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Reimagining the Development of Downtown Cahokia Using Remote Sensing Visualizations from the Western Edge of the Grand Plaza

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Abstract: The distribution of mounds, plazas, and defensive palisades associated with Cahokia Mounds State Historic Site (CMSHS) defines the core urban environment of Eastern North America's first American Indian city. The large mounds surrounding Cahokia's centrally located Grand Plaza, including the palisades that enclose them, are referred to as Downtown Cahokia. In this portion of the site, archaeologists have identified material culture (e.g., ceramics), earthen fills to level the plaza, and several earthen mound constructions. These findings suggest an occupational history for the area that occurred over the 9th–14th centuries CE, with the emergence of plaza delineation and earthwork construction beginning in the early 11th century CE. In sum, Downtown Cahokia and its Grand Plaza are considered by archaeologists to be a vibrant space characterized by ongoing American Indian transformations to an early metropolitan landscape. We conducted magnetometer and electromagnetic induction surveys at the western edge of the Grand Plaza. When compared with the LiDAR-derived visualizations we generated from this portion of the site, our aerial and terrestrial remote sensing data offered new information on the nature and sequence of monument construction in Downtown Cahokia, as well as architectural changes in domestic and special-use structures. These multi-scalar and complementary remote sensing datasets allowed us, without excavating, to trace important sequences of change in Downtown Cahokia's history.

Keywords: Cahokia Mounds; USA; landscape archaeology; historic aerial photographs; LiDAR; magnetic gradiometry; electromagnetic induction

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1. Introduction

People generally structure communal spaces according to knowledge from past and present circumstances, as well as with respect to social positions and roles. Public spaces can be appropriated by specific groups of people, often those in positions of power, to encourage social behaviors and practices as they relate to the symbolically and/or economically significant usages of such spaces [1,2]. At the same time, how public space is defined and used can change alongside shifts in the relationships between societies and their historical circumstances. This is especially true for publicly defined architecture such as plazas, where space is dynamic and organized with respect to the situational needs of a community at any one time [3,4]. Of course, the ways plazas structure social action can change through time with respect to historic events and the ways new iterations of a community elaborate or transform a plaza according to evolving cultural interpretations of how the space should be used [3]. Among American Indian communities, considering perspectives inherent to Indigenous philosophies [5–9], even the non-human occupants of these spaces could exhibit different levels of importance as time and situations changed ([10,11], p. 408).

Barrier and Kassabaum ([12], p. 162) noted that gathering places such as plazas are ubiquitous; they argue that the cyclical and periodic rhythms of social practice lead to the creation of imagined communities that build social ties extending far beyond biological kinship. We add that plazas can also represent social contradictions. They can be exclusive, limiting who can enter and participate in gatherings within them, or they can—sometimes simultaneously—be open and facilitate inclusion through visibility of what occurs within them. This tension can create a form of symbolic communication that helps regulate what can take place within plazas ([4,13], p. 391, pp. 447–449) while also enabling the creation of various levels of social inequality in communities who define and use plazas [14]. The plazas and surrounding occupation areas of the American Indian city of Cahokia [15–17] therefore offer a unique perspective into the ways changes in the physical structure and use of a plaza mirrored micro-histories of Pre-Columbian social relationships over the course of its construction and use [18,19]. Using LiDAR-based visualizations and data from multi-instrument geophysical surveys, we present new information regarding changes in Cahokia's Grand Plaza (Figure 1). In doing so, we speak to changes in the creation of earthen monuments that line the western edge of the Grand Plaza, the defensive wooden palisade, and the nature of the buildings and features that lined the exterior of the Grand Plaza. Our results offer new insights into the details underlying the development of Cahokia as Native America's first city.

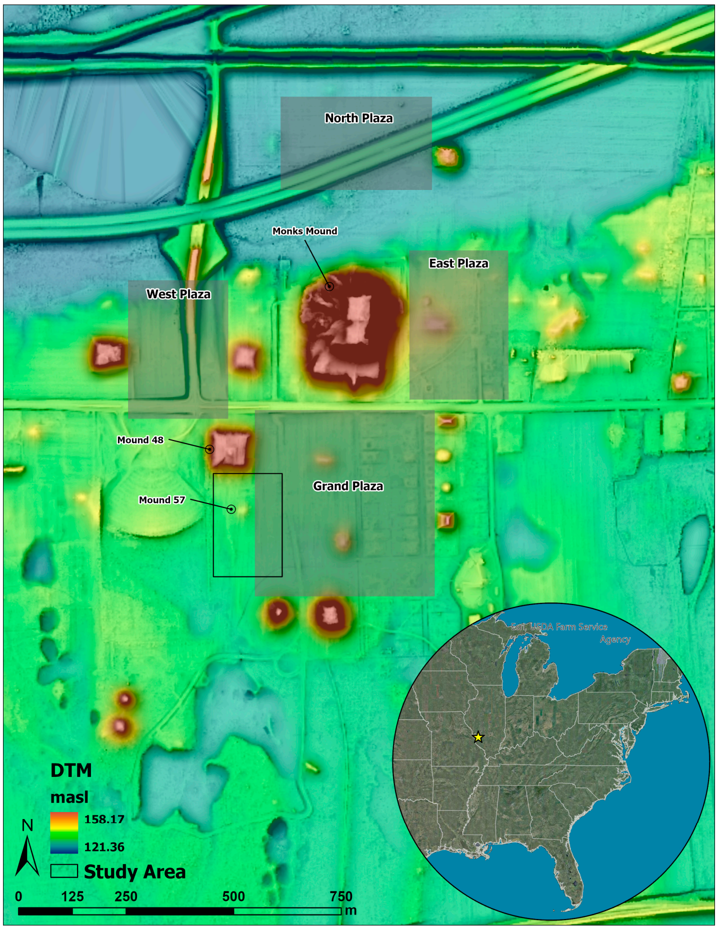

Figure 1. Location of CMSHS in the American Bottom Region of Eastern North America (circular inset) and the site layout of Downtown Cahokia on a LiDAR-derived blended image of the DTM and sky-view factor (primary map). Notable features labeled.

2. Background: Cahokia's Emergence and Developments in Its Downtown

Beginning around 3500 BCE, American Indian communities in Eastern North America organized social life around villages and mound sites ([12,20], p. 164). Paleoenvironmental patterns in the floodplain-dominated American Bottom region of the U.S. suggest that humans began heavily managing landscapes around 450 CE, with maize agricultural production identifiable in lake sediment core data by 900 CE before a pattern of reforestation circa 1350 CE [21,22]. In this context of flood-prone and watery landscapes [22–24], residential populations in the region aggregated into small villages between 650 and 850 CE and then nucleated into larger communities within and around the area that would become the Cahokia site from 850 to 1050 CE. During the Late Woodland and Terminal Late Woodland/Emergent Mississippian periods (600–1050 CE) in the American Bottom, occupation areas such as the range site show sequences of superimposed courtyard groupings surrounded by pit-basin houses with set-post walls [25–27]. Likewise, at the Washausen community, Barrier and colleagues [28,29] used magnetic gradiometry to document arrangements of adjacent courtyard groups and earthen mounds that they referred to as a mound-town.

Both at Cahokia and other sites in the American Bottom, the growing size and complex assemblies of courtyard groupings were also marked by the appearance of important architectural features such as central posts surrounded by quadripartite arrangements of pit features, large "ceremonial" structures that have been interpreted as council houses, and earthen mounds ([25,30] p. 136, Figure 9.2, p. 89, Figure 29). The geospatial data we present here are intended to illuminate how Cahokia's Grand Plaza changed within the context of special architectures associated with similarly palimpsestic courtyard groupings that were buried by fills levelling the plaza, the construction of Mounds 48 and 57, and iterations of the defensive palisade wall enclosing the area. The changes we can trace in these forms of site organization allow us to outline some changes in the conception of social life in and around Cahokia's Grand Plaza.

Designated a UNESCO World Heritage Site in 1982, Cahokia Mounds State Historic Site (CMSHS) is the largest Pre-Columbian American Indian settlement north of Mexico [15,31–33]. Located in Collinsville, Illinois, the nearly 15 square kilometer site is considered America's first city, rising between 1050 and 1400 CE and marked by an unprecedented scale of "stupendous" monumental architecture and residential population that exceeded contemporaneous sites within the United States' modern borders, estimated between 3000 and 42,000 people based on the observed size-dimensions of house structures identified in excavations [15–17,34–40]. Kelly [37,41] and Kelly and Brown [16] recognize two distinct architectural layouts during the height of Cahokia's occupation, demarcated by a series of palisade walls that were built around earthen mound-and-plaza compounds during the Stirling (1100–1200 CE) and Moorehead (1200–1275 CE) phases [41–43]. While Cahokia has traditionally been viewed as a single "site" defined by an epicenter of four plazas surrounding Monks Mound, recent scholarship has focused on Downtown Cahokia's relationships with the nearby East St. Louis and St. Louis mound centers, considering all three sites to be precincts of an urbanized "Greater Cahokia" landscape [44,45] (Figure 2). Moreover, the regionally situated Emerald mound group and the Richland Complex sites have been interpreted as places for pilgrimage (Emerald) and farming (Richland) within Greater Cahokia that also impacted forces of change in the American Bottom [46–52] (Figure 2c).

