The Ohio Serpent Mound: a LIDAR Based Study of Geometric Geoglyphs in the Western Hemisphere

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Abstract

The dragon/serpent and opposing bird motif pairing had prominent symbolic roles in world mythologies during ancient times. The duo, along with the triangle shape, have persisted for millennia and continue to be mainstays in the art, architecture and symbolism of current major world religions.

In a previous paper which demonstrated the prolific presence of unknown symbol using these motifs were located on rock outcroppings at the serpent site proper and adjacent land, the question was asked where are the serpent's bird partners? If the constructors had the motivation, resources and knowledge to construct a 1348’ earthen serpent aligned to solar and lunar events, would they not be able to construct large scale birds?

This follow up paper presents illustrations demonstrating the symbol was duplicated in large scale at Serpent Mound and other sites in southern Ohio and the Western Hemisphere. I also present findings that demonstrate the geoglyphs shape, multiple sizes and number are consistent with canons found in Vedic Śulvasūtra texts specifying the construction and reconstruction of falcon shaped fire altars requiring geometry based measurements.

Using independently derived conventions, it is shown how the symbol exponentially increases in number and their resultant geometric expansion across the landscape. Graphics also suggest the positioning of the serpent effigy and burial mounds were based upon the antecedent symbol.

This is presented using working LIDAR images from multiple imaging studies and symbol template overlays. The paper focuses on my methodology and specific LIDAR features used in the placement and sizing of the templates.

1 Independent Researchers, Indigenous Peoples Research Foundation, a non-profit Georgia corporation
Introduction

All that is presently known about the unknown symbol has been acquired over a three year period, most of which was devoted to determining it's shape, temporal and spatial usage by using free hand tracings on a wide variety of objects from the Eastern and Western Hemispheres. For example: lithic tools, sculptured heads, statuary, pottery, facades of religious buildings, mastodon tusks, a bear mandible, rock outcroppings, Roman coins, cave entrances, waterfalls, and so on. The bulk of the examples were obtained from images gleaned from internet sources and the balance from photographs taken during International and North American site visits.

Briefly summarized, the results show use of the symbol in much of the Eastern Hemisphere commencing during the Paleolithic Period, in both the Far East and Western Europe thru about the Medieval Period. In North America, it appears first on Pre-Clovis and Clovis examples from eastern and western sites. Closer to the Serpent Mound region, the symbol was seen on Dorset (500BCE-1500CE), Glacial Kame (8,000-1,000BCE) and Adena (1,000-200BCE) examples which leads us to the cultural group generally acknowledged as the constructors of the serpent effigy.

The results of this first phase are paradoxical, suggesting that a symbol exists which has not been recognized despite centuries of symbol research along with accompanying fantastical implications.

A turning point in the research is presented in this paper; however more compelling evidence comes from the Middle East during the first century of the Current Era and is the subject in a forthcoming paper. Directing attention to this region was prompted by the following.

“The paucity of references to Christianity in the first century is due chiefly to the fact that Christianity appeared to the men of the times as merely a very small Oriental religion, struggling for recognition, and contending with many others coming from the same region. It had not yet made any great advance either in numbers or social importance.”

During this time and the following centuries, there were many groups proselytizing their eastern based philosophies thru out the Roman Empire vying for converts. One of these, Neopythagoreanism, had resurrected the teachings of Pythagoras from six centuries before. Surprising, at least to me, is many ethno-mathematicians seem to be in agreement the Greeks learned of geometry from the Hindu's, who may have learned it from yet another earlier source. Fast forwarding thru the research of this dynamic period, findings from historiography and color decorrelation imaging studies of religious art clearly show the symbol transitioning into similar but different shapes. Two examples are the angelic Cherub and Seraph motifs appearing in early Judeo-Christian literature and symbology, and with the triangle used to depict the paradox of The Holy Trinity. A glaring example is a 4th century vellum Coptic Codex showing an erased symbol next to it’s 4th century replacement.

Despite the aforementioned and other findings not mentioned, extraordinary claims require extraordinary physical evidence and scientifically produced data. With out these, it is necessary to first determine if others can independently reproduce my findings. Thus the following sections are prepared primarily to be a tutorial of sorts for the reader who may have interest.

