Chillicothe. The existence of modern (post-colonial) features traced on the proposed trajectory of the GHR or traced not far from and along the same azimuth is not surprising. Indeed, as already noted by Kennedy, the GHR may have served as an important route of communication between the two regions for European American settler colonists by the 1790s and beyond (Kennedy 1994). (see also Greber 2006). For example, it is known that many portions of an Ohio frontier road constructed under the direction of Col. Ebenezer Zane in 1796 were based on traditional Native American trails (Martzolff 1904). One such trail became a portion of the modern road between Zanesville, Ohio (east of Newark), and Chillicothe (Park 1870)(Kennedy 1994). Unfortunately, however, the repurposing of the roads would have accelerated the degradation of the parallel earthen walls adding to the difficulty of identifying extant remnants. The repurposing of Indigenous roads is not unique to the GHR. As another example, many Mayan sacbeob were repurposed as roads or railways (Shaw 2008, 980).

4. ASTRONOMY AND THE GHR

The evidence accumulated previously, together with new data presented here, support the existence of a Newark to Chillicothe GHR. The northeast end of the road is clearly indicated on the Salisburys' map (Fig. 1) at the southeastern corner of the Newark Octagon. Our projected course passes less than 300 meters to the east of this point. By projecting instead the course towards Chillicothe, we can propose a reasonable southwestern end for the road. Our projection (in this direction the projected course is 12 km long) neatly crosses the area of a very important Hopewell earthwork, Hopeton (Fig. 8); if it is prolonged farther south-west for about 8 km, it would end at the Steel Group, to the immediate west-southwest of Chillicothe. The Hopeton group has early Hopewell dates (Lynott 2014, 111) and is thought to be coeval with Mound City, which is just across the Scioto River (the Steel Group is probably even earlier).

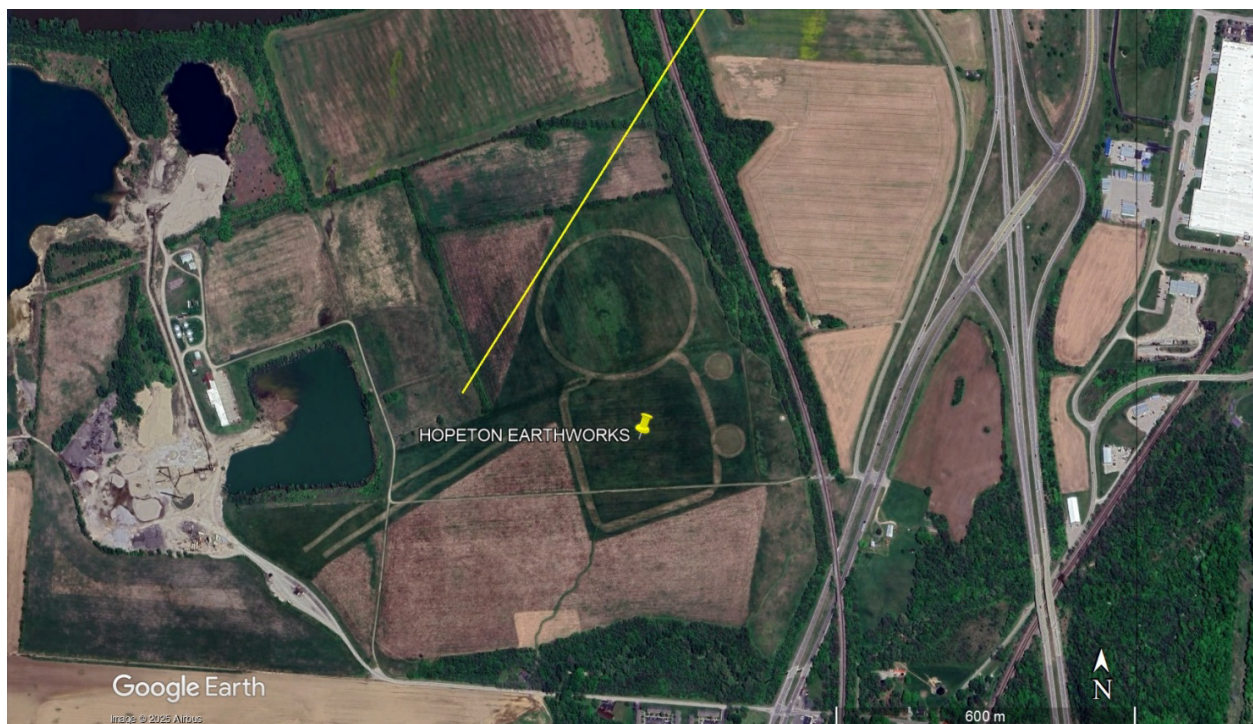


Figure 8. Close up of Figure 5, showing the intersection of the projected course with Hopeton earthworks (Image courtesy GEP; editing by the authors).

