2026 SURVEYORS' Conference

Measuring Ancient Works

Don Teter, PS

JANUARY 11-14,2026 | HERSHEY, PA

Measuring Ancient Works

Presented by

Don Teter
Assistant Professor
of Surveying

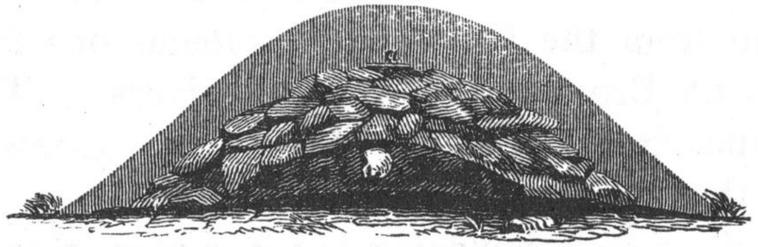


Fig. 199.

The Builders

"I can testify to little beyond the giant Mounds
that the Savages say they guard as Curators,
for some more distant Race of Builders.
I have fail'd to observe more in them,
than their most impressive Size,
tho' Mr. Dixon swears to Coded Inscriptions,
Purposive Lamination,
and Employment,
unto the *Present Day*,
by Agents Unknown of Powers Invisible."

Charles Mason, in Mason and Dixon, by Thomas Pynchon

Ancient Aliens?

"… from everything the physical anthropologists can tell us, there is no reason to think that the people of two thousand years ago were any less intelligent or clever than we are today. Indeed, we can assume that the Hopewell were our cognitive equals. William F. Romaine

Adena (Early Woodland),
1,000 BC – 200 BC

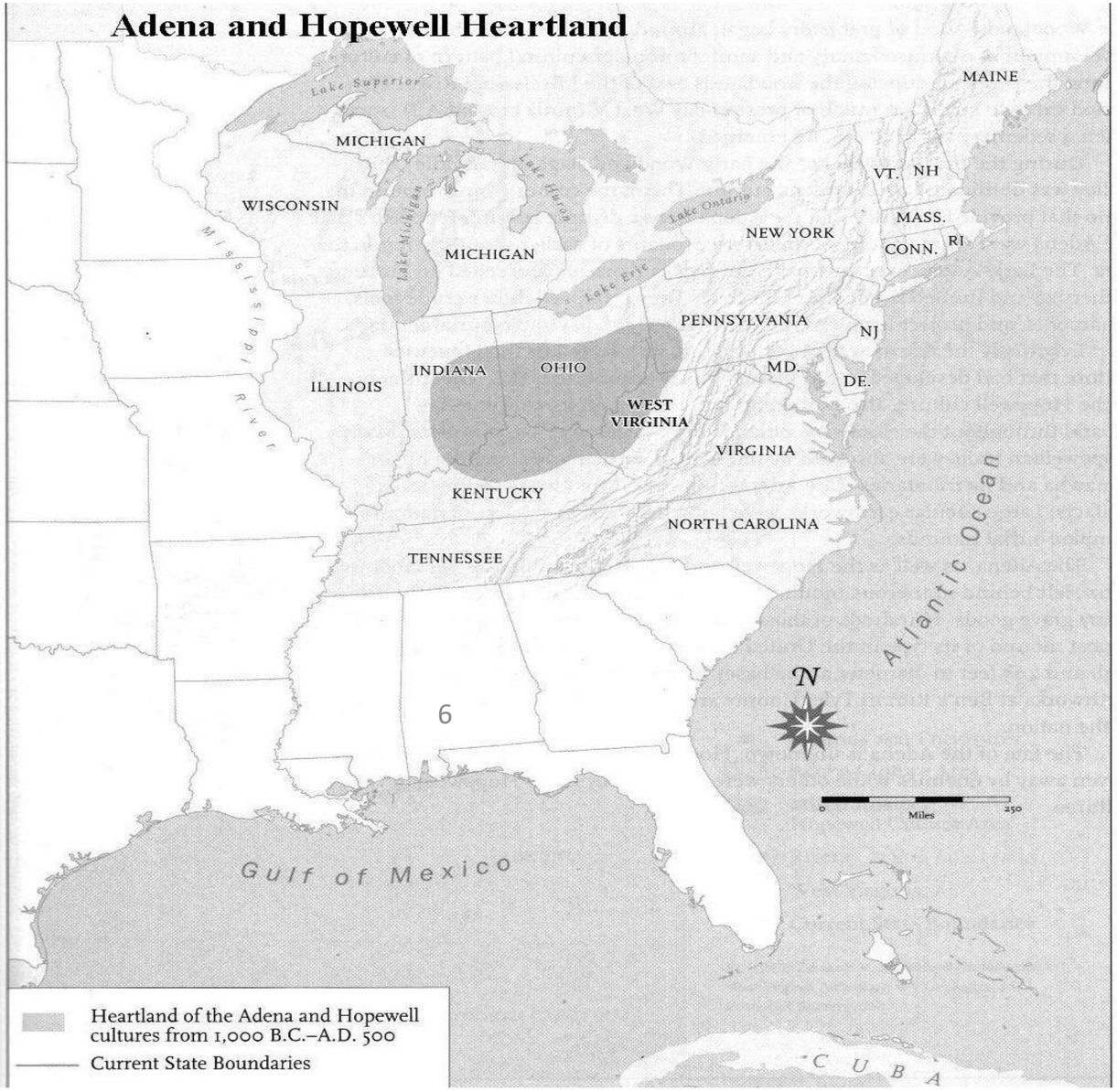
Hopewell
200 BC – 500 AD

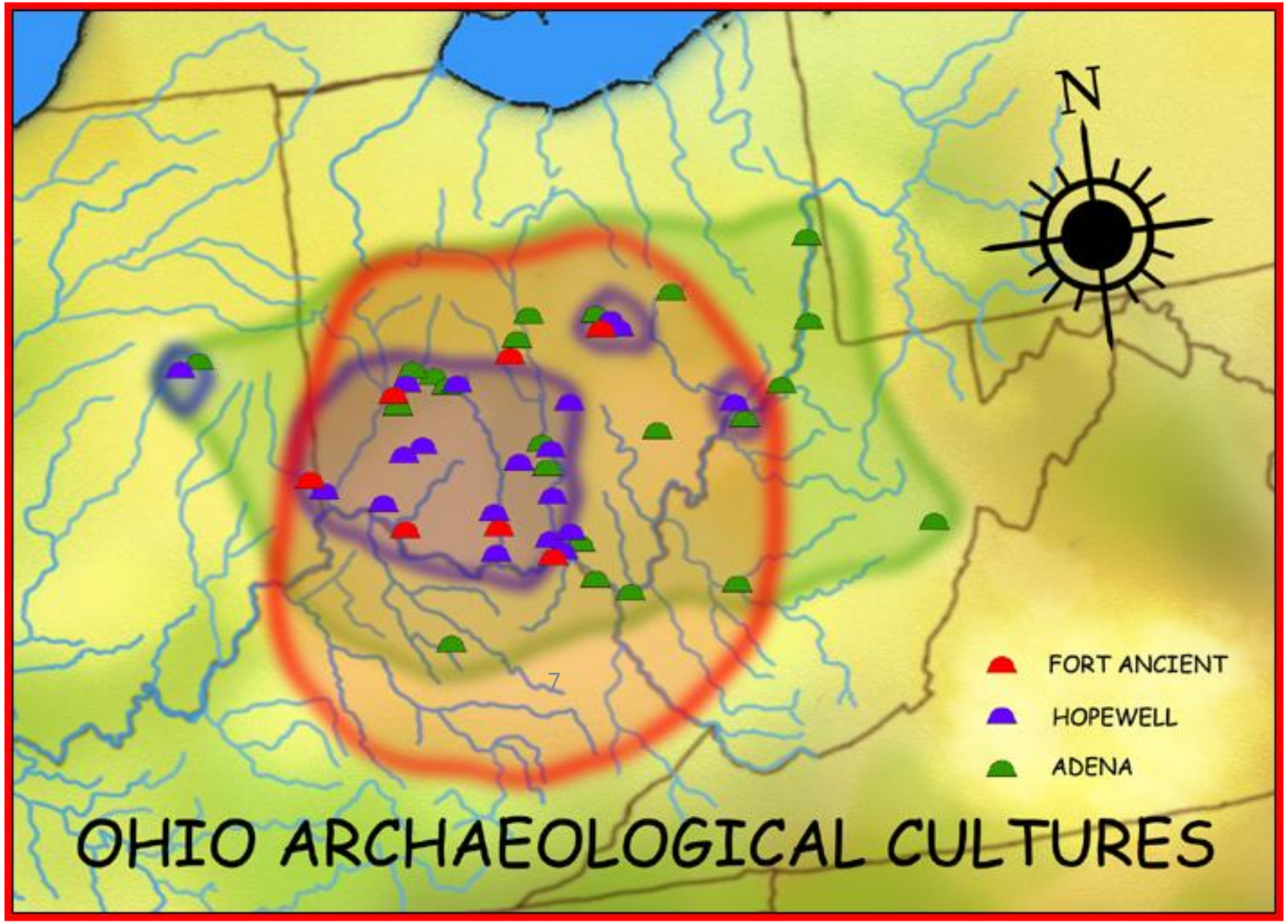
Late Woodland
500 – 1000 AD

Mississippian
800 – 1600 AD

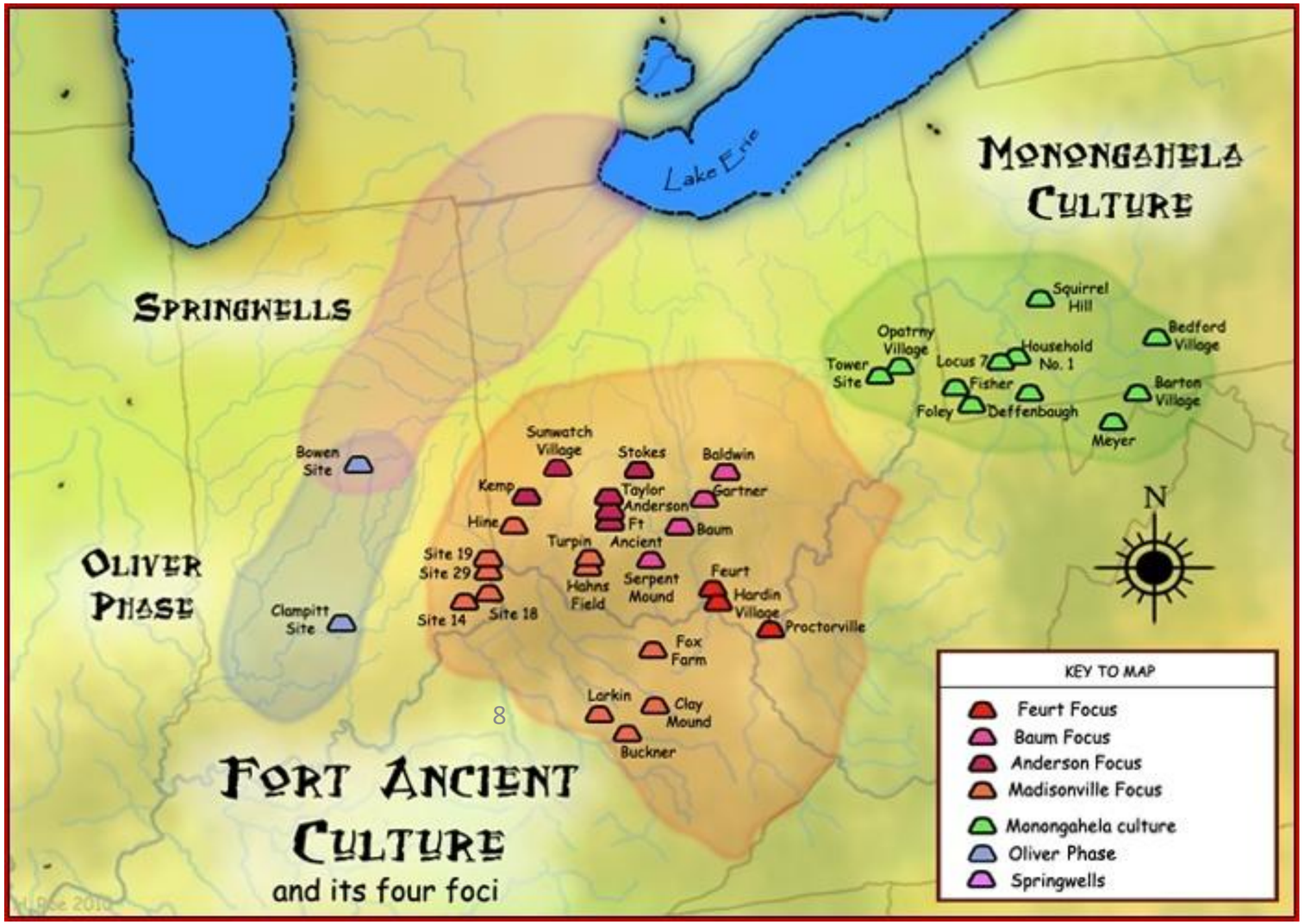
Fort Ancient
1000 AD – 1750 AD

Monongahela
1050 - 1635


Adena and Hopewell Heartland
Lake Superior
MICHIGAN
WISCONSIN
Lake Michigan
Lake Huron
MICHIGAN
Lake Ontario
NEW YORK
Lake Erie
MAINE
VT.
NH
MASS.
CONN.
RI
PENNSYLVANIA
NJ
MD.
DE.
Mississippi River
ILLINOIS
INDIANA
OHIO
WEST VIRGINIA
VIRGINIA
KENTUCKY
NORTH CAROLINA
TENNESSEE
Atlantic Ocean
N
0
Miles
250
Gulf of Mexico
CUBA
Heartland of the Adena and Hopewell cultures from 1,000 B.C.–A.D. 500
Current State Boundaries