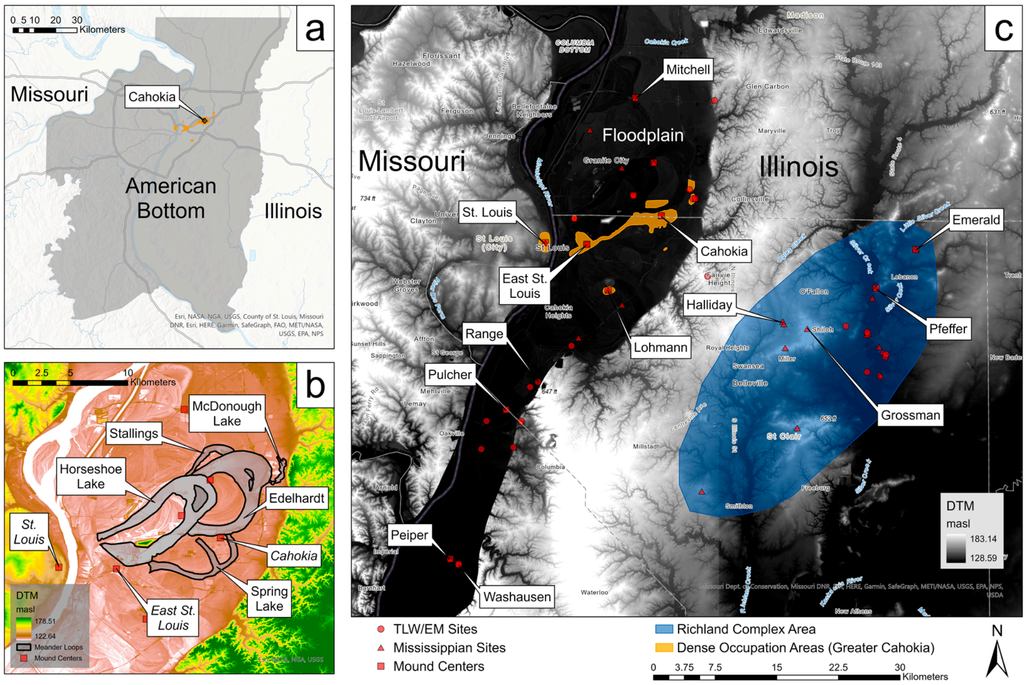

Figure 2. Maps of the American Bottom region, physiographic features, and archaeological sites discussed in the text. (**a**) Map showing the geographic extent of the American Bottom region with respect to CMSHS; (**b**) DTM map showing meander loops of the Mississippi River shaded in gray (regular text) and mound centers (italicized text); (**c**) DTM map showing the extent of the Greater Cahokia Area and Richland Complex denoting a selection of sites spanning the Terminal Late Woodland/Emergent Mississippian and Mississippian periods.

Cahokia itself contains over 100 earthen mounds, Indigenous architectural features created through the prescribed arrangements of various soils, sediments, and stones by Pre-Columbian American Indians that typically occur in conical, platform, and ridgetop forms at the Cahokia site [15,23,53–55]. Additional earthen architectures built at Cahokia include artificially levelled plazas outlined by mounds, not unlike many other large ceremonial centers across the Midwest and Southeast in Pre-Columbian Eastern North America [18,56–59]. Current research suggests that mounds were constructed to support or cover up special-use buildings and pits evidencing a history of complex social events or that they served to hold burial contexts that could include elaborate material expressions [23,43,60,61]. When viewed as a whole, the accumulation of earthwork constructions at Cahokia—their subsequent alterations, rearrangements, and ongoing reinterpretation into the modern day—define its palimpsestic urban core.

Integrated into an introductory class in archaeological geophysics taught by ERH, our research focused on a heavily modified portion of Cahokia's downtown core. In this area, archaeologists have documented a rapid sequence of large-scale transformations to the Cahokia landscape, thus offering a great opportunity to build upon its "biography of place" (*sensu*, [62–64]) by working to trace how dynamic social changes are reflected in, and documented through, shifts in the built landscape and architectural designs. We chose to attempt this in a noninvasive way using aerial and terrestrial remote sensing methods. This approach is important to the conservation of Mississippian archaeological sites such as Cahokia because these methods offer a potential to answer archaeological questions using non-destructive geospatial datasets [65,66]. The area we surveyed in the spring of 2018 covers western portions of Cahokia's Grand Plaza, a public space situated immediately south of its largest centrally located monument, Monks Mound (Figure 1). This area of the site was subject to significant landscape change by Cahokians [18,19,56]. With reference to the management areas subjected to large-scale excavations (e.g., Dunham, Tract 15, and Tract 15B), this area falls within what is known as "Downtown Cahokia" [45,67].

Downtown Cahokia generally encompasses a linear stretch of mounds, plazas, and occupation areas along the Edelhardt Meander Loop's southern bank through the center of the site [68]. The occupants of Downtown Cahokia stripped the natural ridge-swale topography once comprising the Grand Plaza area and leveled it using borrowed artificial fills from potential sources spanning the Spring Lake point bar and the backswamps in the swales of both the Spring Lake and Edelhardt Meander Loops (Figure 2b) [56,69]. Recent excavations in Cahokia's Ramey Field and at other large Mississippian sites with constructed (e.g., levelled) plazas have revealed that similar strategies occurred across the Greater Southeast [58,70,71]. The Grand Plaza and other mound-plaza compounds across the southeast are generally viewed by archaeologists (relying on American Indian ethnographies) as sanctified architectural spaces for public ceremonies—essentially architectural microcosms of social life [16,57,72–77].

Currently, there is little known about the distribution of buildings within and around the Grand Plaza space. Post pits and wall-trench structures have been exposed during efforts to ground-truth palisade wall features in the plaza's southwest corner, nearly directly south of Mound 48 ([78], pp. 10–11). Similarly, water-line excavations north and east of Mound 48 in the Grand Plaza exposed over 200 features. These included several pit-basin houses and wall-trench house structures, pits, and potential palisade wall trenches with large post pits; ceramics associated with the features span all phases of Cahokia's chronology [18] (Table 1). The questions designed for our class-based survey project included a focus on identifying remnants of the palisade and additional potential iterations of the palisade. In addition, we extended our survey area to cover space around Mound 48, including Mound 57. These two mounds form the western boundary of the Grand Plaza.

Table 1. Chronological periods and characteristics of Cahokia's emergence and development.

Chronological Periods	**Chronological Phases**		**Time Range**	**Characteristics**	**References**
(Entire American Bottom)	**North Am. Bottom**	**South Am. Bottom**			
Terminal Late Woodland/Emergent Mississippian	Collinsville	Dohack	850–900 CE	Homestead and hamlet sites scatter the region, but villages (<1 ha) appear at Cahokia. Maize is introduced to the region. Villages resemble cosmograms with central posts and flanking pits centering their courtyards and plazas.	[25,79–82]
	Lloyd	Range	900–950 CE		
	Merrell	George Reeves	950–1000 CE	Small villages (<1 ha) begin nucleating into larger villages and towns with plazas. The earliest known mounds near Downtown Cahokia date to the early 11th century CE. Interregional material exchanges occur, and L/T-shaped structures appear.	[80–83]
	Edelhardt	Lindemann	1000–1050 CE		
Mississippian	Lohmann		1050–1100 CE	Urbanization drives demographic processes in the "Greater Cahokia" occupation areas. Community sizes greatly diversify, and the Richland Complex develops. Mounds, as well as plazas, roads, and woodhenge circles, are being rapidly built at Cahokia and surrounding sites. Population peaks. Palisade is built ca. 1175 CE.	[16,25,39,42,47,84]
	Stirling		1100–1200 CE		

Table 1. *Cont.*

Chronological Periods	Chronological Phases		Time Range	Characteristics	References
(Entire American Bottom)	North Am. Bottom	South Am. Bottom			
	Moorehead		1200–1275 CE	Following a conflagration at East St. Louis (late 11th century CE), populations considerably contract at Cahokia and the site's organization is reconfigured. Mound building continues, the palisade is rebuilt, and nonlocal ties persist.	[38–40,42,82,85,86]
	Sand Prairie		1275–1400 CE	Populations continue to decline to eventual site abandonment around 1400 CE. Mound building ceases before 15th century CE. Brief Oneota occupation follows.	[39,41,82,86,87]

Documenting Known Architecture in the Survey Area

In the initial survey-based map portrayal by John Patrick in the 1870s (Patrick's map of Monks Mound is dated 1876, but no date is provided for his site map), Mound 48 was shown to be a large, rectilinear platform mound rising 7.6 m high, a measurement that Melvin Fowler ([88], p. 111) believed to be close to the monument's original height. After his initial field season at Cahokia in 1921, Warren K. Moorehead ([89], p. 18) reported its basal dimensions as being 61 $\times$ 55 m, referencing Bushnell's ([90], p. 9) reported observations. Although he believed that internments could be found within the "Castle Mound" (Mound 48), Moorehead's ([89], pp. 18, 33–34) field work at this locale only consisted of a couple auger holes that revealed dark sediments, presumably midden. He also noted the presence of a historic farmhouse and established his field headquarters there ([89], pp. 18, 34).

Monks of the Trappist order built and occupied structures on top of and around Mound 48 between 1809 and 1813 under the direction of Father Urban Guillet ([88,90], p. 9, p. 114). The Trappist houses around Mound 48 were observed by Henry Marie Brackenridge [34,35] when he visited Cahokia in 1810 ([91], pp. 19–20). Excavations conducted into Mound 48 by William Woods of Southern Illinois University-Edwardsville and Robert Santley of the University of New Mexico in 1995 revealed soil-stripped surfaces beneath the mound, structure basins, pit and post features, and a possible screen for fence trench [92]. Cores taken from Mound 48 suggest it was rapidly built in a single event during the late 11th century CE [92,93].