It is important to ask from which end the road was originally designed. Taking into account the available archaeological data, which points to a later date for Newark, we propose that an ambitious project was envisioned by a Hopewell ceremonial leader. Starting from Chillicothe they surveyed a straight path that would end at the confluence of Racoon Creek and the South Fork of the Licking River. There they would construct the largest connected complex of geometric earthworks in the Hopewell world, incorporating all the accumulated geometrical and astronomical knowledge of this civilization. And that straight path would become a parallel-walled processional way connecting these two regions.

If this scenario is true, then the question arises as to how they managed to trace such a long, straight path across the uneven terrain. In fact, no perfectly straight roads exist on curved surfaces (the closest thing to a straight path between two points of course is the arc of geodesics connecting them, a thing which likely was not known to the Hopewell). Certainly, the curvature of the Earth can be perceived: the visible horizon of a person (say) 2 meters tall on mostly level ground extends for only about five km – and much less in a heavily forested environment. But by using fires during the nights and/or timber platforms during the day, the visibility could be much increased. Nevertheless, to achieve visibility between two points as far as 90 km distant is almost impossible. The solution adopted by other cultures known for their straight roads relies on a combination of methods: a careful use of visible signals and, in many cases, a reliance upon astronomy. For instance, the Romans traced (in 312 BCE) the impressively straight path of the Via Appia south of Rome (around 70 Km) by using a cardinally oriented centuriation grid and, as a reference, the setting of the star Castor (Magli et al. 2014). This star was imbued of symbolic content, since the two divine twins of the constellation Gemini (Castor and Pollux) were the patrons of the Roman army. Another example, culturally much closer to Hopewell, is that of the Anasazi roads, probably traced again with the use of simple but effective geometrical tools and astronomy (Sofaer et al. 1989; Lekson 1999).

As far as the GHR is concerned, some years ago, Magli tentatively proposed that it may have been oriented using astronomy, combining the direction orthogonal to the summer solstice sunset/winter solstice sunrise with a possible orientation to stars at the two ends (Magli 2009; 2007). We now reassert this proposal in the context of correlative archaeological research.

Let us begin with the sun. The direction orthogonal to the road towards the west (thus azimuth 302°) is very close to that of the sun setting at the summer solstice, and the direction towards the east is very close to the sun rising at the winter solstice. The horizon stays essentially flat on both sides over the entire course (excluding Sugarloaf Mountain to the east in the proximity of Chillicothe) and the declinations (by using the Program Getdec, which considers refraction) are $+23^\circ 32'$ and $-24^\circ 20'$ (obliquity of the ecliptic was $23^\circ 41'$). Of course, it is a kind of alignment which one would be tempted to define as somewhat “strange”. In fact, it could not have been used to project the alignment of the road, since the alignment would be of some help in establishing the right direction for only – say – some 6-8 days each six months, in the days close to the solstices (before and after) when the declination of the sun varies of only a few arcminutes per day. So, either it is a result of happenstance, or it was deliberately designed for symbolic reasons. We argue that it was a design feature of the GHR, because the 90° rotation of directions was a characteristic of Hopewell architecture (Hively and Horn 2023, 14–15). We have already seen a similar phenomenon with the two octagons, which are identical in concept but rotated by 90° . Furthermore, there exists a series of Hopewell square earthworks which share the following feature: one diagonal points to the summer solstice sunset (Romain 1998). These are Hopeton (diagonal 301°) Anderson (diagonal $300^\circ 30'$) the Mound City axis ($300^\circ 15'$) and, though less precise, Seip (diagonal 303°). Now it follows, of course, that the opposite diagonal in these sites is parallel to the GHR.

The sun does not exhaust the archaeoastronomy of the GHR. As mentioned, to maintain a fixed direction for many tens of kilometers with high precision is difficult, and stellar references may be of assistance. Due to the precession of the Earth's axis, stellar alignments remain effective only for relatively brief periods, a couple of centuries or so. In (Magli 2007), two stellar alignments were

proposed. The first is with the bright star Fomalhaut, of the constellation Piscis Austrinus, setting in alignment with the direction of the road. This alignment was effective in the last centuries BCE, but can be disregarded today on the basis of archaeological data, which places the construction of Newark in the first centuries CE. The second alignment is instead optimal for this period and is with the bright star Capella, of the constellation Auriga, at rising (Fig. 9). The data show a good agreement because the direction of the road, with a flat horizon, gives a declination of 40° which is within one degree also the declination of Capella in the first century CE.