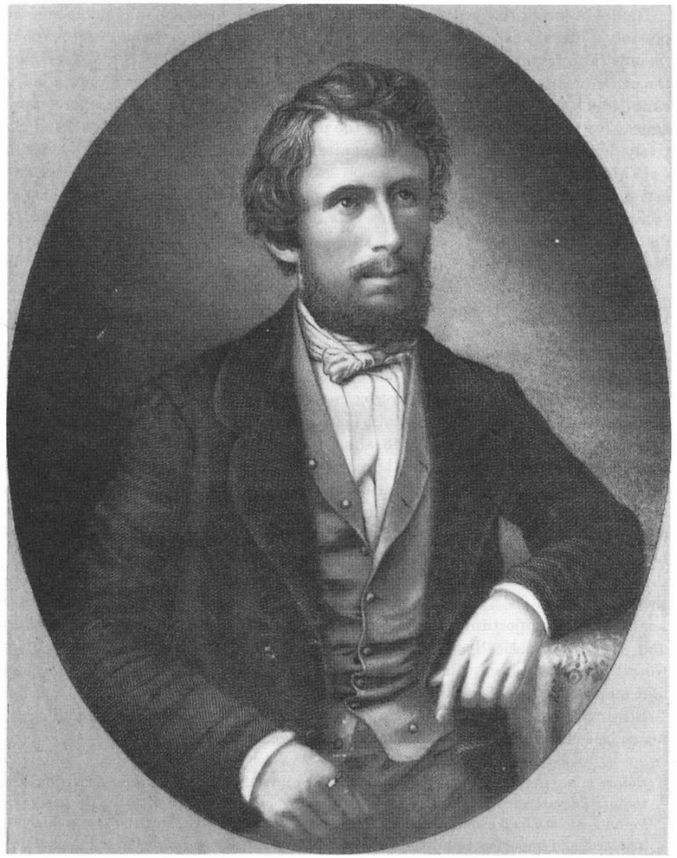
Heironymous Rowe, Wikimedia, 2008



Heironymous Rowe, Wikimedia, 2010

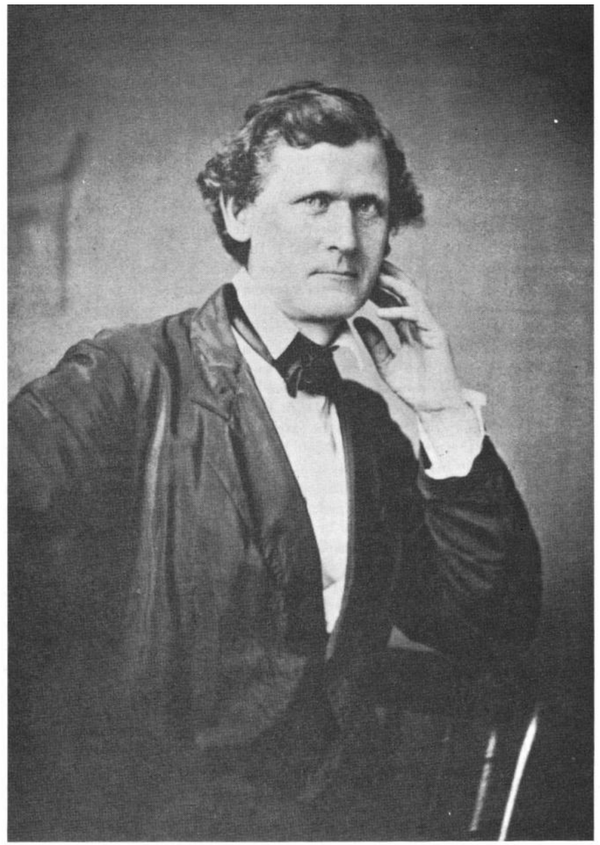
The “Discoverers”

Squier & Davis, 1845-48



Ephraim George Squier. Courtesy of the National Anthropological Archives, Smithsonian Institution

Ephraim George Squier, 1821- 1888;
studied engineering, edited *Scioto Gazette*

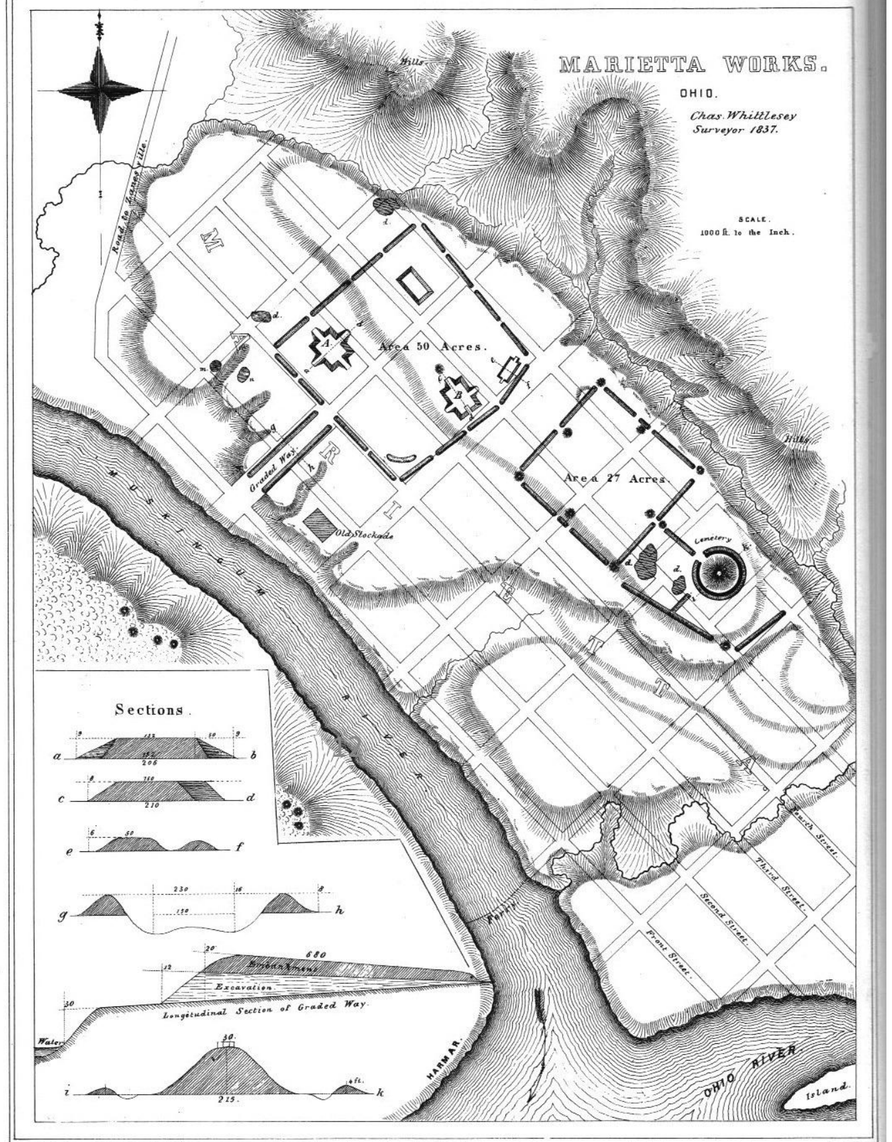


Edwin Hamilton Davis. Courtesy of the National Anthropological Archives, Smithsonian Institution

Edwin H. Davis, 1811- 1888;
practiced medicine in Chillicothe

... the only mode of acquiring information
was to take the compass and chain
in one hand and the mattock in the other
and go into the field in person."
-- Ephraim Squier

In 1848 the Smithsonian Institution published:
Ancient Monuments of The Mississippi Valley:
Comprising the results of extensive
original surveys and explorations
by E.G. Squier, A.M., and E.H. Davis, M.D.



Face P. 73.

Lith. by Sarony & Major

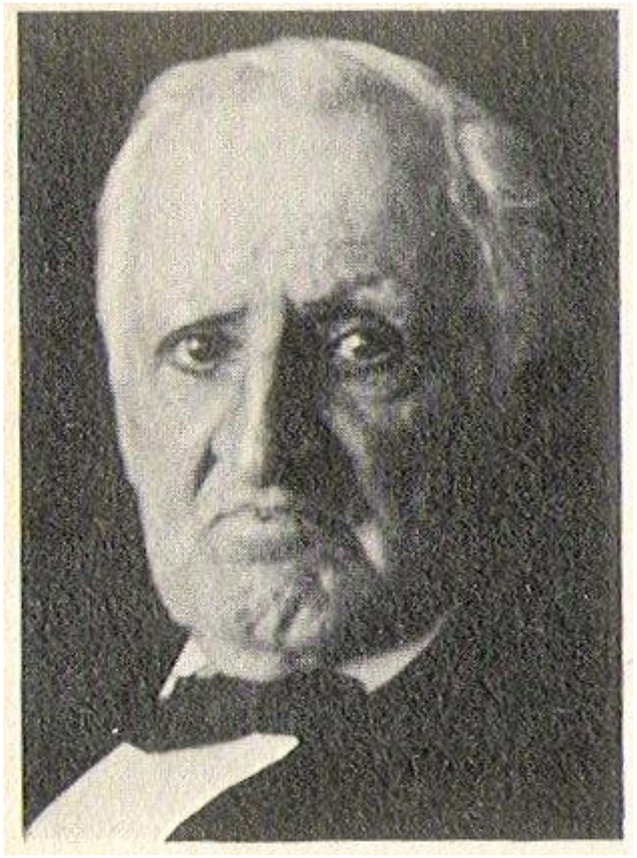
The "Moundbuilders" Myth

The Cincinnati Chronicle, February 2, 1839:
"There are circumstances which
go to show that the period
of the world at which this
gigantic monument was erected,
was very remote, perhaps more than
four thousand years before the flood."

Ancient Monuments is one long argument that the moundbuilders were a numerous, widespread, and homogeneous race of semi-civilized agriculturalists, deeply religious and of necessity militaristic, whose monuments, customs, symbols, artifacts, and cranial anatomy bore unmistakable traces of a deep historical connection to the semi-civilized peoples of Mexico and Peru.”

David Meltzer, 1988

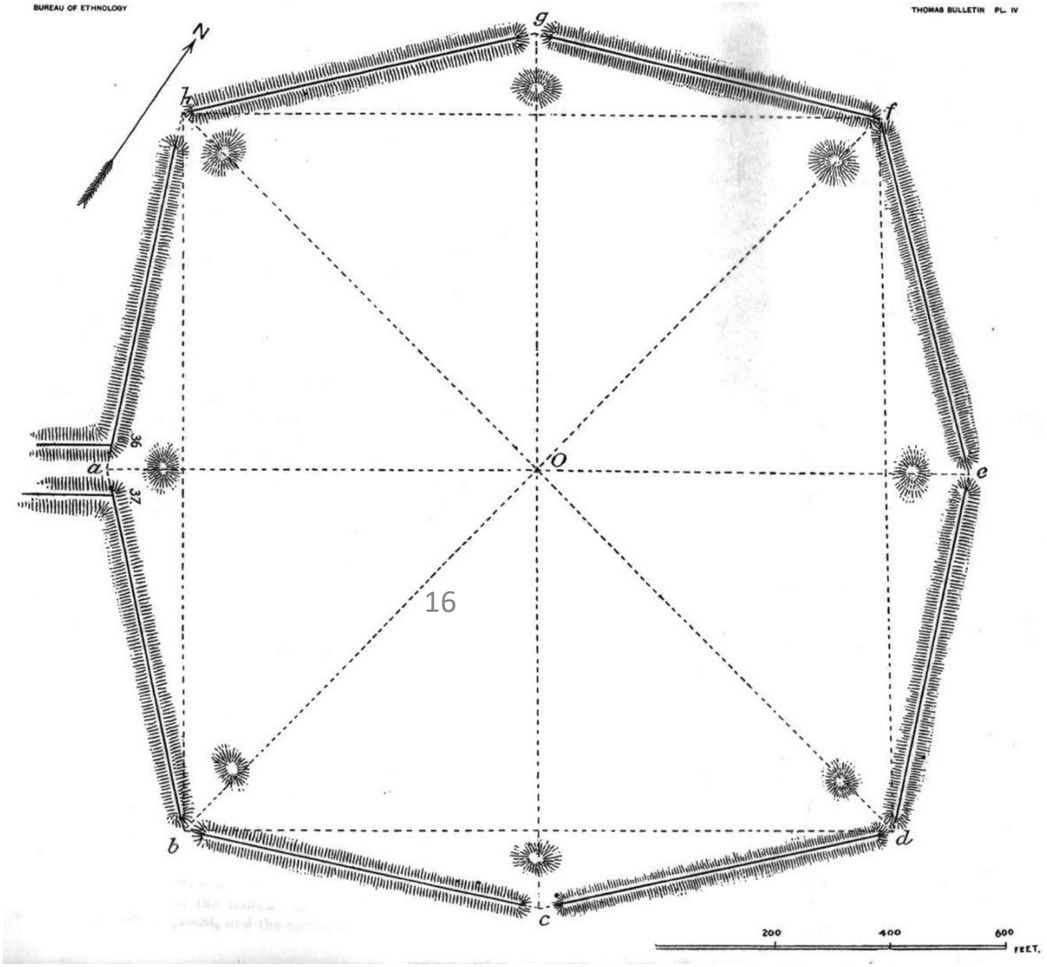
The “Discoverers”, 1880’s-90’s



Cyrus Thomas, 1825- 1910;
Associated with the Smithsonian;