Mound 57 is a much smaller monument located immediately south of Mound 48, and it has been traditionally interpreted as a small conical mound that was only 3 m tall in 1882 (when the William McAdams' map of Cahokia is dated) ([88], p. 122). In the photogrammetric map produced by UWM researchers in 1966, Mound 57 was shown to be roughly 0.8 meters tall, suggesting that historic, modern, and natural disturbances have likely damaged the mound ([88], p. 122). To date, no documented excavations have taken place at this monument. Existing literature and on-site signage differ regarding the nature of Mound 57's form. Across these representations, it appears both as a conical (circular) and platform (rectilinear) mound.

The history of investigations into the sequence of palisade walls around the Grand Plaza began with the identification of soil discolorations in aerial photographs taken by Lieutenants George Goddard and Dasche Reeves in 1922 and 1933, respectively ([15,94,95], p. 2010, p. 89, pp. 65, 68). Beginning in 1966, Anderson [94] supervised excavations into the first documented palisade wall features east of Monks Mound [15]. This project initiated over 30 years of field work tied to exploring the palisade sequence, and portions of these features have been identified in the east, southeast, south, and western portions of Downtown Cahokia [15]. While excavations along the eastern half of the projected palisade have been successful in locating intact features, the western half of the palisade sequence is much less understood, and current maps illustrating complete palisade enclosures are based partly on interpreted projections [96]. However, excavations conducted between 1998 and 2004 located palisade features immediately in the geophysical survey area [78]. The interpretations produced from these excavations suggests the palisade construction sequence corresponds to increasing social instability and conflict into the Middle Mississippian period (1250–1400 CE) across the American Southeast [15,42,43,78]. Dates for the initial construction of the palisade walls cluster around the late Stirling phase (1175 CE), while sampled dates from later palisade wall features in the East Plaza extend into the 14th century CE [15,41,70,96–100].

Compiling and analyzing a combination of LiDAR-based ground surface visualizations and data from multi-instrument geophysical investigations of our survey area allow us to speak to significant changes that took place along the western limits of the Grand Plaza. Our results reveal a palimpsest of changing social relationships through time and space in the organization of the new architectural features we identified. Our data further refine and build upon interpretations of structured space in the Grand Plaza while accounting for different social uses within the existing chronological sequences for Cahokia [42,101]. The super-positioning of geophysical anomalies we identified, as well as a consideration of their spatial dimensions and patterning, afford us the opportunity to create a chronological sequence for features in relation to the nearby mounds and palisade.

The data collected as a part of our class project provide an opportunity to outline details regarding the development of Cahokia's Grand Plaza. In doing so, this project moves forward discussions and inferences associated with the biography of this important urban archaeological site in North America. Below, we outline the methods employed in our investigation and subsequently present our analyses and results. We then contextualize our results within a discussion of Cahokia's established chronology (see Table 1) and how our data speak to changes associated with the site's history of social change.

3. Methods and Analyses

Our approach to the survey area was explicitly multi-scalar and multi-method, with hopes of being able to disentangle some of the palimpsestic [102–104] evidence for social change at Cahokia. Such approaches have proved helpful at other complex monumental sites in the American Mid-South [105]. The aerial datasets we assessed included historic aerial photographs and LiDAR-derived visualizations we produced for the western edge of the Grand Plaza. The terrestrial datasets we collected included magnetometry and electromagnetic induction. All geospatial data were visualized and analyzed in ESRI's ArcPro 3.0 GIS software. Statistical analyses of features identified in our magnetometry survey were conducted in Microsoft Excel and SPSS Statistics software. In this section, we describe the data we obtained in detail and use them to examine the western edge of Cahokia's Grand Plaza.

3.1. *Historic Aerial Photographs*

Several aerial photographs helped us interpret our topographic and geophysical data. These included Goddard and Reeves' flyover photographs, taken in 1922 and 1933 (see Figures 11–13 in ([95,106], pp. 67, 69, 73)). The photographs taken by Reeves [107] were the first vertical stereoscopic aerial photographs taken of the Cahokia site, offering additional details that were not fully captured by the oblique-angle photographs taken by Goddard (see Figure 12 in ([95], (pp. 68–69)). The Goddard and Reeves aerial photographs have long provided useful information about the nature of Cahokia's preservation before several modern developments took place within and around it. Central to the work we present here are the photographs that display soil discolorations likely marking the footprints of earthworks and palisade walls ([95], pp. 70–71). Our use of these photographs included scanning and reanalyzing the Goddard imagery from Crook and working with scanned digital copies of the Reeves photographs obtained from CMSHS. Our copies of the Goddard and Reeves photographs did not provide the resolution (even in their original forms) for detecting individual features; however, they did provide important information for interpreting our LiDAR-derived surface visualizations and geophysical survey results.

3.2. LiDAR-Derived Surface Visualizations

We obtained LiDAR-based digital terrain model (DTM) tiles from publicly available geospatial data layers managed by the state of Illinois (https://clearinghouse.isgs.illinois.edu/, accessed November 2018 and August 2022). The DTM is projected in US feet at a ca. 3 m (10 ft) resolution. It covers approximately 3 km^2, almost centered on Monks Mound and Downtown Cahokia (see Figures 1 and 3). We used the DTM to produce additional analytical raster layers in the Relief Visualization Toolbox (RVT) v. 2.2.1 [108,109] with the hope that a diversity of visualizations would allow us to identify subtle topographic features (*sensu*, [92]). Blended images such as those described in Henry et al. [105] were also produced from individual RVT visualization layers.

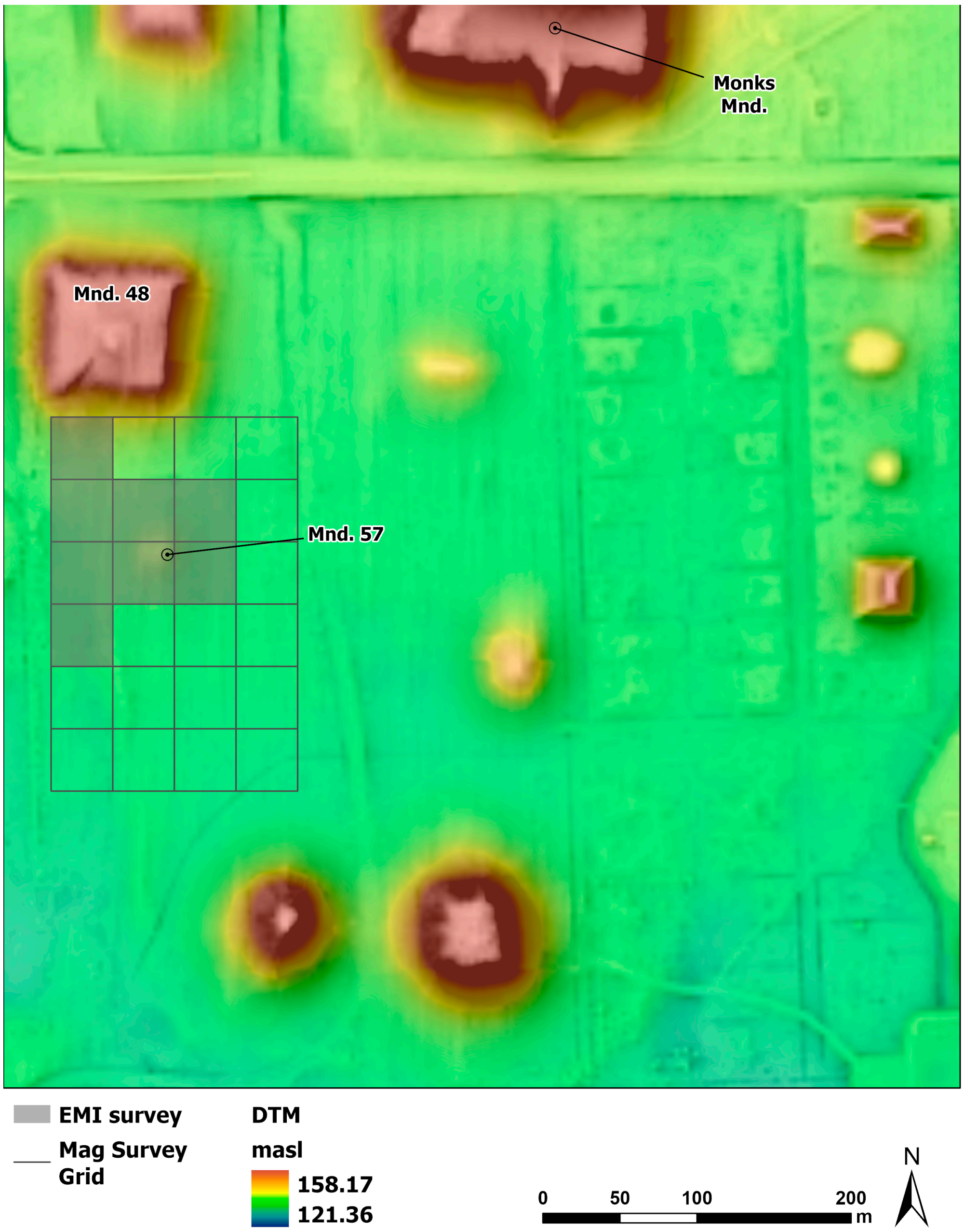

Figure 3. Location of geophysical survey areas at the western edge of Cahokia's Grand Plaza.