2 Ancient Church History From the Apostolic Age to the Close of the Conciliar Period, Joseph Cullen Ayer, Jr., Ph.D
3 Ritual Origin of Geometry, Abraham Seidenberg, 1962
Symbol Conventions and Tracing Methodology
Without knowledge of the following basic conventions and knowing what you are looking for, making sense of the maze of subtle parallel curvilinear lines coursing across a surface is difficult if not impossible.

- The symbol's shape remains constant regardless of spatial or temporal factors.
- Progressively smaller symbols are located within a larger.
- Symbols are always located in three locations within a bird motif.
  - As the “eye” located in an anatomically correct position.
  - At the upper breast area with one margin parallel to that of the bird.
  - Tip of the tail
  - In some examples, it also presents in the 8 o'clock position of the bird head with one margin parallel to the bird.
- From each of these symbols, 3 more birds are formed. This process is repeated resulting with symbols exponentially increasing in number and spreading across a given surface.
- The symbol will extend across a 3-dimensional surface.

In this study, the procedure begins with preparing a sketch layer and identifying certain portions of the symbol which historically are distinctive. The is done by following a curvilinear series of similar features and different color shades that are consistent with the symbol's shape. No extrapolation is used. When a “line” is no longer obvious, tracing stops. From experience, guessing on a bird results in a disproportioned profile.

Distinctive margins of the bird include the arcing top of the head, or a double rounded shape of a pair which mimics the top of the heart symbol. Because there are progressively smaller birds within a larger, there are multiple closely spaced concentric arcing lines that can be traced. These lines start to diverge rapidly at the 2 o'clock position of the head as they start forming the posterior margins of the various sizes of birds in the array.

Another distinctive feature is the triangular “V” shape forming the tip of the tail. Because of various bird lengths, this shape is duplicated vertically and have increasingly larger interior angles as the bird size increases. Because a symbol is located in the tail, it serves as the eye of another bird positioned beneath the tail.

Equally, if not more noticeable, is the rounded triangular shape. Again because there are smaller symbols within a larger, on more clearer examples, the margins of the various sizes were revealed by LIDAR features. Smaller symbols can appear in the corners and/or centered in a larger. Once familiar with it's symmetrical shape, it is strikingly obvious.

Illustration 1: Initial sketch layer of area between the tail of the effigy and parking lot. The image is darkened to show 1 & 2 pixel dots. Green=bird, red=triangle motif.

Once these often subtle diagnostic shapes can be recognized and understand their relationship to each other, recognizing
the symbol and either in free hand tracing or using a template becomes not a question of pareidolia but one of predictability.

Examples are shown in illustration 3 where magenta arrows indicate a bird head facing the ravine, and yellow and red arrows indicating subtle color differences. There are numerous examples where three distinctive similarly shaped and evenly spaced LIDAR features are located at the top of a bird head and tail tip and which will match up with a properly sized bird template (blue, green arrows). These features are particularly obvious on the flat areas of the New Love site (Ill. 2).

When the bird template is sized to most accurately match sketched dots and untraced LIDAR features, it is flashed off and on, or reducing opacity, to confirm it's placement. The template is then duplicated, horizontally flipped and positioned by the same procedure. One side may produce more confirming untraced features than the other, if so, adjustments are made accordingly. Because additional symbols are formed from another by the conventions previously explained, great care is taken in achieving the best alignment as is possible with the visual information available to avoid compounding an error and skewing a size comparative study discussed later.

The critical component of the procedure is the bird template. The template used in this study was prepared from a tracing done from a 6K x 4K macro photograph of an exceptionally clear ~6" example on a large rock at the Interpretative Center at Battleground, Indiana. Despite inherent vagaries associated with tracing, it is a accurate as possible representation of the bird profile. Though it has previously worked successfully on a wide range of examples, it does not exactly match the geometry upon which it is based (Illustration 4). After placing several templates, I was surprised that no rotation was needed, until realizing the LIDAR images had a north/south orientation and is not different from the symbols north-south orientation found on other surfaces.