Debunked Moundbuilders Myth
Criticized Squier & Davis

Thomas plat of the Newark Octagon



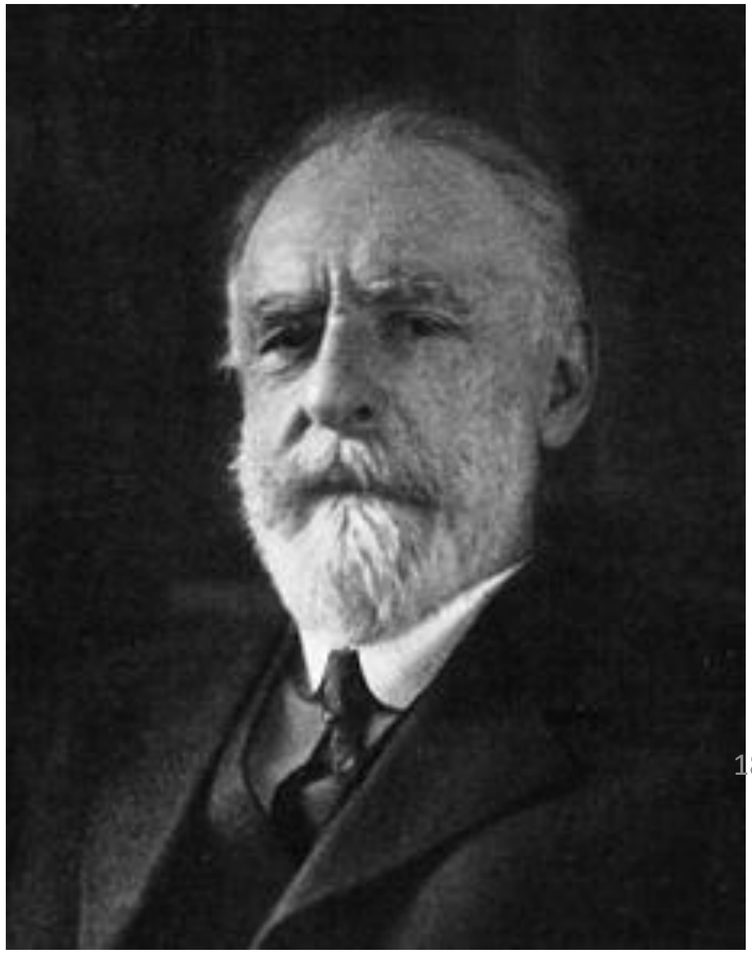
Notes for Thomas plat

Survey of the Octagon.

Station.	Bearing.	Distance.	Width of wall.	Height of wall.
	° ′	*Feet.*	*Feet.*	*Feet.*
36 to 37	S. 36 32 E	82		
37 to *b*	S. 49 41 E	580	40 to 43	5.7 to 4.5
b to *c*	N. 64 18 E	624.5	37 to 48	4.3 to 4.2
c to *d*	N. 39 50 E	625	47 to 39	5.9 to 5.8
d to *e*	N. 25 28 W	622	41 to 50	3.4 to 3.5
e to *f*	N. 51 32 W	621	40 to 37	2.5 to 2.6
f to *g*	S. 65 40 W	613	47 to 43	3.8 to 4
g to *h*	S. 39 15 W	621.5	45 to 47	4.3 to 4
h to 37	S. 25 40 E	581.5	43 to 41	3.8 to 3.7

Thomas also noted the diagonals crossed

Each other at nearly perfect right angles



Frederic Ward Putnam,
1839- 1914;
Peabody Museum
at Harvard University

Putnam was instrumental in the preservation of the Great Serpent Mound.

In 1890, F.W. Putnam:
"a symbol of the old serpent faith, … from
…the religions of the East …?"

"The serpent …, in combination with phallic
and solar worship, …extended from
Central America to Peru and Mexico."
He saw the "egg" in the Great Serpent's mouth as
"… several symbols which in Asia would be accepted … to
be a phallo-solar shrine combined with the serpent faith."
Overall: "the fulfillment of special religious rites
connected with the older faiths, which, …had their greatest
development in Asia, which …we have reason to consider as
the original home of the brachycephali,
one of the early peoples of America."

Adena

Small settlements, 1 or 2 buildings, paired pole walls of bark or wicker, conical roof, likely bark covered.

Several settlements scattered around mound sites.

Adena Culture

Hunted Animals and Birds

Gathered Seeds and Nuts

Cultivated Pumpkin, Squash, Sunflower, Goosefoot

Adena house, Wikimedia, Siyajkak, 2005

(Hopewell) Fort Ancient reconstructions, 2017

Adena Mounds

Generally circular,

20-300 feet,

ceremonial and burial.

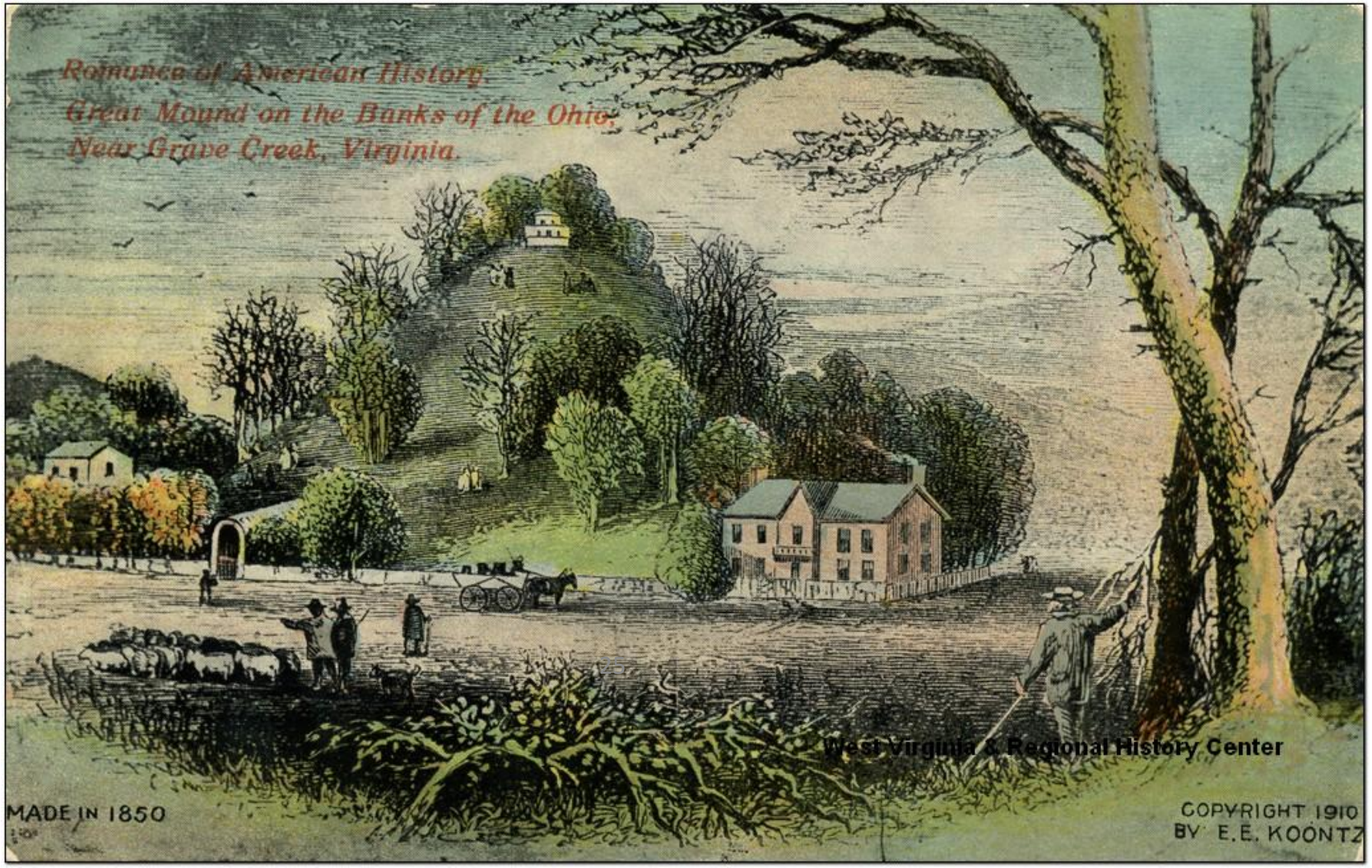
Layers built up with

burned mortuary structures

and earth;

Hundred of thousands

of wicker baskets of dirt



Grave Creek Mound, 1910 postcard, 1850 illustration.
Mound reportedly 69’ high, 900’ circumference.
West Virginia and Regional History Collection.