We produced and assessed several of the visualizations in the RVT using the DTM, but we focus here on presenting the results of the sky-view factor (SVF) and positive openness. These two surface visualizations offered our research the most information on the organization of the Grand Plaza. SVF is the product of calculating a proxy for illumination based on a given pixel's location within DTM data. This helps alleviate a common problem in hillshaded imagery, such as the highlighting of only some surface features from a specific light angle. For every pixel location in the DTM, positive openness calculates the mean zenith and horizon angles of that locale. It is useful for highlighting subtle convexities on the landscape [110,111].

3.3. Archaeogeophysical Surveys

Like several other research projects from the American Bottom and surrounding regions, we conducted an archaeogeophysical survey to determine whether evidence for intact subsurface archaeological features could be identified and spatially analyzed to reflect larger social patterns [29,65,70,112–114]. Our surveys included the use of a multi-channel cart-based magnetic gradiometry system and a dual-coil electromagnetic induction (EMI) meter. The magnetometry survey covered 3.8 ha. in 24 40 $\times$ 40 grid squares situated south of Mound 48 (Figure 3). Data were collected at a field resolution of 0.5 $\times$ 0.1 m with a Foerster Ferex 4.032 DLG Karto 4-sensor fluxgate gradiometer mounted on a non-magnetic cart. Raw data from the Foerster system were processed using TerraSurveyor ver. 3.0.36.x with the application of destagger, destriping, and Gaussian low-pass processes prior to interpolating the imagery to a 0.1 m^2 resolution.

Recent statistical analyses performed on imagery from a subsurface magnetic survey at Cahokia's Spring Lake Tract by Baires and colleagues [112] demonstrated that length:width ratios (L:W) can be compared across buildings of known size (determined from previous excavations) with those identified in gradiometry data to help tease apart their general temporal placement within the established Cahokia site chronology (see Table 1). In following their methodology, we calculated L:W ratios and floor area measurements (m^2) from magnetic features in our survey data after they were digitized as polygons in ArcPro. Following the methods outlined by Baires et al. [112], we then applied a natural logarithmic transformation to our calculated structure areas for comparison to their respective L:W ratios. Using the trend lines published for regional architectural structures [112], we generated a scatter plot with log-area values (y-axis) and L:W ratios (x-axis) to facilitate the linear regression analysis of structures in the Grand Plaza via Microsoft Excel and IBM's SPSS Statistics software (Table S1 and Figure S1). Residual values for magnetic signatures interpreted as architectural features were estimated by determining their distances above or below the best-fit trendlines for structures across the American Bottom, and the residual values that were closest to 0 for a given structure in the Grand Plaza geophysical data indicated their most likely temporal affiliation. This led us to identify patterns in house structure dimensions that conservatively corresponded to Cahokia's key chronological phases discussed earlier (see Table 1).

We used the Geonics EM38-MK2 EMI meter to collect quadrature-phase (QP) earthen conductivity and in-phase (IP) magnetic susceptibility data at two depths over a subset of our magnetometer survey (Figure 3). This slingram instrument incorporates two coil separations at a spacing of 0.5 m and 1 m from the transmitting coil. This array offers a general depth penetration of 0.75 m and 1.5 m for conductivity (QP) data and 0.3 m and 0.6 m for magnetic susceptibility (IP) data. The EMI survey area completely encapsulated Mound 57; data were collected at a field resolution of 0.5 m^2 and processed using TerraSurveyor with despike and high/low-pass functions applied. Data were then interpolated to 0.25 m for import into our GIS. Rinita Dalan's [56,69] pioneering work in geophysics at Cahokia showed that mounds and palisade remnants generally exhibit low conductivity values compared with the surrounding Grand Plaza fills while the buried ridge and swale topography alternates between high (swale) and low (ridge) values.

4. Results

Our multi-scalar remote sensing investigation of the Grand Plaza's western edge identified numerous surface and subsurface features that allow us to offer new insights into the development of Downtown Cahokia. We begin by discussing our comparative analyses of the historic aerial photographs and the LiDAR-derived DTM visualizations. We then present the results of our geophysical surveys and discuss how we analyzed architectural variation in the magnetic gradiometry imagery to discern changes in the Grand Plaza through time.

4.1. Aerial Imagery and Insights from the Western Edge of the Grand Plaza

The Goddard and Reeves aerial photographs revealed the presence, form, and state of preservation for several mounds in the central portion of the Cahokia site. Mound 57 is discernible in oblique photographs captured by Goddard and published by Crook [115] as a conical raised area of light-colored vegetation (Figure 4a,b). The historic home that once stood atop Mound 48 and two small farm buildings appear near Mound 48's southeastern corner. In other aerials by Reeves ([95], p. 73), remnants of the palisade wall are visible along the eastern side of the Grand Plaza (Figure 4c) but fade along the western edge of the plaza south of Mound 48. An area of lightened vegetation corresponding with the location of Mound 57, south of Mound 48, is visible in this planview photograph. This depiction represents the mound as more rectilinear in shape.

Figure 4. Historic aerial photographs analyzed as part of our project. (**a**) Oblique aerial photograph of Grand Plaza area taken by Goddard and published by Crook [115], view to northeast; (**b**) oblique aerial photograph of Grand Plaza area taken by Goddard and published by Crook [115], view to west; (**c**) planview aerial photograph of Grand Plaza area taken by Reeves and published by Fowler [95], palisade remnants denoted by arrows; this image used courtesy of CMSHS.

4.2. LiDAR-Derived Surface Visualizations from the Grand Plaza

LiDAR-derived surface visualizations of the western border of the Grand Plaza allowed us to combine information from historic aerial photographs and previous excavations in this area to better understand how this portion of Cahokia was spatially arranged. Surface visualizations also provided insights on iterations of the palisade and its relationship with Mound 48. The blended sky-view/DTM imagery we produced depicts the complex palimpsestic landscape we know modern Cahokia to be, complete with remnants of a mid-late twentieth century neighborhood and drive-in movie theater (Figure 5). Traces of the historic house that once sat atop Mound 48 are also visible. However, several features important to our study stand out. The first is an iteration of Cahokia's palisade.

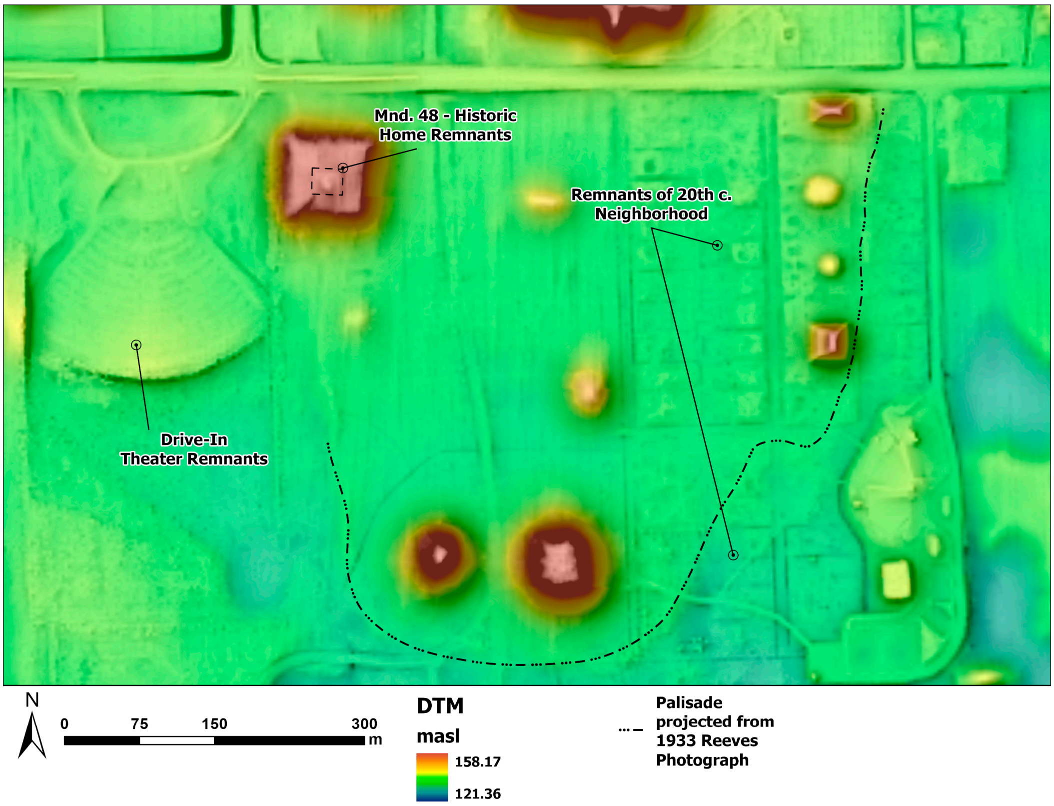

Figure 5. Cahokia's Grand Plaza and surrounding areas visualized through LiDAR-derived blended image of the DTM and sky-view factor showing modern features and an iteration of the wooden palisade as projected from the 1933 Dasche Reeves aerial photograph depicted in Figure 4c.

The excavations initiated by Mary Beth Trubitt in 1998 [78,116] identified palisade remnants, including a bastion, within our survey area. Using a sub-centimeter GPS system, we tied into the traditional Cahokia grid system so that we could overlay their planview excavation maps of palisade features using a first-order polynomial transformation. This allowed us to compare their excavation results to our surface visualizations with an accuracy of roughly a centimeter in terms of RMS error. In comparing these data, we observed a correlation between identified palisade remnants [78] and a small linear rise (possibly constructed) that is roughly 4.5 m wide and encapsulates mounds along the east, south, and west of the Grand Plaza. The topographic profiles produced from the DTM show that this surface feature is subtle, rising only roughly 10–20 cm above the surrounding ground surface south of Mound 48 (Figure 6). This linear rise interestingly extends to the southern edge of Mound 48, nearly 15 m east of the earthen monument's southwestern corner. Moreover, the feature can be seen to extend north of Mound 48 almost 20 m from its northwestern corner before being intersected by Collinsville Road. The linear rise continues north of Collinsville Road, albeit at a slightly reduced height of 5–10 cm. Assuming this feature corresponds to one of Cahokia's four iterations of the central palisade, it provides new implications for the construction history of Mound 48 and Downtown Cahokia.