Illustration 3: Arrows indicating distinctive features, Serpent Mound

Illustration 2: Arrows indicating the distinctive group of three Lidar features at head and tail of bird motif, New Love Mound Group, Ohio
Briefly explained, findings indicate the symbol is based upon or has parallels with ancient Hindu Vedic texts known collectively as the Śulvasūtras. Four of these include geometric based measurements to be sequentially followed in the construction of falcon and symmetrical shaped sacrificial fire altars. One of these texts is dated c.800BCE.

The various altar shapes, along with a corresponding verbal ritual, are constructed for a specific heavenly request. Two of these shapes are the triangle = “for those with many foes” and several falcon shapes = ”for those desiring heaven”. The altars had a one time use and had to be rebuilt in one “unit” larger which will be discussed later.

The shapes are formed using a rope and stake method following a prescribed sequence. The first step however is to determine the cardinal compass directions, with the east-west orientation the most important.


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4 Thanks to Cynthia J. Huffman, Ph.D. and Scott V. Thuong, Ph.D., Pittsburg State University for permission.
Serpent Mound Graphics with Interpretation

A surprising aspect of the tracing study was how effortlessly the bird template could be positioned on the LIDAR images. While the natural arcing and tapering shape of the hills in the area somewhat mimic the shape of the bird template, one gets the impression that in some areas that land sculpturing occurred. An example is the curvilinear feature on the slope facing Brush Creek (Ill. 6). It is not known if this is a natural or manmade feature, but it does match the anterior margin of at least two birds, with the green bird posterior margin following the edge of the upper elevated area. Within the green bird head is an untraced circular feature giving the impression of an eye (Ill. 7).

The large bird in 7 was positioned based principally on sizing the tail to correspond with the V shape topography and other features along the posterior margin. The bird's eye is the large Adena mound located near the curved parking area. Presumably there are other slightly different sized birds occupying this area.

The placement of the birds in 8 are considered reasonably accurate because the large bird eye is positioned anatomically correct and the green bird head is properly positioned to be the left bird of an untraced symbol located in the tail. This is mentioned to illustrate that because of the previous listed conventions, there are multiple reference points that confirm the placement of a template. If these do not appear, then the template is probably misplaced or an incorrect size.

As will be seen and discussed later, there appears to be a positional relationship between the symbol and the serpent and burial mounds. Before leaving these graphics please note the triangle appearance of the end of the elevated area and the overall site's resemblance to a bird head.
The following graphics are included to illustrate the great effort expended to complete a symbol. This has only been seen before on a large scale at the \( \sim 12^{th} \) century Church of St. George (of dragon fame) in Ethiopia, where large birds span the height of a three story building with their heads on top of a flat roof all while maintaining a correct shape.

Illustration 10 provides a marginally diagnostic view of the near vertical slope west of the shelter house but does reveal features that could be traced with confidence that suggest human intervention. The red dots indicate defined margins of a triangle shape. At the top of the slope, are two examples of the familiar rounded “V” shape of bird head pairs (green).

The green dots within Brush Creek mark the ends of underwater curved features which conform to the tail and symbol. The right side, which is less defined than the left, is aligned with a prominent untraced fissure that extends up the slope. The left side maybe there but cannot be clearly seen. However in 11, more distinctive features can be seen which align with tail templates. The LIDAR features indicated by the lower two white arrows are indicative of routinely seen features which just don't look natural and conform with symbol margins. A possible example of this may be the isolated rocks in a “V” formation located on the narrow east bank (Ill. 12). For reference, they are located near the left green dot in illustration 10.
Close inspection of a Google Earth unprocessed image and various software enhanced versions, clearly show curvilinear lines of partially submerged and underwater rocks that correspond to symbol margins.

Initial tracings were done in green, followed with template overlays which could be applied and sized with ease. As with the balance of templates in this study, these did not require any rotational adjustment.

Two attempts to inspect and plot these features failed because of water level and turbidity which also prohibited underwater photography and video. It is planned to revisit these features when better conditions prevail.
The extent of the geoglyphs was surprising. Despite the large FOV, pixel density permitted magnification which provided sufficient detail of smaller features which aided placement. The areas north, east and south of the effigy site proper, provided more and clearer diagnostic features than from the site itself. These included two clear examples of the tripartite bird headdress (Ill. 16).