Squier visited in 1846

Reported it 70’ high, 1,000’ circumference

Had been excavated in 1838, two skeletons

and numerous artifacts found

Owner/excavator Tomlinson attempted

commercial development, failed,

skeletons, etc. in disarray when Squier visited

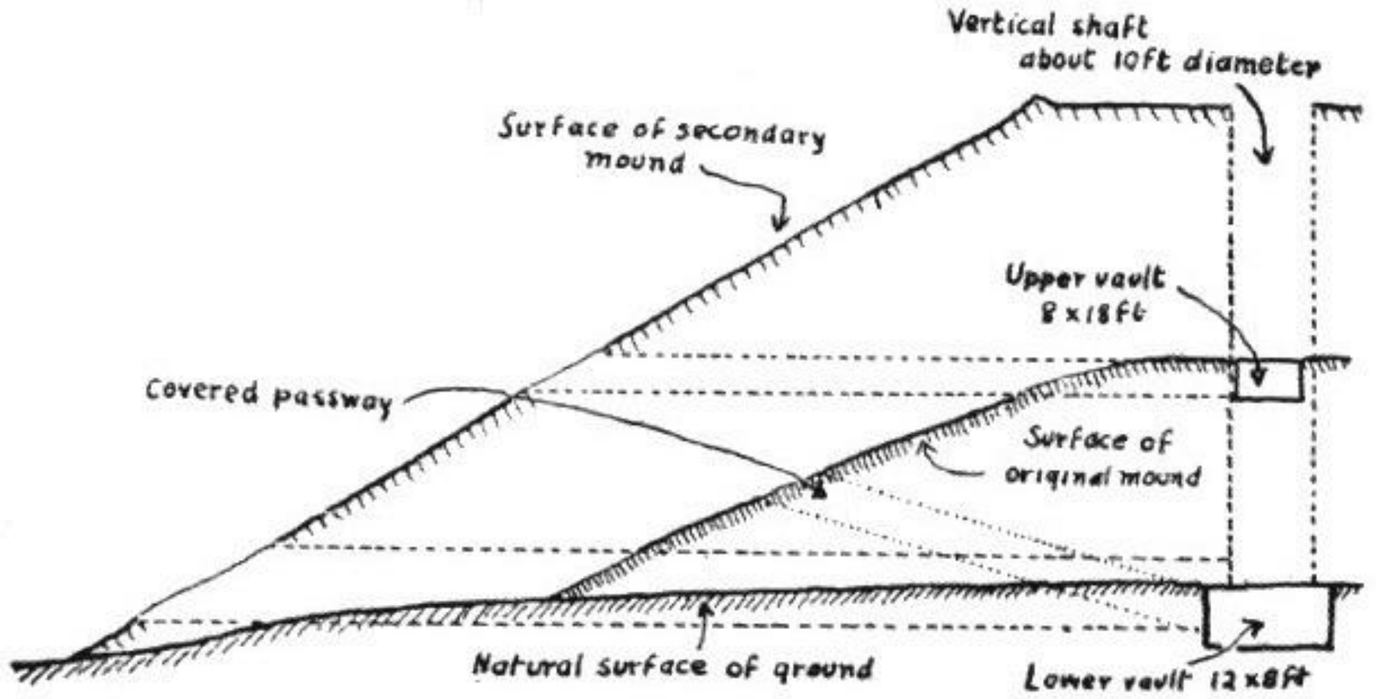
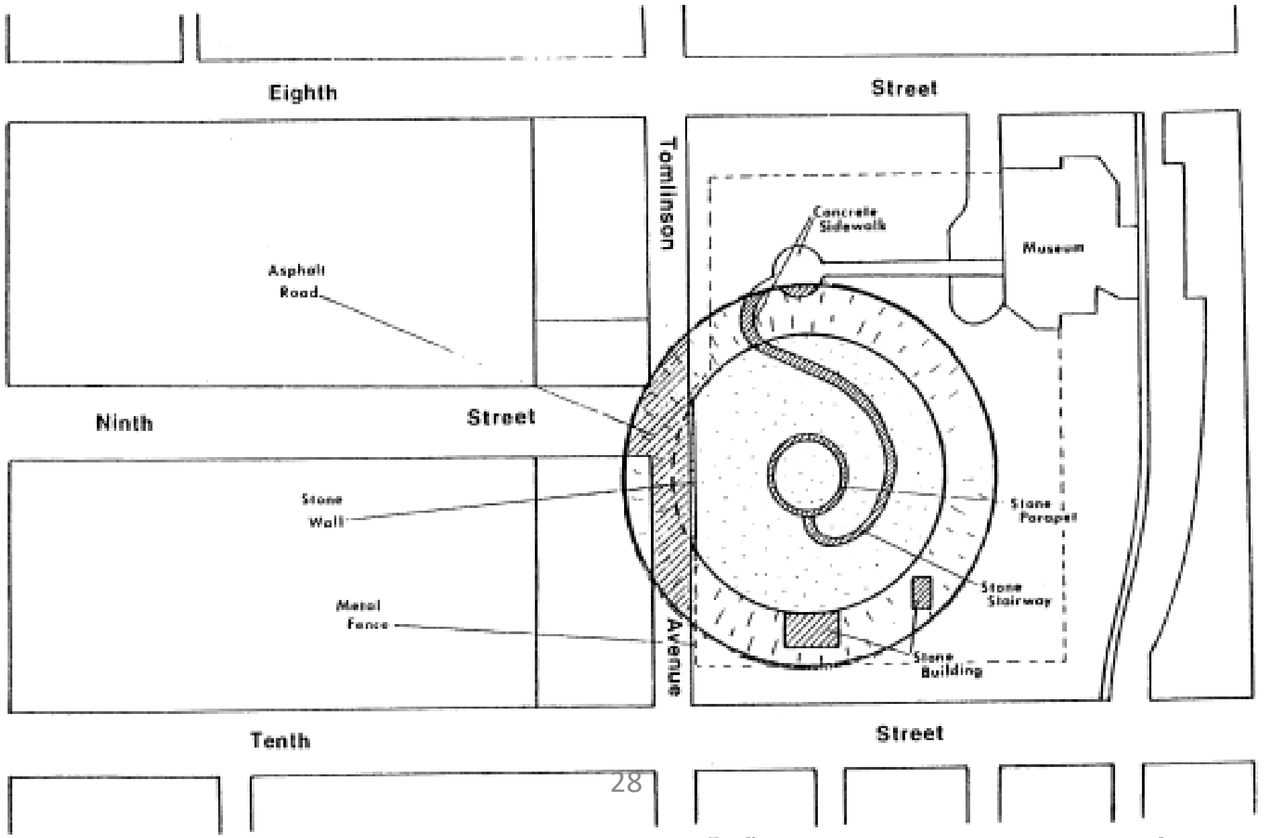


Diagram showing the original mound, the secondary mound, and excavations made in 1838.

Delf Norona's cross section drawing, 1962



MAP "A"

GRAVE CREEK MOUND

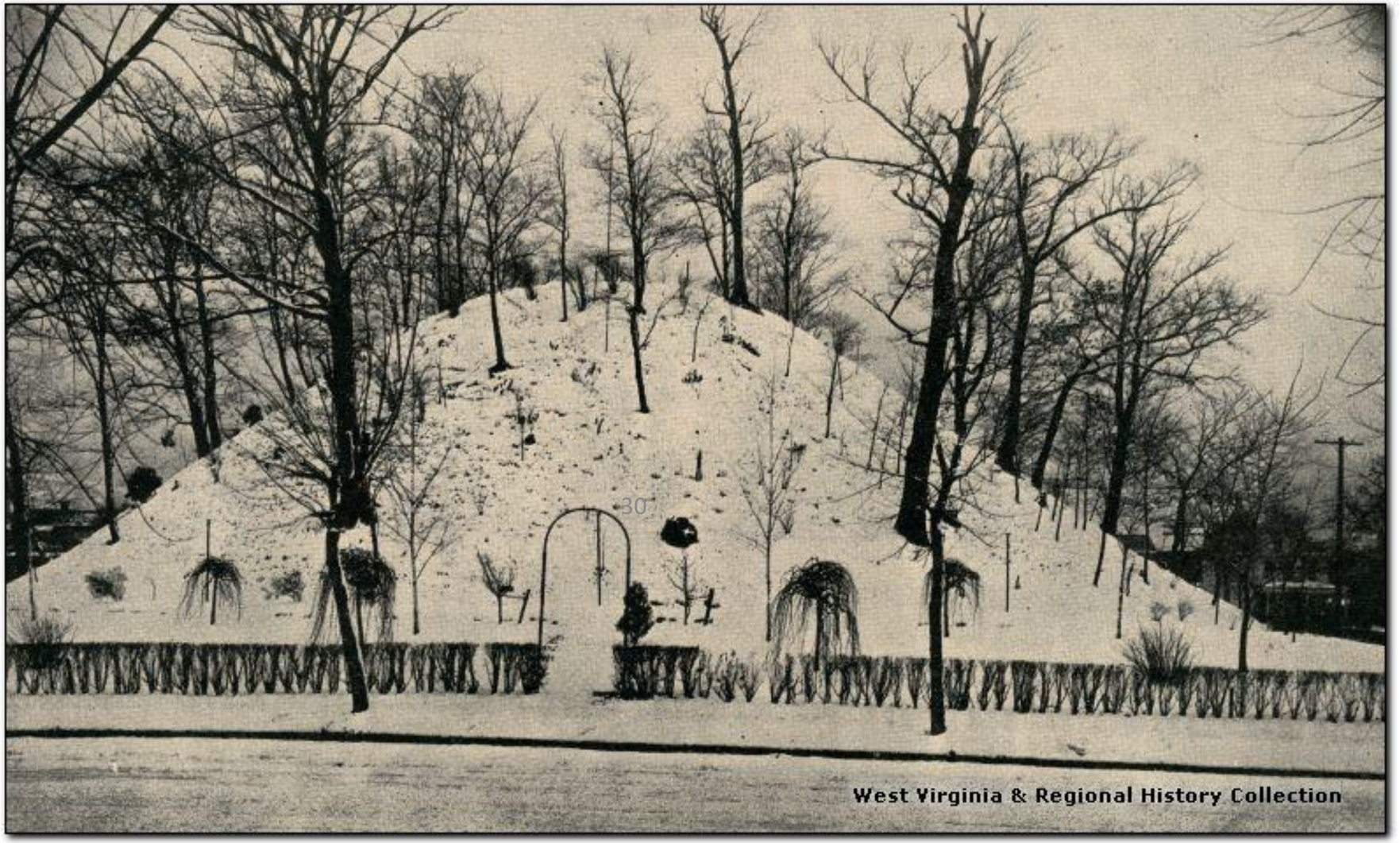
LEGEND:

- LANDMARK BOUNDARY
- Mound
- Site of Buried Moat
- Noncontributing Feature

N

not to scale

Grave Creek Mound, c. 1927



Grave Creek Mound, February 2013

View from the top.

Tourists ask:

Why did they put the mound so close to the prison?

Hopewell

"… the Hopewell were a special people who, to a greater extent than any of the peoples in eastern North America who preceded them, unlocked the secrets of geometry, developed a sophisticated system of measurement, and even came to understand the great cycles of the sun and moon."

They lived in small hamlets scattered around their ceremonial centers, each hamlet likely made up of an extended family.

Hunter-gatherers, but accelerated move to agriculture.

Extensive trading networks, Lake Superior to Florida, Carolinas to the Rockies.

Hopewell

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Hunter-gatherers, but accelerated move to agriculture.

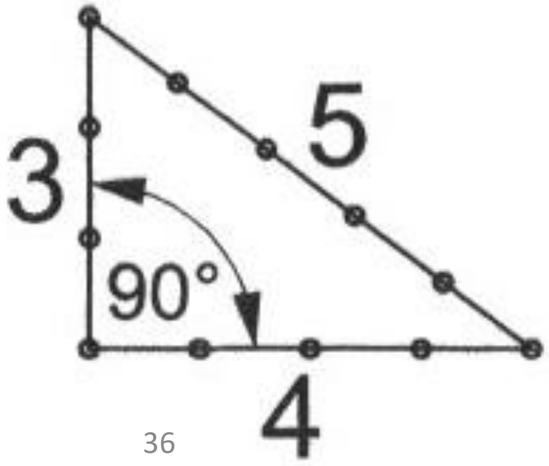
Extensive trading networks, Lake Superior to Florida, Carolinas to the Rockies.

Discovered the fabric of the universe can be described in the language of plane geometry, arithmetic, measurement and observational astronomy.

Built geometric enclosures as symbols of the universe, used a unique alignment system to tie the symbols into the solar and lunar cycles of time.

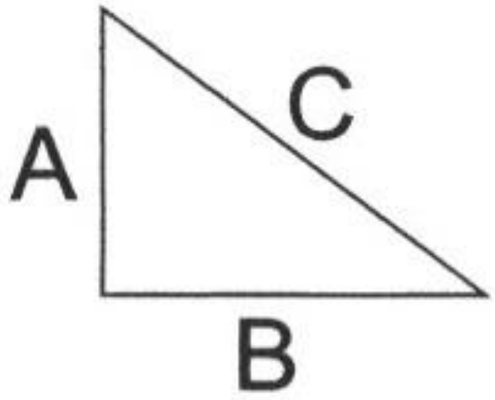
It would be worthy to investigate whether straight lines exist only in our brains.
Eugène Delacroix, 1798-1863

Druids Cord



evenly spaced knots

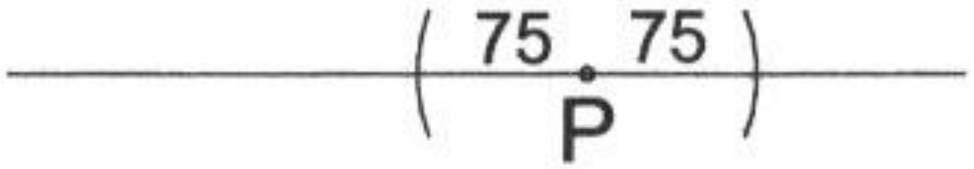
Pythagorus (c. 575 - c. 495 BC)



$$A^2 + B^2 = C^2$$

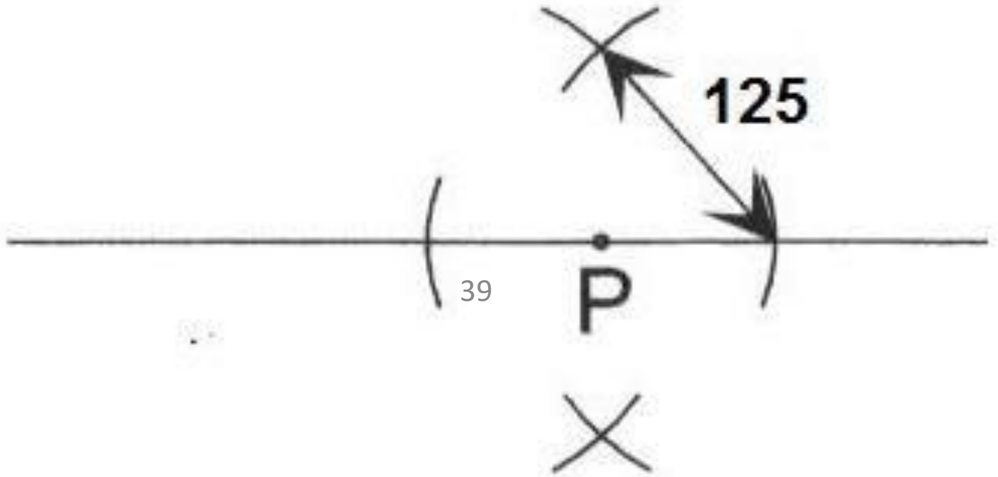
Babylonians knew some triangle results 1000 years earlier