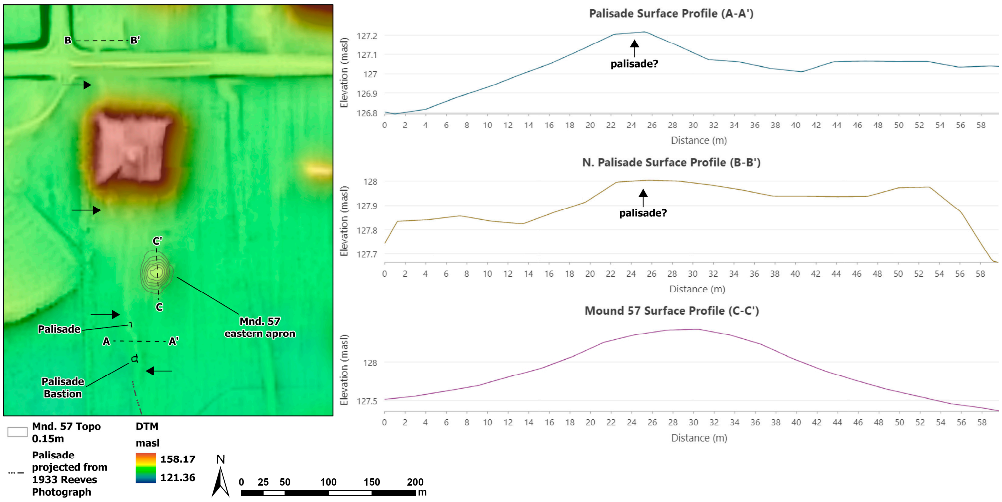

Figure 6. Grand Plaza and surrounding areas visualized as LiDAR-derived blended image of the DTM and sky-view factor. The linear rise discussed in the text is indicated by arrows, and the palisade remnants identified in excavation [78] are overlaid on rise and designated. Topographic profiles for palisade and Mound 57 are also shown.

The other feature we examined was Mound 57. This small mound is visible in our surface imagery to the southeast of Mound 48. Currently, its footprint measures roughly 51 m north–south by 37.5 m east–west; it is just under 1 m in height (0.92 m). Surface profiles suggest the mound is indeed conical in shape. However, the base topographic contour for Mound 57 denotes an extended apron protruding from the mound's eastern flank. This apron-like feature leads us to question the initial form and, as a result, potential function of Mound 57.

4.3. Magnetic Gradiometry Survey

The imagery produced from our cart-based magnetic gradiometer survey reveals not only large areas of historic debris but also the remnants of several Cahokia-era archaeological features. Most evident in our data are the concentrations of historic magnetic noise south of Mound 48, likely associated with the historic farm that once operated around the mound (Figure 7a). Old farm roads are also evident in the data, as is a CMSHS gravel trail that runs south of Mound 48 in a north–south orientation along the palisade and then turns to the west. Two clusters of modern magnetic noise roughly 155 m and 200 m south of Mound 48 represent previous palisade excavations reported by Altizer et al. [78]. The ferrous monopole anomalies scattered across the survey area likely related to the historic use of the area as a farm (e.g., fence posts), but some may also represent metal pin flags that demarked previous shovel test surveys of the area (Dr. John Kelly, personal communication 2019). Aside from modern disturbance of the Grand Plaza, various kinds of pre-Contact architectural remnants and features (e.g., refuse pits, combustion features, and post alignments) can be identified throughout the magnetic gradiometer data (Figure 7b). This includes what are likely shallow rectangular pit-basin structures and larger special-use structures (e.g., L-shape structures). Several potential rectangular basin structures loosely arranged in courtyard groups are situated to the southeast of Mound 48. South of these features, pit-basin and wall-trench architecture of various shapes and sizes can be observed. Good examples of archaeological features can be seen throughout this eastern half of our survey, including potential evidence for a set of range site-style quadripartite pits [27] situated at the southeastern edge of our data.

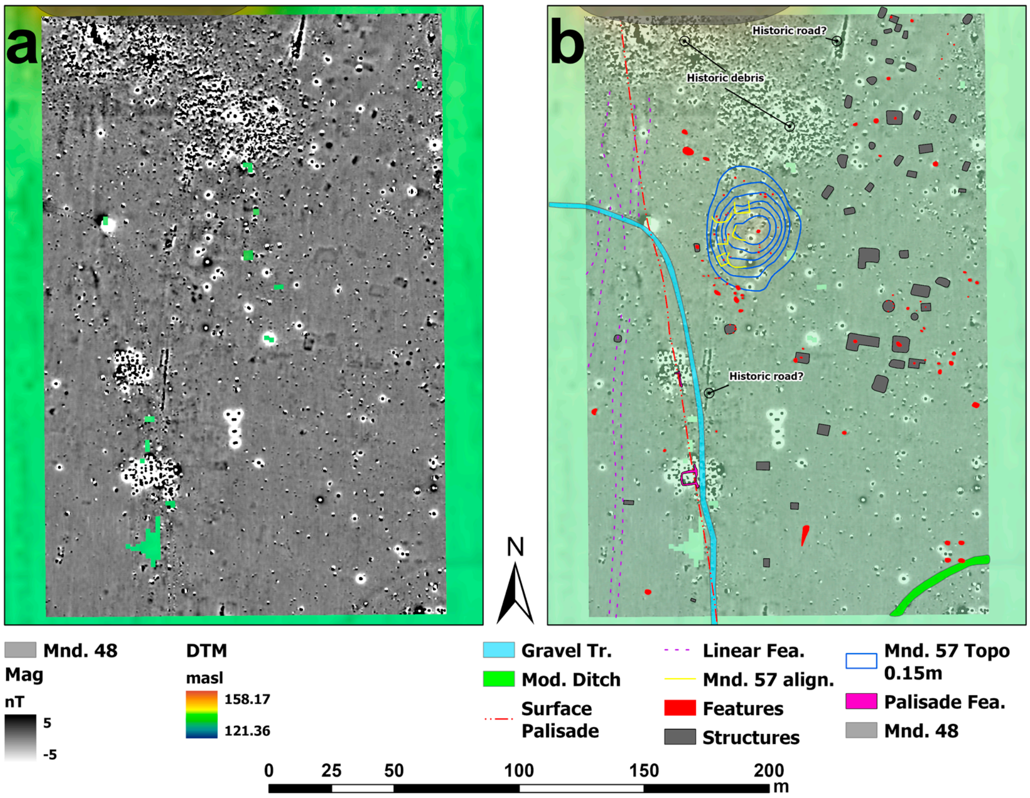

Figure 7. Results and interpretation of the magnetic data from this study; (**a**) magnetic gradiometery imagery overlaid over the local DTM; (**b**) interpretive layers overlaid onto magnetic gradiometery imagery set at 50% opacity.

The footprint of Mound 57 contains several high magnetic features likely corresponding to a variety of subsurface archaeological and modern features. There are also potential examples of pre-mound and/or mound surface architecture associated with Mound 57. These take the form of curvilinear and rectilinear arrangements of enhanced subsurface magnetism (Figure 7b). However, the magnetic gradient imagery did not help inform us of the mound shape (e.g., conical vs. platform). Adjacent to the southern edge of Mound 57 are a cluster of elevated magnetic features that we interpreted as potential features associated with mound construction and/or post-construction use (e.g., features containing feasting debris). West of Mound 57, a series of linear north–south magnetic anomalies extend into the modern disturbance just south of Mound 48. We suspect that some of these anomalies may be related to iterations of the palisade. However, we cannot rule out that some of these subtle magnetic features might be related to old farm roads or a driveway leading to the top of Mound 48 in the historic past.

Several clear architectural clusters, in addition to some that are less clear, can be identified east of Mounds 48 and 57. These include what have been identified as pit-basin structures in other American Bottom magnetic datasets [29,112], but also clear in the magnetometer imagery are a variety of wall-trench structures, some of which exhibit unique styles, such as L-shape features. What we consider to be pit-basin-style houses most clearly cluster to the southeast of Mound 48. East of Mound 57, trending southward, are large potential special-use buildings, including those exhibiting an L-shape construction. Our findings offered a means of comparing structural remnants, represented as magnetic features, from our geophysical survey area within the Grand Plaza with those previously published from the Spring Lake Tract [112]. Our application of the L:W structure ratios and regression analysis in a post-processing analytical framework for the gradiometry data (see Table S1 and Figure S1) highlighted shifts in architectural style through time in the Grand Plaza's social space (Figure 8).