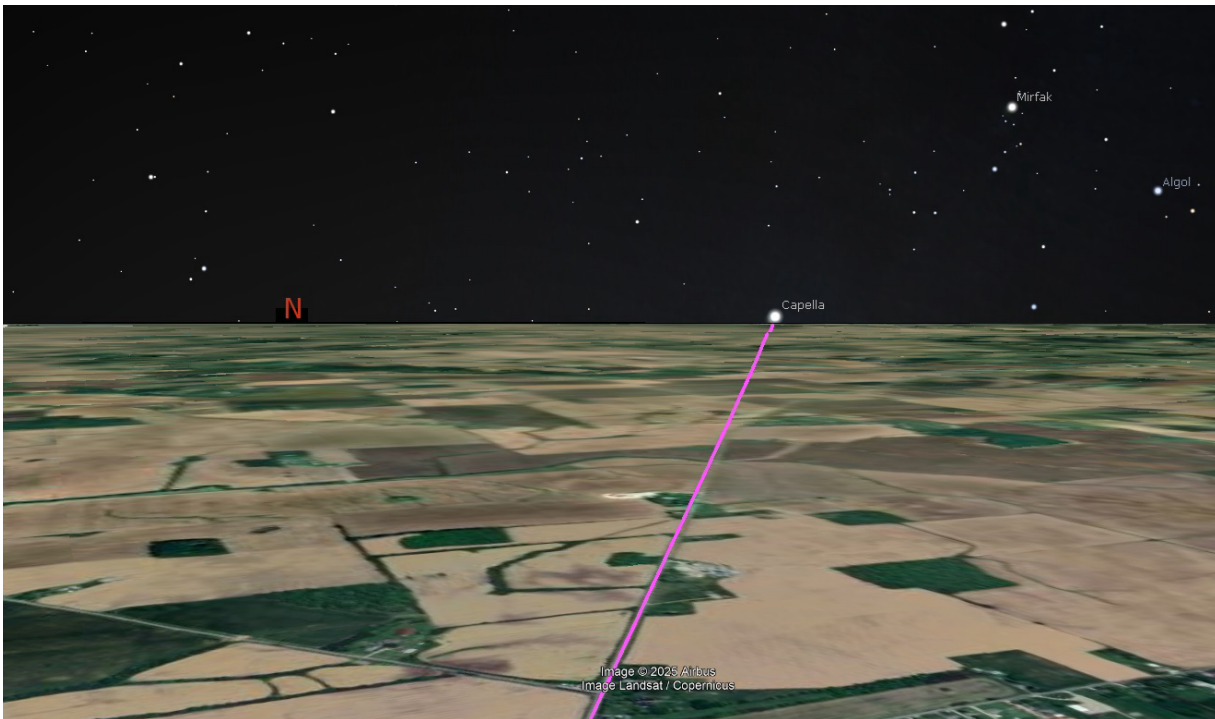


Figure 9. Simulation of the rising of Capella in alignment with the GHR in the first century CE (images from GEP and Stellarium, elaboration by the authors).

Capella is the sixth brightest star in the sky, and it should have been visible, although faint (due to extinction) at horizon, almost immediately after rising. Interestingly, since the latitude of Newark is 40° , Capella was culminating at the zenith in those centuries, a fact which may have strengthened its cosmological significance. Heliacal rising of the star occurred around the first week of April, with rising remaining visible up to the second half of September. Capella is a star of the “northern branch” of the Milky Way (like e.g. Deneb, Alpha Cygni, which had a similar declination) and an association of the road with the rising of this part of the Milky Way has also been proposed (Romain and Buchanan 2015). Although being visually suggestive, this is only approximated since the galaxy is not a celestial object on its own, but an extended object approximately 12° in width.