Constructing a perpendicular
from any point (P) on a line

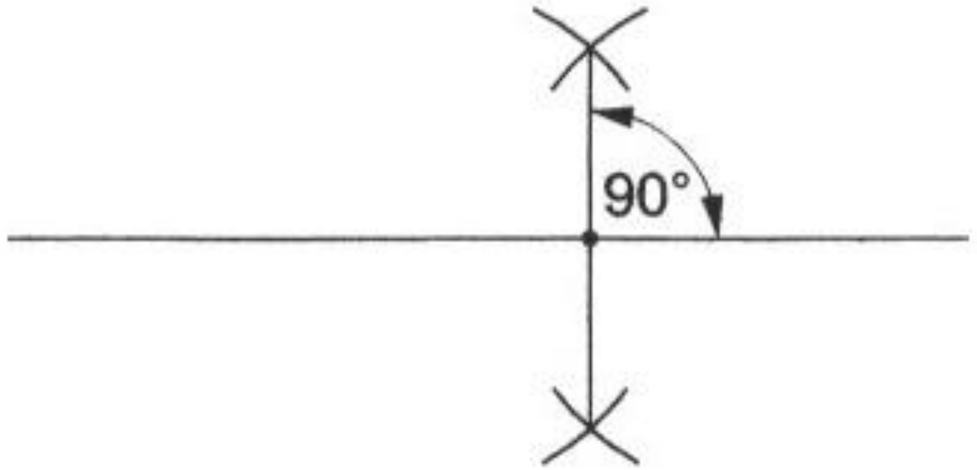


Strike arcs at same radial distances from P

From arc intersections on line strike arcs at a larger radius



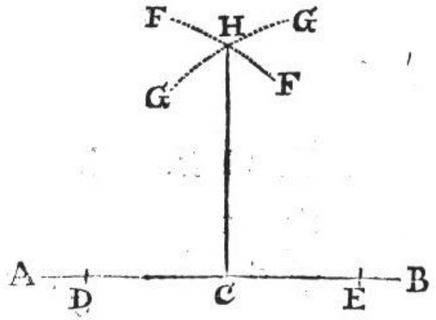
Connect the intersections
of those arcs



The Same Method By John Love in 1688

How to make a Line Perpendicular to a Line Given.

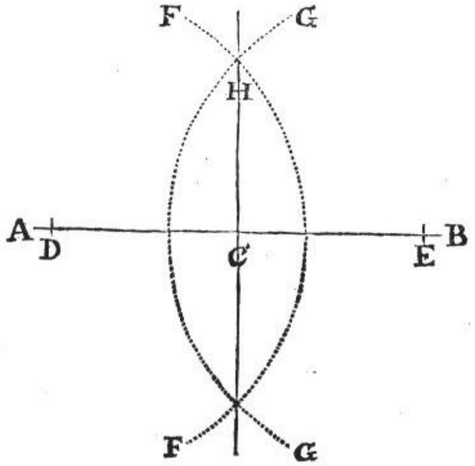
THe Line given is AB, and at the Point C it is required to erect a Line which ſhall be Perpendicular to AB.

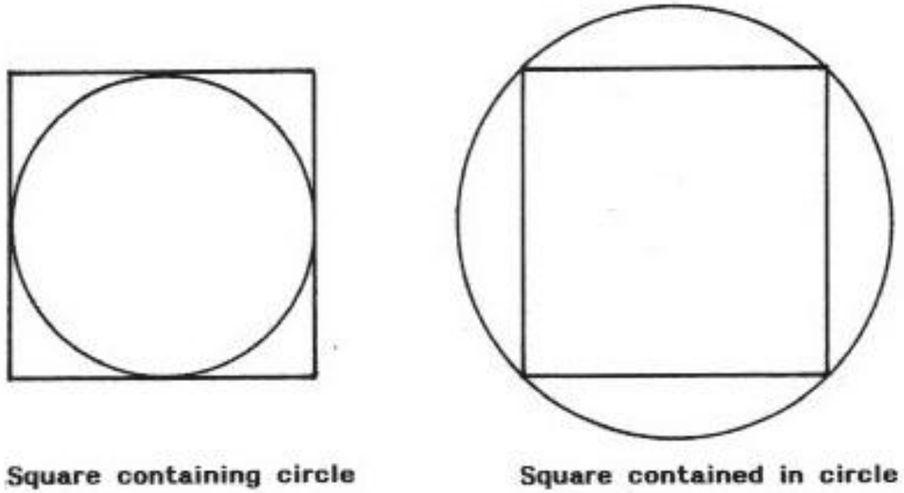


Open your Compaſſes to any convenient wideneſs, and ſetting one Foot of them in the Point C, with the other make a Mark upon the Line at E, and alſo at D; then taking off your Compaſſes, open them a little wider than before, and ſetting one Foot in the Point D, with the other deſcribe the Arch F F, then without altering your Compaſſes, ſet one Foot in the Point E, and with the other deſcribe the Arch G G.

Laſtly, Lay your Ruler to the Point C, and the Interſection of the two Arches G G and F F, which is at H, and drawing the Line H C, you have your deſire, H C being Perpendicular to A B.

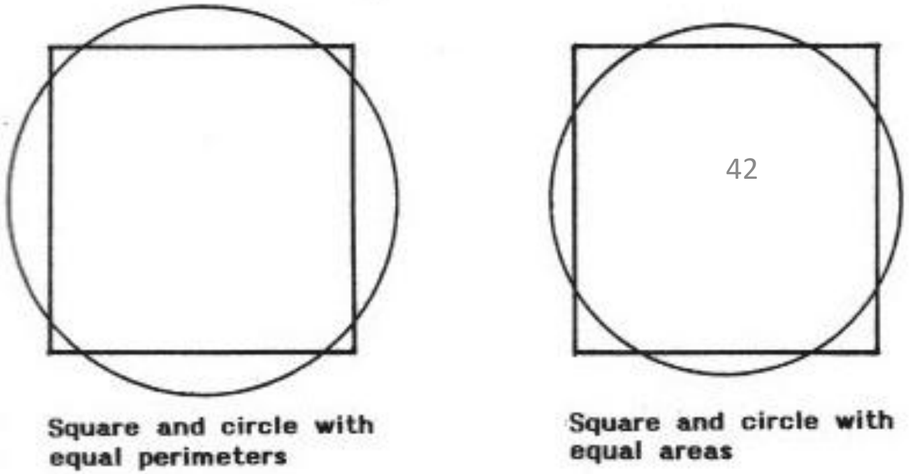
See it here done again after the very ſame manner, but may perhaps be plainer for your Underſtanding.





Square containing circle

Square contained in circle



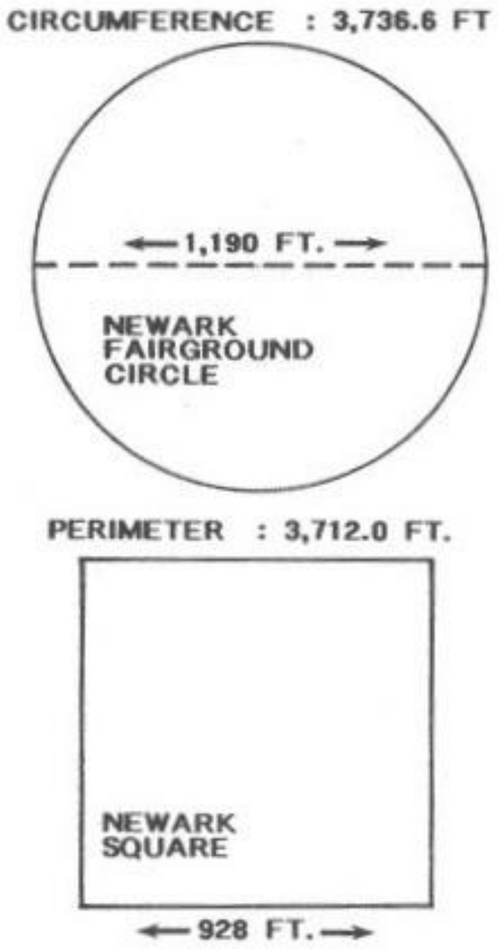
Square and circle with equal perimeters

Square and circle with equal areas

Four Fundamental Relationships Between a Circle and a Square

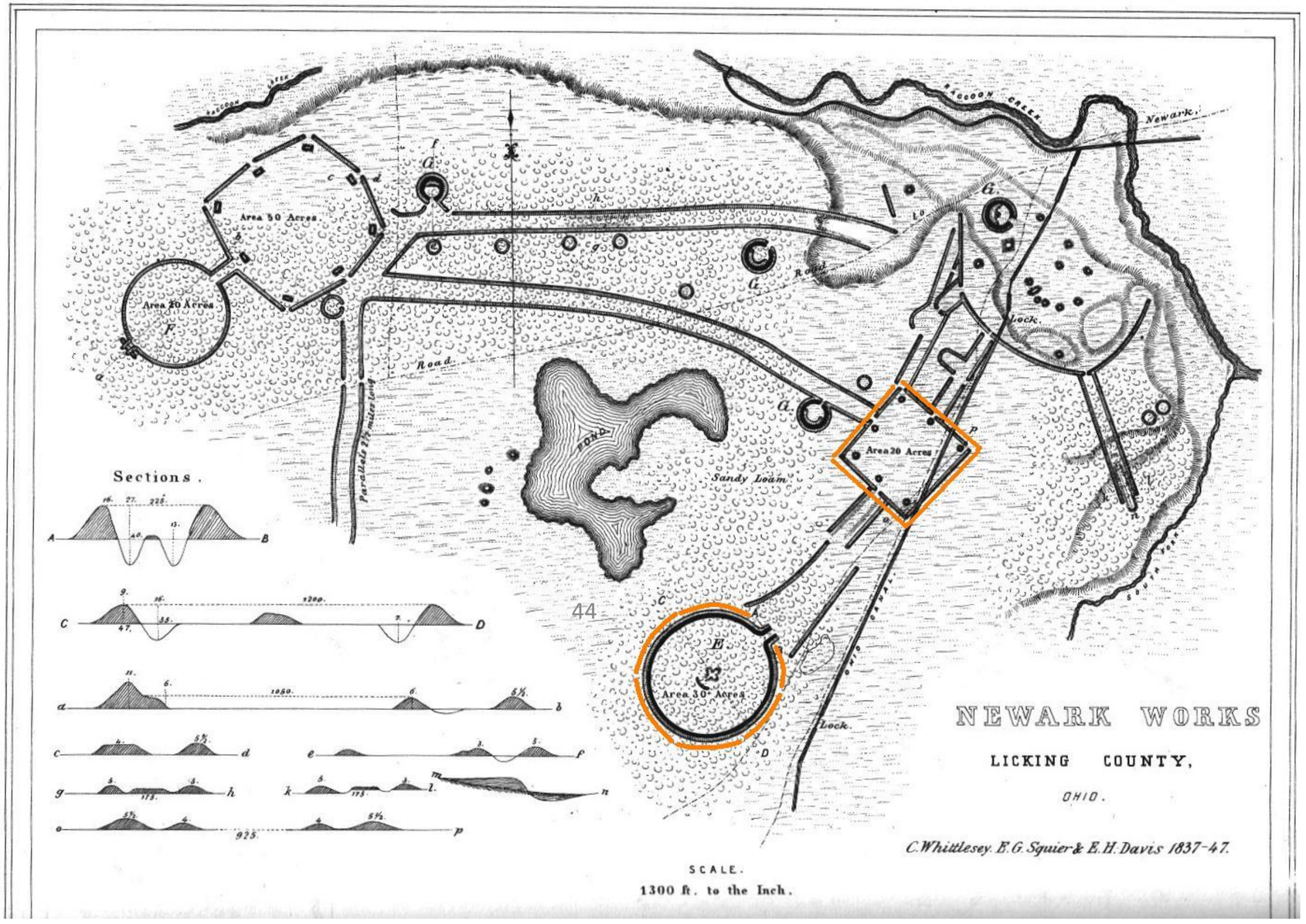
Romain, p. 49

Hopewell Geometric Figures



Squaring the circle

Romain, p. 40



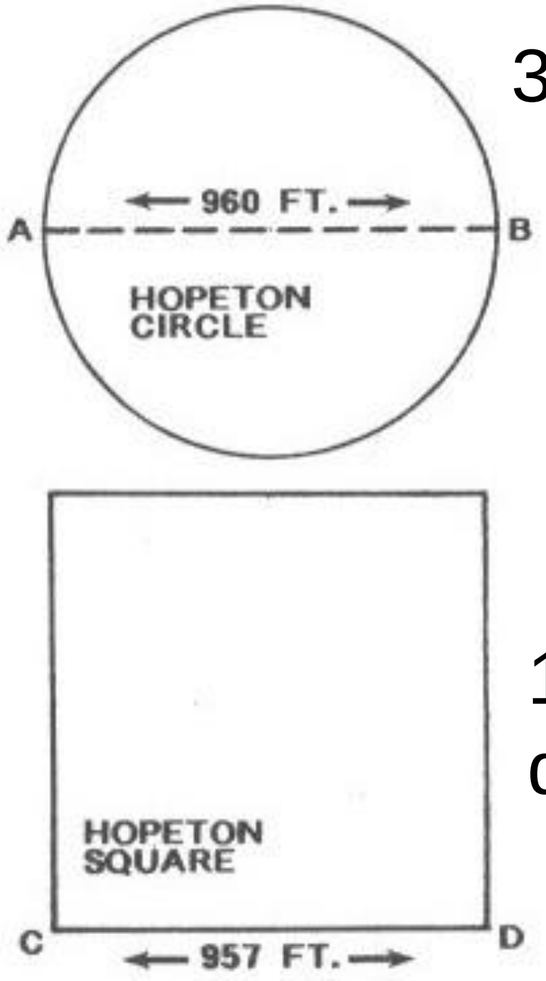
NEWARK WORKS

LICKING COUNTY,

OHIO.