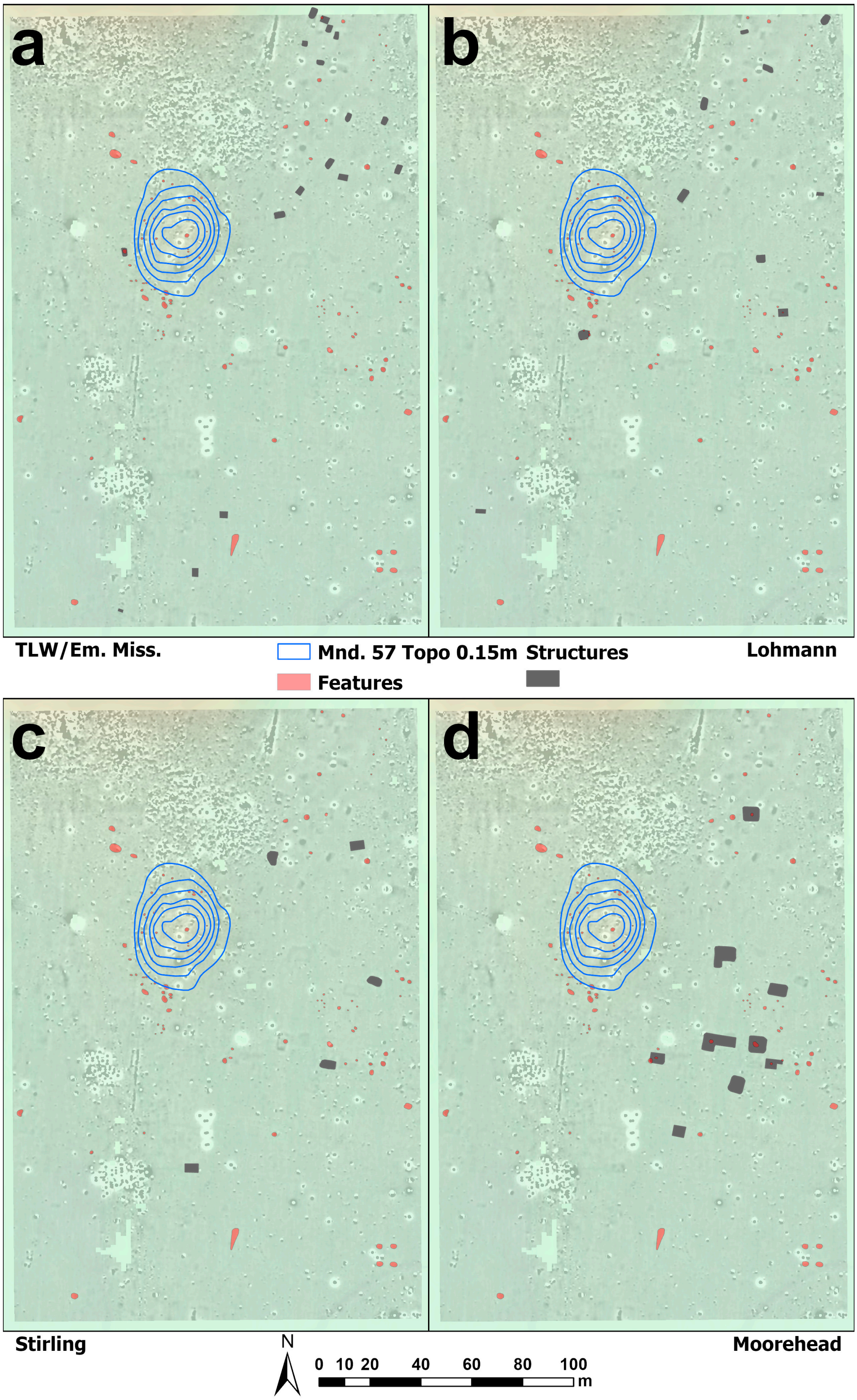

Figure 8. Generalized chronological organization of structures we mapped in the Grand Plaza as determined by our regression analyses of structure area (m^2) and L:W ratios. (**a**) Terminal Late Woodland/Emergent Mississippian (850–1050 CE) structures; (**b**) Lohmann (1050–1100 CE) structures; (**c**) Stirling (1100–1200 CE) structures; (**d**) Moorehead (1200–1275 CE) structures.

These architectural patterns derived from our magnetic data help show how Cahokia's Grand Plaza represents a landscape in motion. We assigned 17 structures to the Terminal Late Woodland/Emergent Mississippian period (TLW/EM; ca. 925–1050 CE). These can be observed as configurations of courtyard groups clustered southeast of Mound 48 with a few buildings scattered throughout our survey area (Figure 8a). However, after 1050 CE, we can observe a change in the number and distribution of structures along the plaza boarder. We assigned 10 structures to the Lohman Phase (1050–1100 CE), where we observed more dispersed and scattered placement of architecture across the western portion of the Grand Plaza (Figure 8b). This trend continues into the Stirling Phase (ca. 1100–1200 CE), to which we only designated five structures (Figure 8c). However, we allocated nine buildings to the Moorehead Phase (1200–1275 CE), a time where the size of structures increased and their layout clustered closer to one another and near Mound 57 (Figure 8d). Moorehead-assigned structures in our study area also exhibited changes to focus on what are clearly special-use structures such as L-shaped buildings.

As their names imply, these wall-trench structures roughly conform to "L" shapes in planview, consisting of a larger rectilinear room with a smaller addition. Although assuming a variety of forms at both Cahokia and its contemporaneous settlements nearby as far back as the 11th century CE, L-shaped structures have been interpreted as having special uses, an inference based on examinations of their distinctive storage additions ([46,61,117,118], p. 223, p. 39, p. 145). Common characteristics of several special buildings that conform to L, T, and/or cruciform shapes during the Mississippian era in the American Bottom include: their placement around plazas [30,46,112,117,119,120], a close spatial proximity to mounds ([61,121], pp. 39, 144–145, pp. 54–56), and circular-shaped sweat lodges ([45,118,122], p. 63). These types of buildings are also known to contain special items ([61,123–125], p. 44, p. 267), suggesting that they were places where ritual participants utilized well-crafted paraphernalia. Moreover, the position of these buildings affronting the largest and most public plaza at Cahokia speaks to their importance within the context of how this space was arranged, even if at one point in the city's history. We should note that we also identified several (n = 5; see Table S1) circular features that are not easily assigned to a temporal phase but, as we mention above, may represent special-use structures such as sweat lodges. The spatial correlation of two circular buildings within the cluster of Moorehead structures helps support this hypothesis (see Figures 7b and 8d).

Being able to map these social and temporal changes within the context of the Grand Plaza allows us to see, even if on a small scale, how the Cahokia landscape was changing from what we might consider early domestic neighborhoods in the TLW/EM to a use of space that centered on larger performative events during the Stirling and Moorehead phases.

4.4. Electromagnetic Induction Survey

Our EMI survey covered a sample of the magnetometry survey, including both Mound 57 and areas south of Mound 48 where palisade remnants should exist. The imagery produced from our conductivity data collected from the 0.5 m and 1 m coil separation showed some correlation with subsurface historic metal debris we identified in the magnetometry survey, as well as the CMSHS modern gravel walking path (Figure 9). However, one of the L-shaped structures identified in the magnetometry data appears east of Mound 57 as a feature of low conductivity. Information from the conductivity data over Mound 57 and the palisade area also offered subsurface insights that the magnetometry survey did not. Beginning with the palisade, a 15-m-wide band of low conductivity can be seen trending from the south to the western edges of our survey area. This feature is likely a sand ridge associated with the buried ridge and swale system that has been documented beneath the plaza [56,69,78]. However, emerging from the northern boundary of this subsurface alluvial feature is a 4.5-m-wide linear anomaly exhibiting low conductivity; a long linear anomaly of high conductivity running the entire north–south portion of our survey area is also present. Because this feature exhibits low conductivity, as described by Dalan [69] for EMI responses to palisade remnants, and is approximately the same width as the topographic expression of the palisade we identified using LiDAR-derived visualizations of Downtown Cahokia, it could represent subsurface remnants of a different iteration of Cahokia's palisade that stretched west of Mound 48 in its final form.