5. DISCUSSION: A STRAIGHT ROAD IN A SACRED LANDSCAPE

Minimization of the distances was certainly a motivation in the project of straight roads. However, there is no doubt that, at least in many cases, a symbolic significance related to pilgrimage was attached to “going straight”: for example, the Ancestral Puebloan roads and the Maya *sacbeob* (“white roads”) (Shaw 2008, 119; Palka 2014, 10). The Inca also made pilgrimages, again with a focus on “going straight” (Christie 2008, 54). Moreover, Inca pilgrimages also appear to have included a formal observance of the setting sun on the summer solstice (Bauer and Stanish 2001, 211). Given this nearly Pan-American complex of religious beliefs and practices, it should come as no great surprise that the Indigenous Hopewell culture might have shared a related set of ritual prescriptions tailored to their own circumstances. The experience of pilgrims following the GHR, going literally straight from Chillicothe to the sacred site of Newark, with views of the sun setting/rising and, in spring/summer, a bright star also rising in alignment with the road, must have been a liminal experience worthy of a pilgrimage. Perhaps, however, most of the pilgrimages occurred on days close to the winter solstice. This period is, in many cultures, associated with death, as shown for instance in the current archaeological interpretation of Stonehenge as a “place for the ancestors.” Its astronomical alignment, rather than being used solely as a calendrical device, was related to pilgrimages at or near the winter solstice (Ruggles et al. 1997; Pearson et al. 2020; Magli and Belmonte 2023). In this connection, the role of the Newark Ellipse as a dedicated space for burials – possibly for ceremonial leaders – appears relevant (Lepper 2016).

The principal axis of the circle/octagon complex at Newark was aligned very precisely to the Moon rising at the northern standstill. However, the long-term variation of 18.61 years in the Moon's rising points overlaps with the cycle of Moon phases in a complicated way. This means that a standstill can even occur at a new Moon and thus be unobservable. It happens, however, that a spectacular phenomenon can be enjoyed in the year of the lunistice and in those close by: the full Moon closest in time to the winter solstice is at the maximal declination available in that lunar month, and therefore in those years it is very close to the standstill (it will be precisely at the standstill only if the two cycles coincide). Therefore, the midwinter full Moon rises in alignment with the circle+octagon earthwork (which could accommodate thousands of people), culminates very high in the sky (higher than the Sun at summer solstice, in particular), and remains in the sky the longest. This provides a night show worthy of a long pilgrimage. A similar case of Moon-based pilgrimage is documented in the relationship between Cahokia and Emerald Hill (Pauketat et al. 2017).

The sophistication of the design of the GHR is consistent with the complexity of the design and of the astronomical alignments of the entirety of the Newark Earthworks. In addition, Jennifer Pederson found that the route corresponded to a remarkably linear geographic boundary between relatively flat, poorly drained soils to the west (Till Plains) and relatively rugged, well-drained soils to the east (Glaciated Appalachian Plateau) (Pederson 1999). This grand synthesis of topography, astronomy, and geometry speaks to the sacred character of the GHR and supports the interpretation of the road as a route of pilgrimage (Lepper 2006).

Hively and Horn drew attention to several additional interesting and relevant facts regarding the GHR:

First of all, "it has been noted previously by Magli (2009, 127-128) and Romain (2015, 66) that the walls are closely perpendicular to a summer solstice sunset. A line orthogonal to these walls toward the northwest points, with sub-degree accuracy, to a summer solstice sunset at zero-degree altitude. A line perpendicular to the walls in the reverse direction, toward the southeast, points with subdegree accuracy to a winter solstice sunrise at zero-degree altitude." (Hively and Horn 2023, 7).

In addition, "a southwest extension of the [Octagon Earthworks] wall DC (41 miles along a line orthogonal to the major southern extreme moonrise) passes through Circleville, Ohio, near the Circleville earthworks. Thus, there are 'lines' along the extreme southern rise points of both the Sun and the Moon to the two sites most similar to the Newark Earthworks (Anderson 2011)" (Hively and Horn 2023, 15).

These various alignments establish that the GHR alignment is not the only projection of an astronomically significant straight line connecting the Newark Earthworks with other Hopewell earthworks located at considerable distances. Hively and Horn concluded that, when one considers "that the Hopewell culture of this time and place was simply extraordinary" with their "sophisticated knowledge of geometry, and ... with earthworks of unprecedented scale and precision ...[w]e should not be surprised that the Hopewell possessed the motivation and capability to perform the generations of observations and planning necessary to encode astronomical knowledge in their marvelous earthworks." (Hively and Horn 2023, 33).

To conclude, we believe that the picture emerging from the present analysis is that of a vast and complex sacred landscape, in which geometry and astronomy played a dominant role in the design and orientation of each single element. To travel in such an ordered landscape, a straight, astronomically anchored path was of course needed, and this was provided by the GHR.

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