C. Whittlesey. E. G. Squier & E. H. Davis 1837-47.

Pi
3.1415

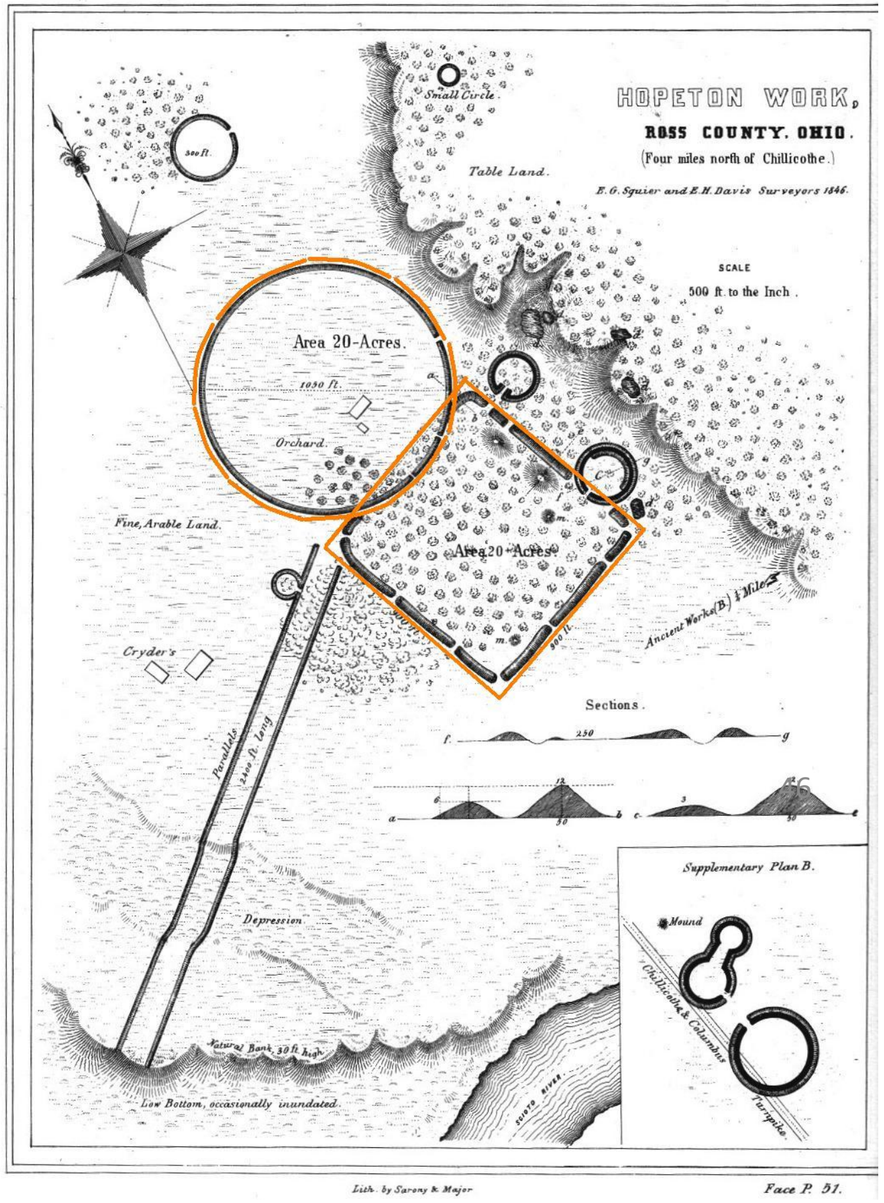


1.4142
diagonal

Incommensurate Ratios

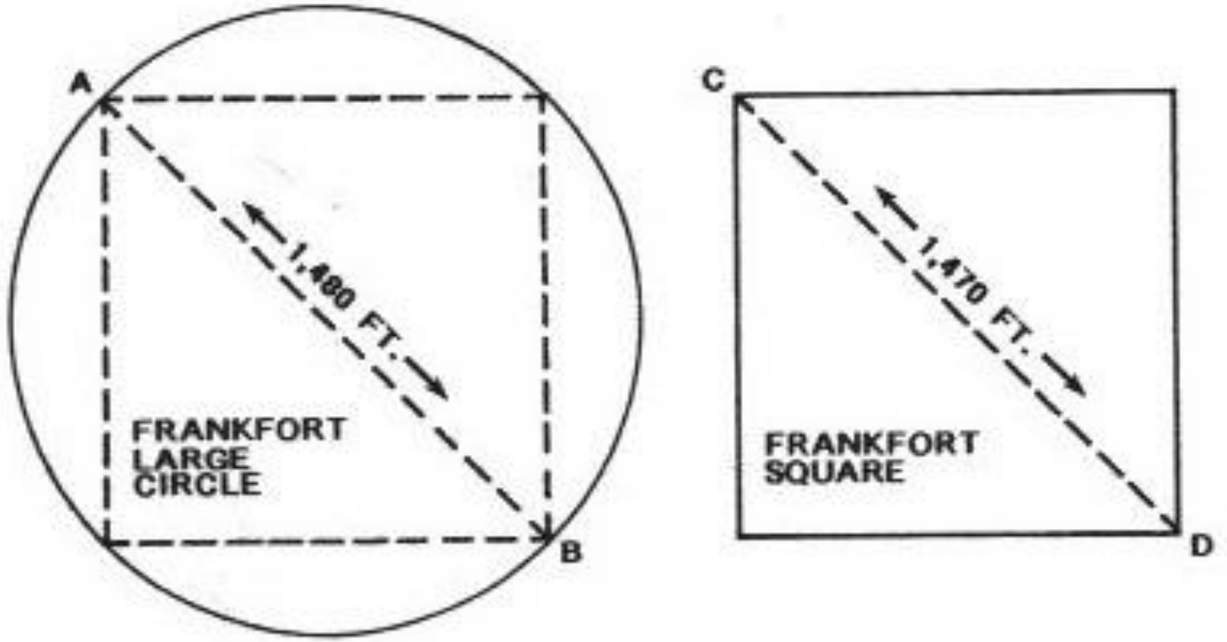
Romain, p. 40

Diameter of Circle =
Length of side



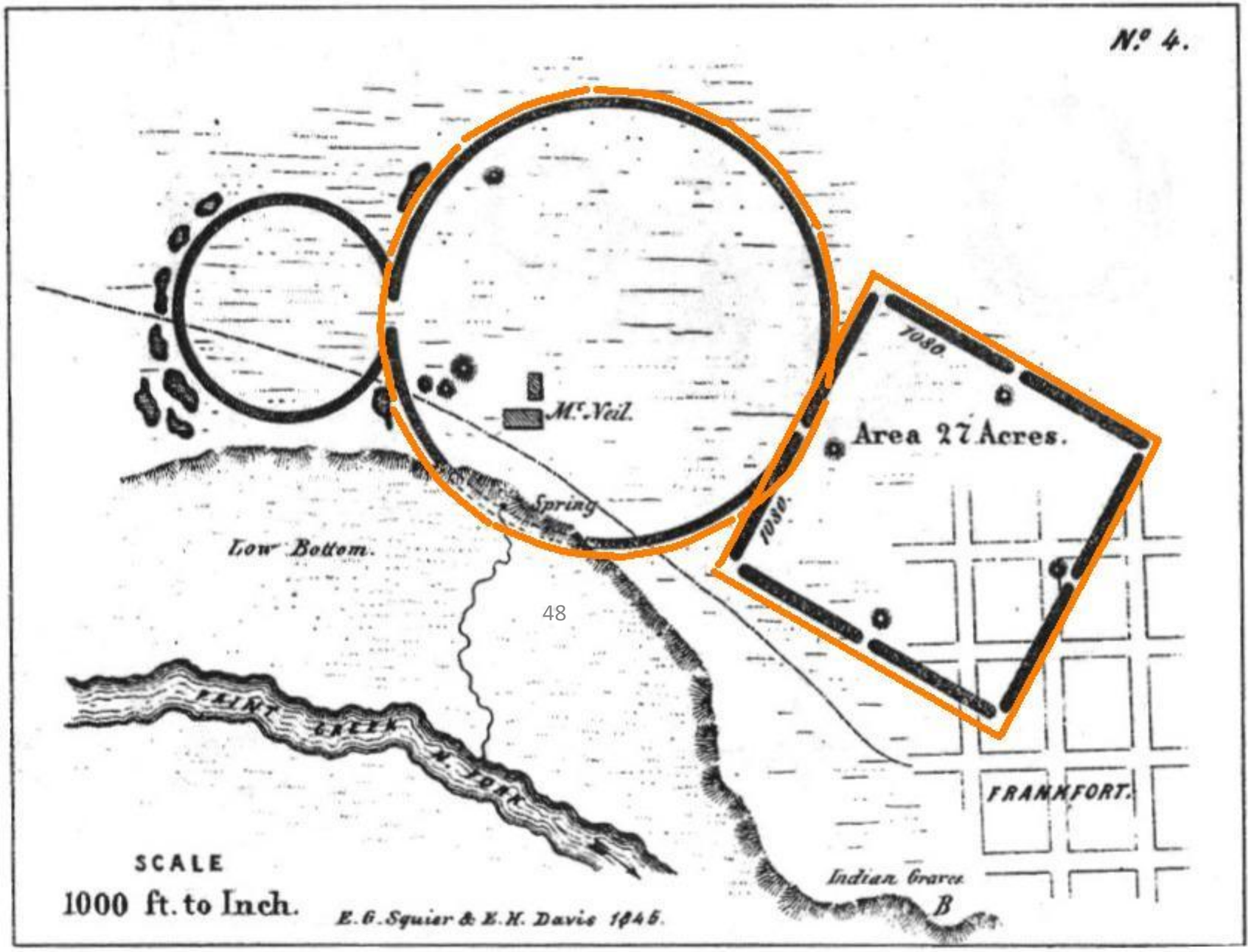
. . . Important was the visual expression of ideas . . . You do not need to be able to define what an incommensurate ratio is in order to make a circle and square that have components that are of equal length.

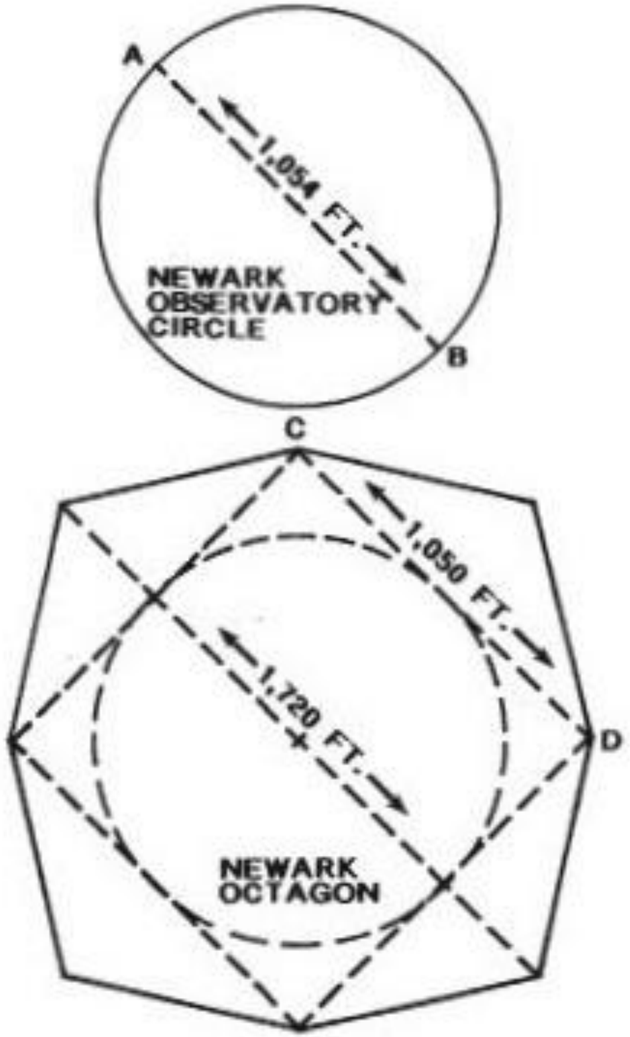
Romain, p. 43



Nested Squares

Romain, p. 47


No. 4.
Mc. Neil.
Spring
Low Bottom.
1080.
1080.
1080.
Area 27 Acres.
FRANKFORT.
FLINT CREEK
N. FORK
SCALE
1000 ft. to Inch.
E.G. Squier & E.H. Davis 1845.
Indian Graves
B