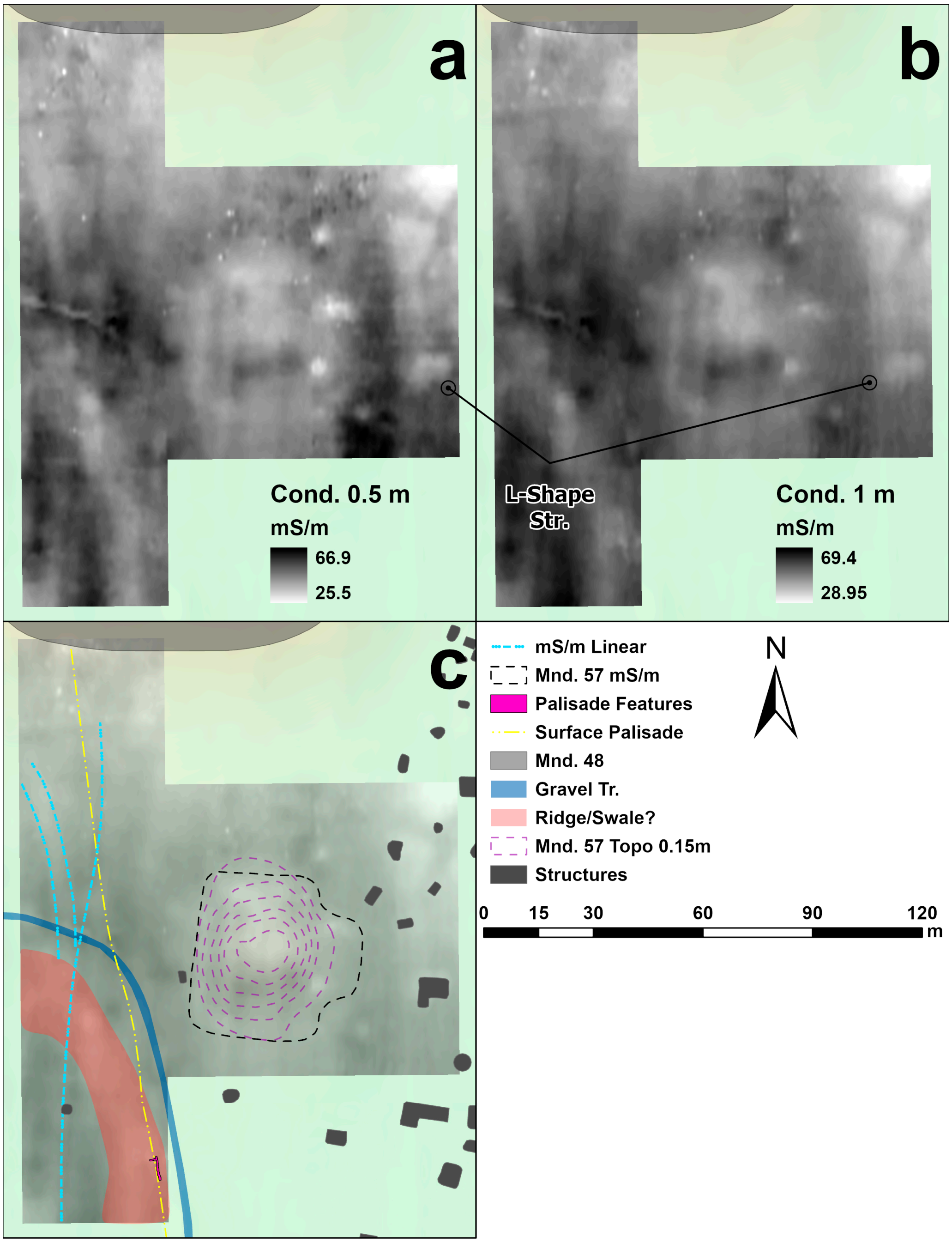

Figure 9. Results and interpretation of our quad-phase EMI survey in the Grand Plaza. (**a**) Conductivity data from the 0.5 m coil separation; (**b**) conductivity data from the 1 m coil separation; (**c**) interpretive layers overlying the 1 m conductivity data set at 50% opacity.

The conductivity imagery over Mound 57 depicts the earthwork as having a clear rectilinear morphology with internal variations in conductivity. This is visible in the 0.5 m coil data, as well as the 1 m coil data (Figure 9a,b). In both layers, isolated areas of lower conductivity are concentrated in the northern part of the mound, while areas of higher conductivity are visible in the southern parts of the mound. These differences may be related to construction methods that incorporated fills with very different origins and physical characteristics. However, Mound 57 fits the low-conductivity pattern described in previous work by Dalan and colleagues for deflated mound remnants [56,69]. At the eastern edge of the mound is a low-conductivity extension that spatially coincides with the topographic apron-like feature discernable from our LiDAR-derived surface visualizations. These data strongly suggest that Mound 57 is a platform mound that likely had a ramp facing east, toward the center of the Grand Plaza.

The magnetic susceptibility imagery from the 0.5 m coil generally exhibits little more than surface noise related to the gravel walking path and the historic debris at the base of Mound 48 (Figure 10). However, data from the 1 m coil separation indicate the presences of linear features oriented north–south at the western limits of our EMI survey, as well as potential remnants of a bastion associated with the palisade identified by Altizer and colleagues [78]. Observations from Altizer et. al.'s excavations into the eastern and southeastern palisade wall features indicated that 20 meters typically separate the bastions connected by curtain walls ([43], pp. 30–31), an estimate that roughly conformed to the length of our proposed bastion in the magnetic susceptibility imagery and the bastion identified through excavation immediately south of it ([78], pp. 7–8). Unfortunately, little information pertaining to any mound-top features or construction fills associated with Mound 57 is present in the magnetic susceptibility data from the EMI survey.

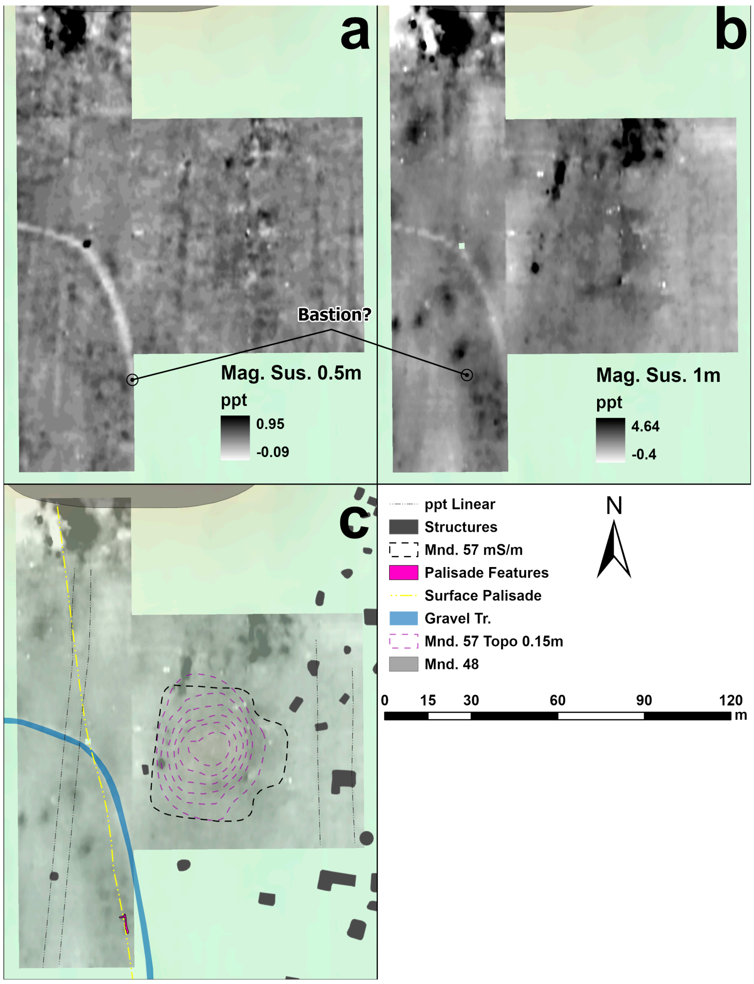

Figure 10. Results and interpretation of our in-phase EMI survey in the Grand Plaza. (**a**) Magnetic susceptibility data from the 0.5 m coil separation; (**b**) magnetic susceptibility data from the 1 m coil separation; (**c**) interpretive layers overlying the 1 m magnetic susceptibility data set at 50% opacity.

The results of our geophysical surveys confirm that Mound 57 was most likely a platform mound, but they also provide some insight into how the Grand Plaza at Cahokia was socially changing over time through changes in architecture. We found mixed results in geophysically identifying potential palisade remnants because they are hard to separate from old road/driveway features related to the farm that operated around Mound 48. Our best candidate for a late-stage palisade iteration rests in the low-conductivity anomaly exhibiting the same width as the potential palisade rise and running west of Mound 48 (Figure 9). Nevertheless, when considered within the context of our LiDAR-derived visualizations and existing literature on archaeological deposits and features at Cahokia, we can use the results of our aerial and terrestrial remote sensing data to build a narrative of architectural and social change that is not commonly possible from two-dimensional geospatial imagery.

5. Discussion

Our combined analyses of LiDAR-derived surface visualizations and multi-instrument geophysical survey data allow us to document new details pertaining to changes in the organization and use of space in Downtown Cahokia. The new insights our research offer to understanding the development of the Grand Plaza at its western limits relate to the historical trajectory of Cahokia's palisade and its relationship with Mound 48, the form of Mound 57, and the architectural transformations that occurred along this area in the plaza. The palisade, as we mapped it as a subtle linear rise 5–20 cm high, extends under Mound 48 and continues north past Collinsville Road. The topographic relationship between the palisade and Mound 48 is such that the palisade serves as a terminus ante quem for the completion, or perhaps the initiation, of Mound 48. Because the mound extends over the palisade by a large portion (ca. 15–20 m), we must assume that the palisade predates the mound in some way. However, we cannot be sure that Mound 48 had not been partially constructed and then expanded upon, as later iterations of the palisade extended further west. Nevertheless, it is also possible that Mound 48 was a later construction in the sequence of mounds around the Grand Plaza and did not exist when the palisade was initially erected.

Our geophysical surveys over this area identified linear features that run both adjacent and parallel to the topographic rise we associate with the palisade feature. While some of these anomalies are potentially parts of iterations of a palisade, we cannot tease apart a clear palisade sequence from them. Moreover, we cannot confidently separate what might be subsurface palisade remnants from what might be remnants of historic farm driveways and roads. This said, we identified a notable correlation in our conductivity data with the low-conductivity feature that angles to the west just south of Mound 48. We suggest that this feature, which is comparable in width to the palisade rise (e.g., both 4.5 m wide), is a subsurface remnant of a palisade iteration that post-dates the final construction of Mound 48.