Illustration 15: Large area view showing symbols north-south orientation along Brush Creek valley.

Illustration 16: Tripartite headdress
One of the more compelling areas suggesting land sculpturing is shown below. The shape is confirmed by the equilateral symbol template and proportionally sized bird. Other triangle examples are shown in 21.

The larger of the two smaller birds was placed by using the V shape at the top of the slope and arcing features for the head. The smaller was placed using barely discernible features at the tail and sized to conform to the enigmatic feature protruding from the serpent head.

**Illustration 17:**

**Illustration 18:**

**Various Serpent Mound Graphics**

**Illustration 19:** Other triangular areas including on which is not marked
Illustrations 20, 21: Template aligned to margins of unknown darker area. Top margin of next larger head is visible as are other symbol margins.

Illustration 22: 130px 260px 520px template doubling sequence

Illustration 23: 35, 50, 70, 125, 130, 150, 180, 260, 275, 375, 520px templates
Illustration 24: One example of experimentations with the “Golden Spiral”

Illustration 25: Select layers from this specific study

Illustration 26: Google Aerial Overlay
Other Ohio Sites
Glenford Enclosure, Perry County, Ohio USA
This image sequence of a bird shape hilltop enclosure illustrates an inherent limitation related to human visual perception, which can be summarized “you don't see what you are not looking for”. In illustration 27, it's author identified: arcing features, three similar shaped round features, and red traced curving parallel lines coursing from the Central Mound area. It is not known the reason for doing this, but importantly he did see the features.

Similarly, in a paper reporting results from artifacts found at the Page-Ladson site in Florida, the author in a lengthy paragraph goes into excruciating detail describing the maze of parallel and intersecting curving lines on a 14,000 BCE mastodon tusk shown below.  

Illustration 27: Graphic courtesy of Jarrod Burks, Ph.D.

Illustration 28: Authors interpretation based upon tracings in 27

Illustration 29: from Jessi J. Halligan, by author

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5 Art Analysis of fig. S31. Composite photomicrograph of new cast made from Webb’s patch mold (24).
These examples illustrate one of the reasons the symbol has not been recognized. Though essentially a simple symbol, it is exceedingly complex because it differs from the one symbol per surface area we are accustomed to seeing, and further more, most often the margins are very subtle. With respect to the later, in a unscientific experiment, people chosen at random, were shown the image in 29 on an iPad and asked the following question: “Do you see a large familiar shape”? The following two hints were used if needed: “It is a symbol that has curved edges and is associated with a day celebrated annually”, followed with “It is a symbol associated with Valentines Day”.

No one could initially identify the “heart” shape, however one did see a “face” which the symbol does resemble. After the first hint, 2 people pointed to the symbol and could outline it. After the second hint, 5 people could recognize it and responded with some astonishment they had not see it before.

Illustration 30: Triangle altar shape, additional layers added
New Love Mound Group, Clark County, Ohio USA

This site was exceptionally easy to work with because of the flat terrain, well defined contours and numerous examples of 3-4 evenly spaced similar LIDAR features mentioned earlier. Also, the triangular shape was quite distinctive in a number of locations which is an important landmark in applying and sizing the bird template. No rotational adjustments were required.

The heart shape in 31 illustrates an unresolved question regarding the symbol shape. This shape is formed by two birds rotated so their tails join forming a cartouche around the symbol. The heart shape is routinely seen but not in great numbers. It is not known if this is incorporated on all symbols and cannot always be seen, or if it is a separate symbol.

As a side note, the heart shape has an interesting and long history before appearing on Valentine cards and is discussed in more detail in a previous paper on Serpent Mound.

Illustration 31: Heart shape formed by subtle difference in elevation.