Truncated Squares

Romain, p. 56

Octagon

Romain, p. 57

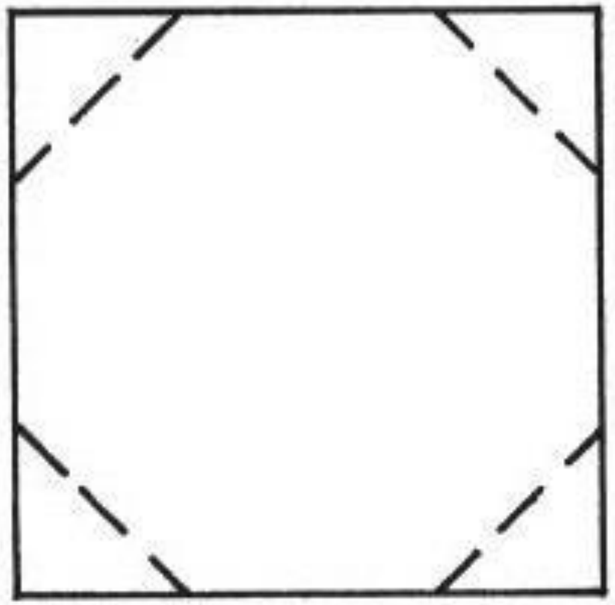
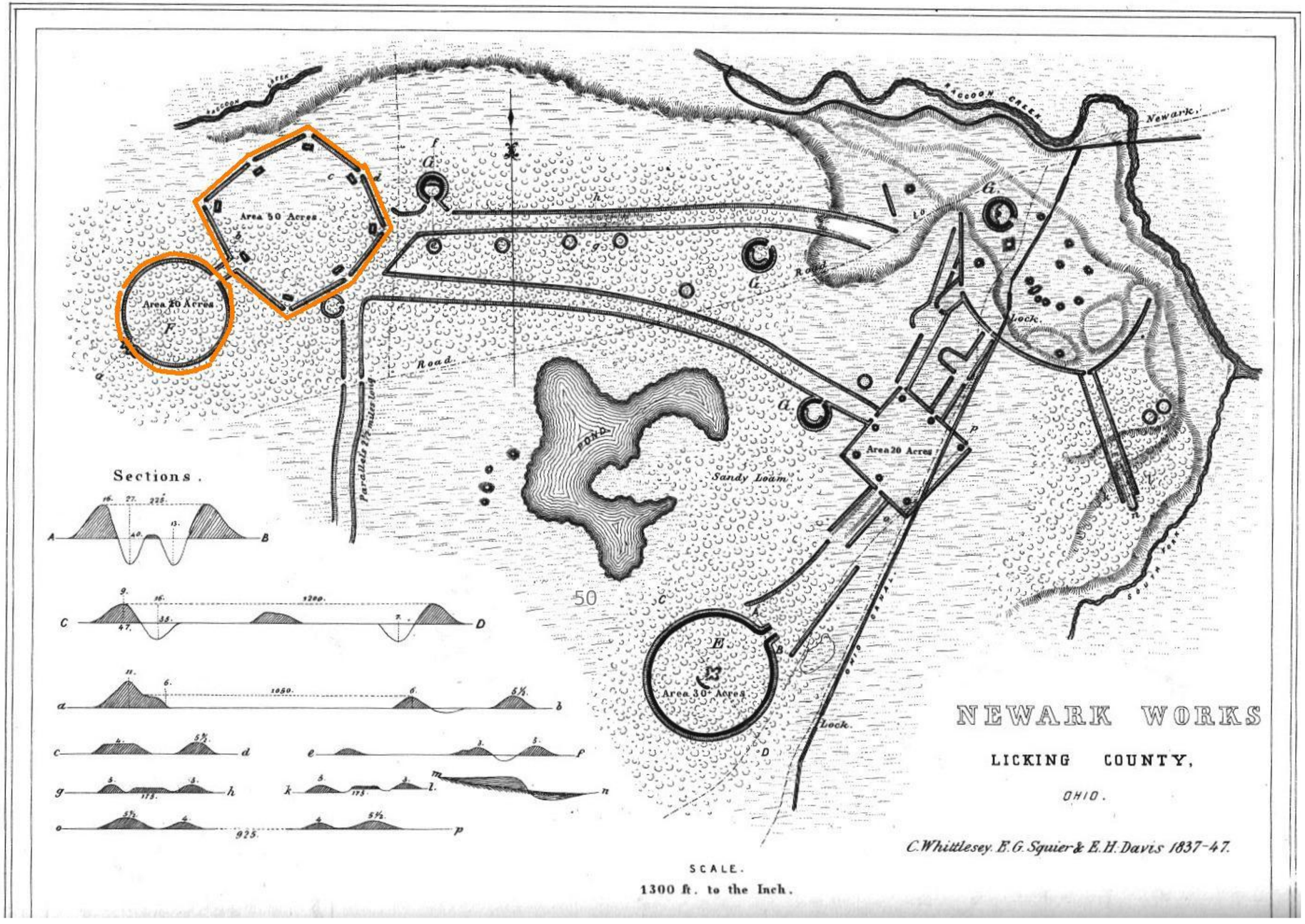


FIG. 2.17. This illustration shows how an octagon is created from a truncated square.



NEWARK WORKS

LICKING COUNTY,

OHIO.

C. Whittlesey. E. G. Squier & E. H. Davis 1837-47.

50

How the Hopewell Likely Guided the Work

Models?

Warren K. Moorehead Reported in Hopewell Mound 25 (Excavated 1891, horse-drawn scraper, 1893 Chicago Fair)

120 Pieces of Sheet Copper,

Possible Drafting Tools

Squares, circles, straight edges, etc.

No Altar or Remains

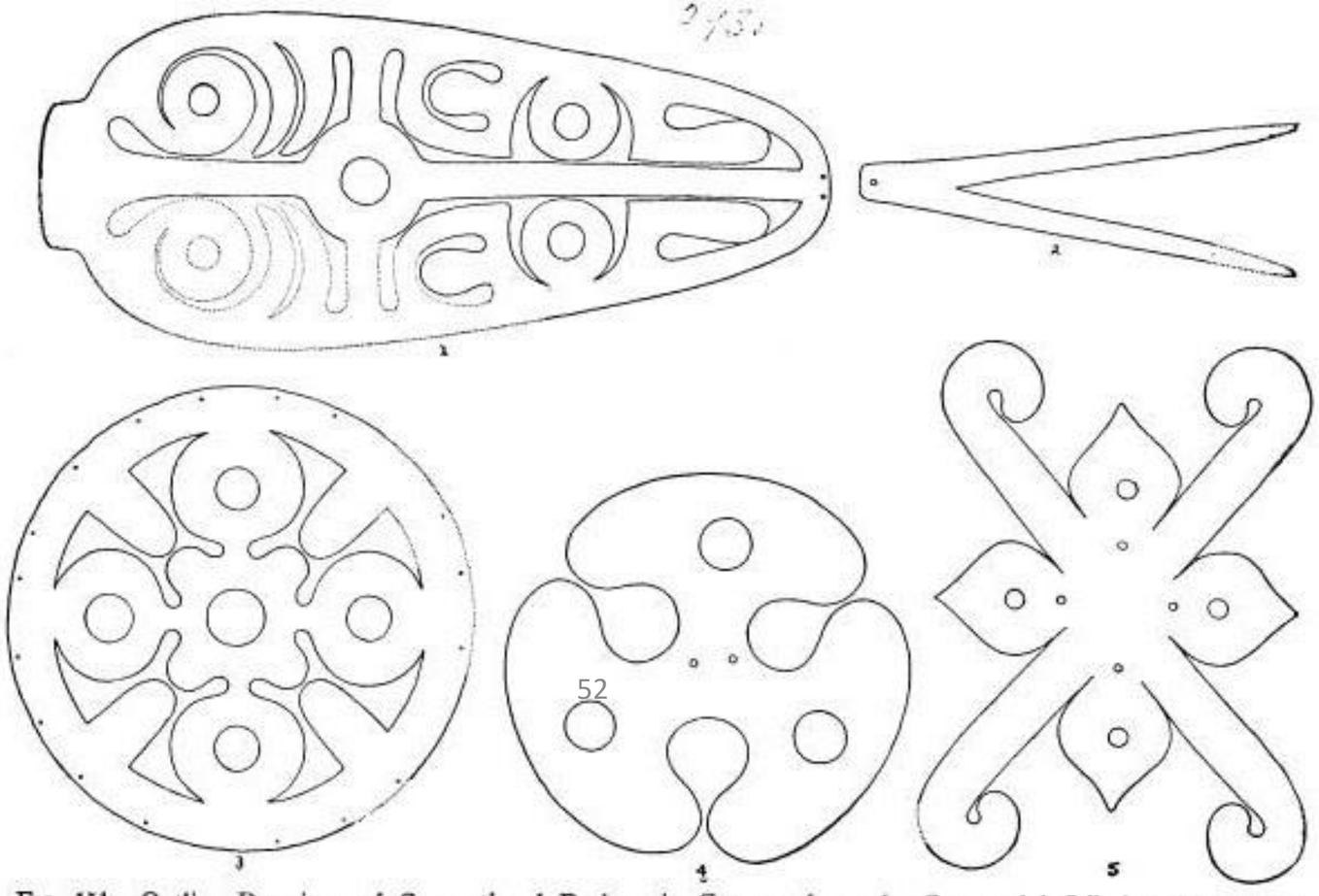


FIG. 151. Outline Drawings of Conventional Designs in Copper; from the Ceremonial Offering, Mound 25; former Survey. (1/2)