Based on amassed radiocarbon dates that have been subjected to multiple Bayesian modeling restraints over the past two decades, the history of palisade construction at Cahokia is thought to have begun at approximately *1175 cal CE* and ended at *1410 cal CE*, [42,70,82]. As these chronological models suggest, the first iteration of palisade wall construction circumscribed the Grand Plaza and Monks Mound prior to the 13th century CE. This timeframe is close to Trubitt's assertion that warfare coincided with social changes at Cahokia around 1200 CE [116]. Additional palisade reconstructions (iterations II through IV) are thought to have spanned the 13th and 14th centuries CE, the last occurring immediately prior to Cahokia's abandonment ([43], pp. 37–38). Radiocarbon dates sampled from Cahokia's palisade wall features were collected from a variety of contexts during subsequent field seasons. Several of the Cahokia Palisade Project excavation findings remain unpublished [96] but continue to delineate the spatial footprint of the palisade wall constructions and elucidate their construction sequence relative to nearby structures, plazas, and mounds [43,78]. As these pertain to Mounds 48 and 57, water line excavations undertaken along Collinsville Road, north of Mound 48 by Alt et al. [18], and the western palisade wall features reported by Altizer et al. ([78], p. 13) indicate that "the palisade avoids Mound 48 to the north . . . include[ing] it [and Mound 57] within the enclosure with what appears to be a slight trending . . . to the west." With the caveat that the first iteration of the palisade wall is potentially superimposed by Mound 48, our geophysical results largely fit this interpretation and indicate that Mound 48's construction was complete (or initiated) sometime roughly after the late 12th century CE following the completion of the first palisade wall.

Our multi-scalar approach to Mound 57 provides new answers pertaining to this monument, but it also points to new questions. The LiDAR visualizations we produced suggested that the mound was conical in form, but a potential feature extending to the east toward the plaza kept the form of the mound from being confirmed. The magnetometry data, while revealing potential features associated with pre-mound and post-mound construction and use, do not offer any clear information on the shape of the monument. However, the results from our conductivity survey leave little doubt that Mound 57 is a platform construction. In her previous application of magnetic susceptibility studies to mound construction and taphonomy at Cahokia, Rinita Dalan ([126], pp. 188–193) specifically addressed how hillslope erosion affected Mounds 36 and 62, obscuring the original forms they assumed. Referencing her findings at Mound 36, platform mounds can appear conical after hillslope erosion has eroded the summit edges, and the resulting toe-slope deposits accumulate around the skirt. Considering our EMI results, this appears to be the case for Mound 57, as the buried skirt edges of the mound indicate that it was originally shaped like a platform mound and it exhibited low-conductivity responses similar to those in Dalan's other EMI research on mounds in the Grand Plaza [56,69].

These previous studies help contextualize and support other conclusions we drew from our EMI data associated with Mound 57. For instance, the topographic feature (i.e., apron) we identified extending toward the plaza is now better characterized as a potential mound ramp, which we can observe as aligning to Mound 54, another small platform mound, on the eastern side of the Grand Plaza. While Mound 57 is severely diminished from historic land use practices, Mound 54 might be a good analog when thinking about what Mound 57 might have once looked like. The relationship between these two mounds should also point future researchers towards thinking about symmetry and the tension between imagined communities in the development of Downtown Cahokia.

Another important outcome of our conductivity survey of Mound 57 is that it provides some baseline information regarding the construction of the mound. Along the western and southern edges of the mound, our conductivity data exhibit low rectilinear responses situated adjacent to discreet areas of high conductivity that surround another area of low conductivity. Our interpretation of this relationship is that these data represent different fill sources (e.g., soils and sediments) or different techniques used to construct the mound. The exterior band of low conductivity visually resembles a boundary or a low berm that may be present underneath the slopes of the mound. We can think of few other internal features of mounds that might resist moisture moving through the soil column to produce such as response. However, the larger patches of higher conductivity within (inside) this low boundary might represent more moist soil fills (clay-rich) used to build up the core of the monument during its construction. Potential box and fill construction methods like these have been documented at other sites in the Eastern U.S., such as Graveline Mound on the Mississippi Gulf Coast [127]. Our new research at Mound 57 offers future questions to better understand the nature of construction methods at the small earthwork. These could be examined using both non-invasive methods (e.g., ground-penetrating radar or electrical resistivity tomography) and minimally invasive geoarchaeological methods (e.g., solid soil coring and subsequent soil analyses).

Our magnetometry survey offers further insights into how the nature of space changed during the emergence of Cahokia. Smaller, generally domestic in nature, pit house-style basins are present in a greater number and density near the southeastern corner of Mound

48. As the city of Cahokia grew and shifts in the social fabric that underlay it emerged, this pattern changed to larger and more architecturally elaborate structures that were situated in a north–south arrangement at the western boundary of the Grand Plaza. The L-shape structures that once stood in front of Mound 57 specifically point to the use of the plaza as a place where visually spectacular, and socially powerful, objects were being crafted, used, and potentially stored [23,128–136].

Our geophysical results provide insights into how the sequential arrangement of architectural structures offered a view into changes in the use and separation of space at Cahokia. Moreover, the changes in architectural form highlight the role of both visible and hidden practices in the Grand Plaza area. The rectilinear structures interpreted from our survey results conform to distinct clusters that persisted into Cahokia's later occupation history and were aggregated along the western periphery of the Grand Plaza space. This observation echoes findings from Moorehead's [89] early descriptions of "Village Areas" present across multiple tracts of the site, as well as the courtyard groups that Warren Wittry exposed at Tracts 15A and 15B during the 1960s through 1980s [45,67]. Perhaps reflecting larger scale patterns described for the American Bottom region from the 7th through 12th centuries CE (in which the initial aggregation of smaller villages occurred at a steadily increasing tempo and then transitioned into village nucleation marked by plaza-focused cosmopolitan activities [16,81]), the western extremity of the Grand Plaza space shows a palimpsest of small courtyard groups, specialized structures of various shapes, and earthen mounds. Both at Cahokia and other large mound and village sites in the American Bottom, clusters of houses were built and abandoned, but their arrangements were elaborated upon to create increasingly complex arrangements of compounded plaza groups as each cycle of construction and abandonment turned over (*sensu*, [25]). In their totality, the various components we identified at Cahokia's largest event space provided eclectic settings for diverse behaviors that likely ranged from the clandestine to the spectacular. Considered alongside patterns identified from the archaeological record at Cahokia, our geophysical data provide a non-invasive means to trace the shift toward a consolidated "Cahokia Identity" [73,137–141] reflected through architectural design. This shift is marked by the formal delineation of space represented in the creation of the Grand Plaza, as well as transitions in economic strategies concerning prestige good production, use, and exchange [16,40,142]. Perhaps reflecting inhabitants' concerns for securing the sanctity of Grand Plaza events during interactions with nonlocal peoples [85,87], the Grand Plaza compound was ultimately encapsulated by the palisade before site abandonment [41,43].

6. Conclusions

Our investigation of Cahokia's Grand Plaza adds further details to the existing evidence demonstrating that Cahokians were constantly transforming their landscape in ways that renewed, revisited, and rearranged connections to and meanings of social space. Particularly for large urban centers in the archaeological past, the social processes that structured communal spaces were influenced by the shifting relationships between individuals, social collectives, and the historical circumstances underlying their organization at different points in time. In Cahokia's archaeological past, new communities comprising socially situated agents negotiated interpretations of how publicly defined architectural spaces should be used in relation to existing features such as plazas and their surrounding mounds. Among American Indian communities, both human and non-human agents engaged in these processes, mutually influencing and being influenced by the transformations their landscapes experienced. Consequently, the events that contributed to the complex history of the Cahokia site and the social processes that framed them afforded good results for our interrogation of diverse remote sensing datasets.

Our analysis of historic aerial photographs, LiDAR-derived surface visualizations, and subsurface geophysical surveys provided complimentary and comparative datasets with which we assessed changes in the use of space at Cahokia. Our outcomes further reinforce the idea that geomatic technologies and approaches greatly aid today's landscape archaeologists, whose perspectives are built upon integrating and assessing data collected across decades of research. Perhaps more importantly, we show that extensive and relatively non-invasive geospatial approaches (e.g., we relied on summary data from excavations) offer the ability to go beyond horizontally or vertically understanding space and contextualize spatial change through time. The research we describe here reinforces how public architectures associated with the Grand Plaza in Downtown Cahokia culminated in a unique gathering place that led to the creation of imagined communities ([12], p. 167) whose memory may have been invoked through the exchange of special artifacts bearing distinct Cahokian signatures ([140,141], p. 122, pp. 128, 131).

Monumental architecture that contributed to the overall aesthetic of this public space included Mounds 48 and 57. These mounds greatly differed in size but were spatially positioned near each other within the Grand Plaza and may have been related in some way to potentially paired earthen monuments across the plaza to the east. This is implied by the orientation of the ramp we identified for Mound 57. Additionally, our comparison of aerial photographs and LiDAR-derived visualizations also captured new aspects of Cahokia's palisade wall construction sequence. Tying these visualizations and aerial photograph anomalies to previous excavations by Altizer et al. [78] indicates that our identified palisade anomalies that exist around Mounds 48 and 57 likely correspond to iterations II through IV of Cahokia's palisade wall constructions. These palisade iterations spanned the 13th and 14th centuries CE [43]. Circumscribing Downtown Cahokia, the palisade wall provided a unique boundary to protect, and perhaps restrict access to, a sanctified social arena. As Chappell [138] noted, it is possible that the organization of the Grand Plaza reflected Cahokia's larger social macrocosm and the associated subscription to the practices and ideologies its occupants and participants subscribed to.

Our study reinforces the notion that the founding and occupation of Downtown Cahokia resulted in the creation of a heavily palimpsestic landscape that was continually transformed according to the situational needs of the communities that were enmeshed within and influenced by the site's historical trajectory. Drawing on the combined examination of multiple geospatial and remote sensing datasets has consequently permitted us to draw out the interplay between the societies that participated in the creation of Cahokia and the changes they left inscribed into the landscape.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/land12020342/s1, Table S1: Results of our linear regression analysis of structure L:W ratios and area (m^2); Figure S1: Best fit regression line produced from our linear regression analysis of structures we identified in the Grand Plaza.

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