Illustration 32: 2 to 1 length/width ratio rectangular altar substitution, New Love Mound Group, Clark County, Ohio
Other Examples
Junction Mound, Ross County, Ohio USA

Illustrations 33, 34: Images from Jarrod Burks, by author
Poverty Point, Louisiana USA

Illustration 35: Earthen mound locations relative to golden spiral, Mound locations from William F. Romain and Norman L. Davis by author

Chaco Canyon Holmes Group, New Mexico USA

Illustration 36: yellow=mound, image from Richard Friedman by author
Aztalan, Wisconsin USA

Illustration 37: from Romain and Nelson, by author

Baking Pot, Belize CA

Illustration 38: Image from http://www.mdpi.com
Discussion

The introduction of Vedic altar design specifications into the research provided a needed historical source supporting previous results. Equally important provides a mathematical basis for testing the symbol's variable size.

At this time there are two known formulas. One method is explained by James L. Kelley.\(^6\)

“[T]he sacrificer is instructed to build a falcon-shaped altar of seven unit squares: four squares for the body, one for the tail, and one each for the wings. In an ascending order of sacredness the next altar is to be built in the same shape, but one unit square larger and so on until the altar is one-hundred-and-one times as large as the first”

The other is less complex and requires that falcon and other shaped altars be doubled in size.

In a test using the doubling formula, the pixel width of 34 bird templates in one Serpent Mound imaging study were rounded (e.g. 86=85, 128=130). Three were excluded because their doubled size exceeded the largest size template used. A simple average resulted in 55\% of the templates having a double. Those without a double deviated either 10 or 20 pixels from the closest double, with two outliers at 50 and 60 pixels. While initially thought disappointing, when considering the incalculable number of symbols not traced, the result may be understated.

A far more simple experiment of the doubling formula is shown in illustration 22. The 130px template, which was known from a previous exercise, was placed on a new LIDAR image, duplicated twice in a 260px and 520px size and then both effortlessly positioned in place.

A trial and error method in sizing and rotating the Golden Spiral suggests that the geometry associated with it is a basis in determining the sizes and locations of other symbols. The best results occur with placing the start of the spiral at the tip of the triangle motif. In many attempts the spiral passes thru existing earthen ceremonial structures and public architecture in the Belize example.

Four templates required more rotation than the occasional $1-2^\circ$ adjustment for best fit. Two birds, a smaller one within a larger, at Serpent Mound required -26.7$^\circ$ from north, and two triangles at Junction Group required -25$^\circ$. Although there was little ambiguity in how the templates should be placed at both sites which seems to minimize the possibility of misinterpretation, this remains a possible explanation. What makes this outliers intriguing is that it occurred at two different sites with, for all practical purposes, the same rotation. Because nothing in this exercise indicated randomness and suggests another explanation.

**Conclusions**
The purpose of this imaging exercise was to demonstrate the presence of large scale geoglyphs and acquiring additional data confirming that the enigmatic symbol exists. Both objectives were met for the following reasons.

As principally a visual based experiment, one compelling result is the lack of effort required to place and size the templates. Being the first time using LIDAR images, it did not take long to start recognizing the repeatable visual cues and shapes identifying the symbol. Because of this and the predictability of the symbol, completing an illustration is merely a methodic repetitious task.

As was evident in many cases, a presumed later in time earthen mound is positioned as the eye of or in the tail of the bird template which strongly suggests their location is based upon the antecedent symbol. The lack of accompanying earthen birds suggests a change in burial practices occurring during the Adena use of the site. The mounds positioning along the trajectory of a Golden Spiral leading from the symbols further supports the symbol's geometry basis.

Notably, Serpent Mound and Glenford, each had a particularly unambiguous triangular altar feature diagnostic to the symbol which is most dramatically presented by the Central Mound at Glenford. As was personally learned during the overall research, the triangle shape is the most unrecognized shape in Pre-Contact symbology. It is believed that it's use started to wain during Adena and by the Mississippian Period it disappeared. The reasons behind the introduction of serpent effigies in eastern North America continues to be confusing and not well understood. It is likely the serpent, and the symbol's bird motif ultimately were conflated into the “Feathered Serpent” character known by many names in Western Hemisphere mythologies.

This initial foray into the geometry of Pre-Contact symbology provides a basis for future math related research, and as a cultural fingerprint, the symbol is an avenue for better understanding human global diaspora.
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