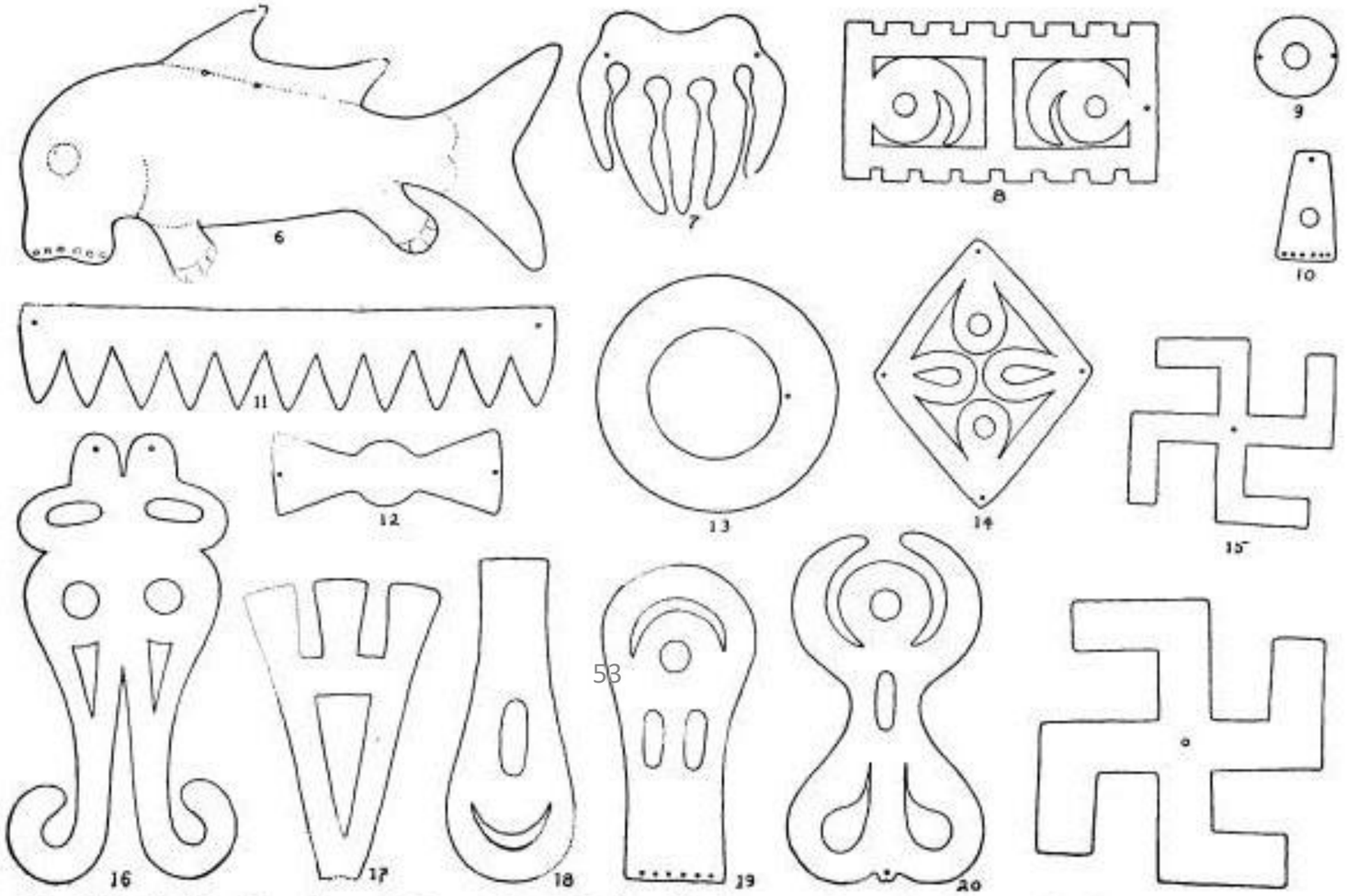
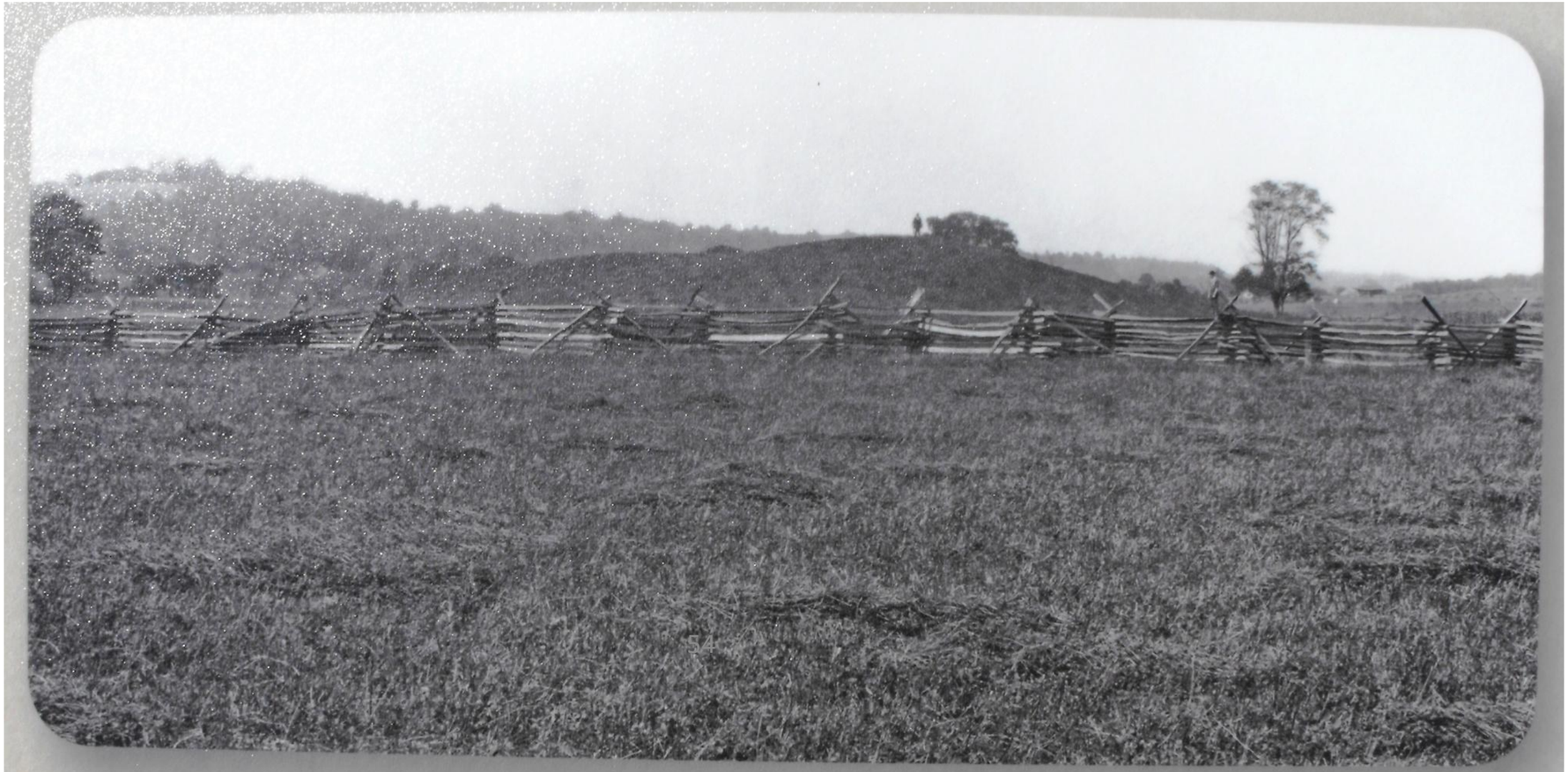


FIG. 152. Outline Drawings of Conventional Designs in Copper; from the Ceremonial Offering, Mound 25; former Survey. (1/1)



This photo shows Mound 25 (*above*) before archeologist Warren Moorehead excavated it with horse-drawn scrapers. Over a period of weeks his team removed thousands of ancient objects for display at the 1893 World's Columbian Exposition in Chicago.

Mound 25 Today

Translating Models Requires:

A basic unit of measure,
Expandable by multiples of itself,
Divisible by "lesser multiples"

An agreed standard of measure

A Method of Counting

The Units of Measurement

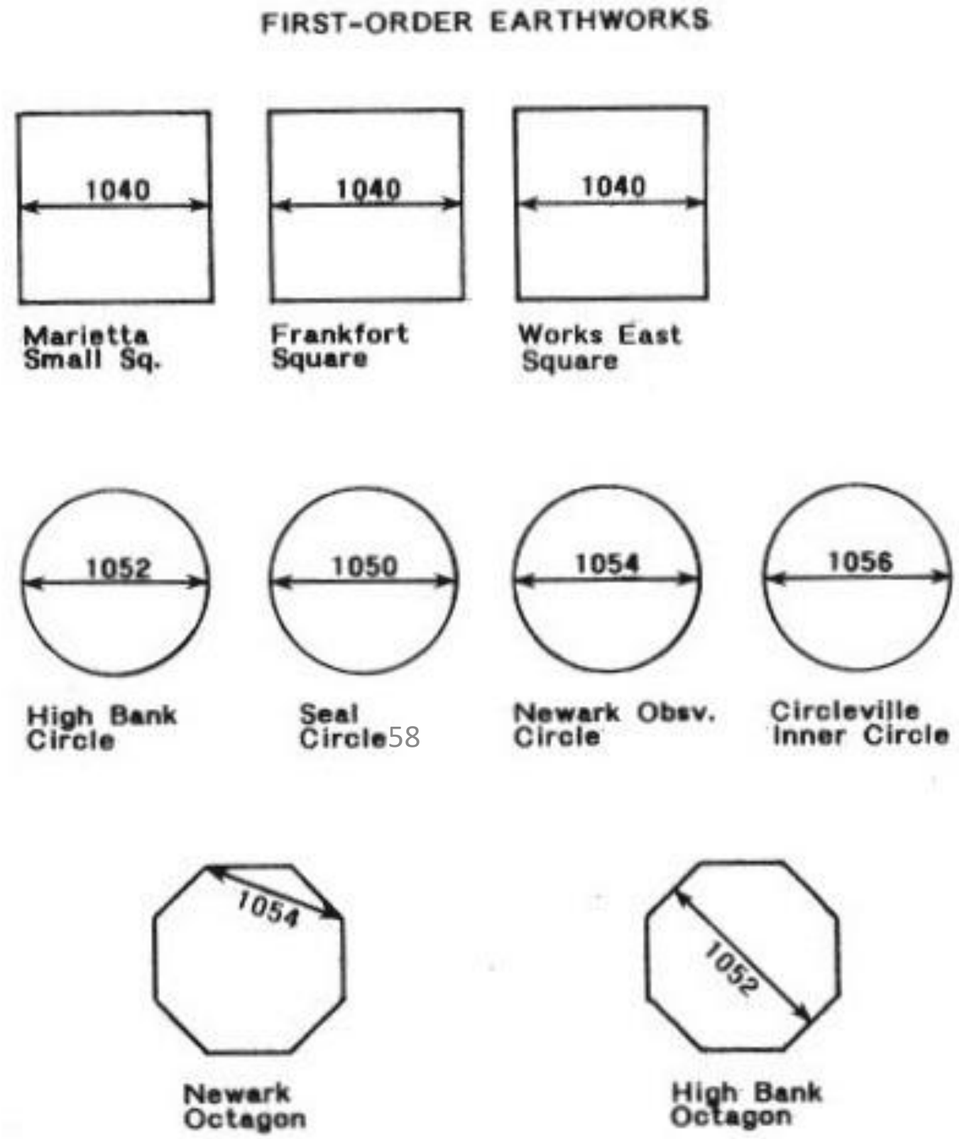
The Romain Theory

1053’ (+/- 2%) length

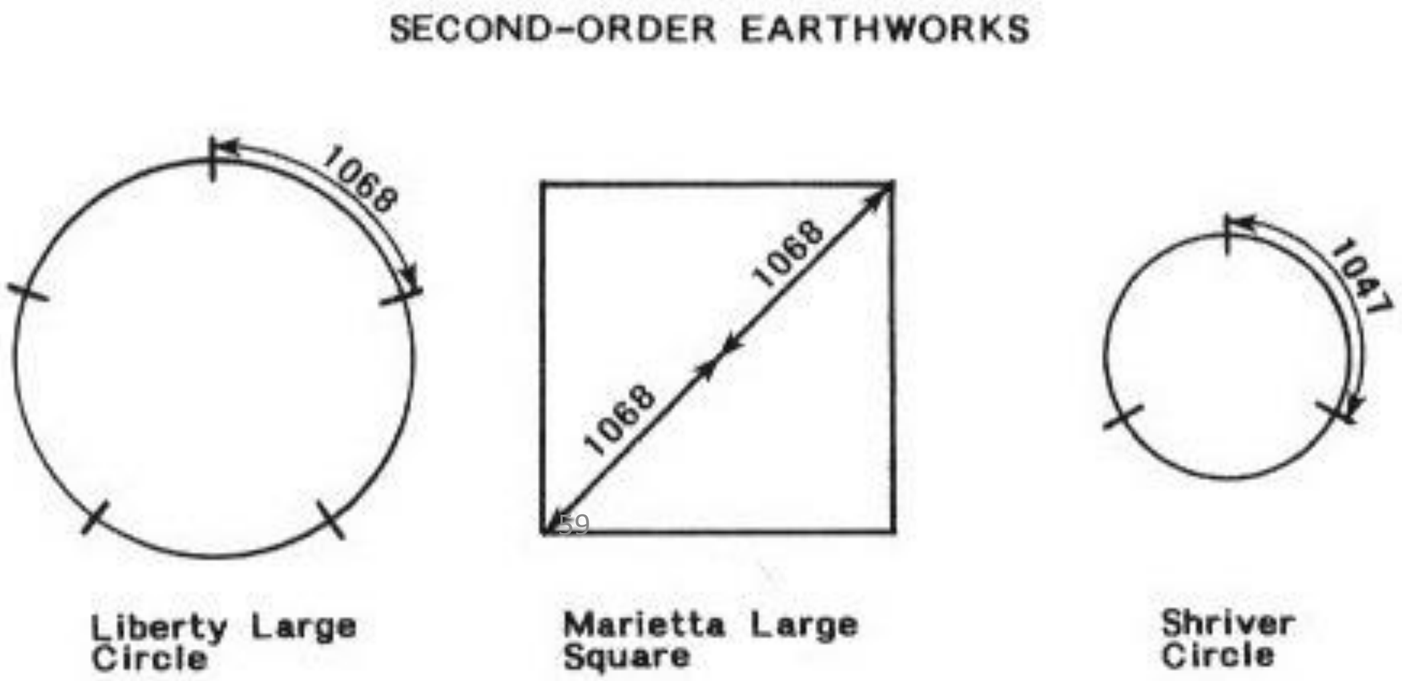
found repeatedly

24 examples cited

First Order Enclosures



Second Order Enclosures



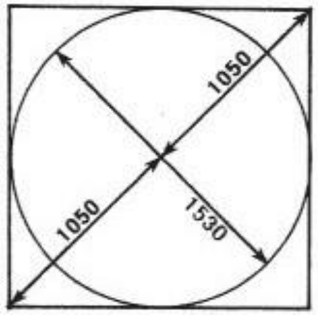
Third Order Enclosures

Frankfort
Small Circle

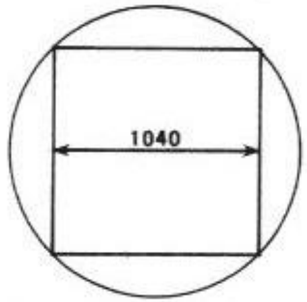
Baum
Small Circle

Seip
Small Circle

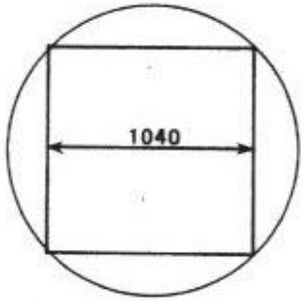
Works East
Small Circle



Seip Large Circle

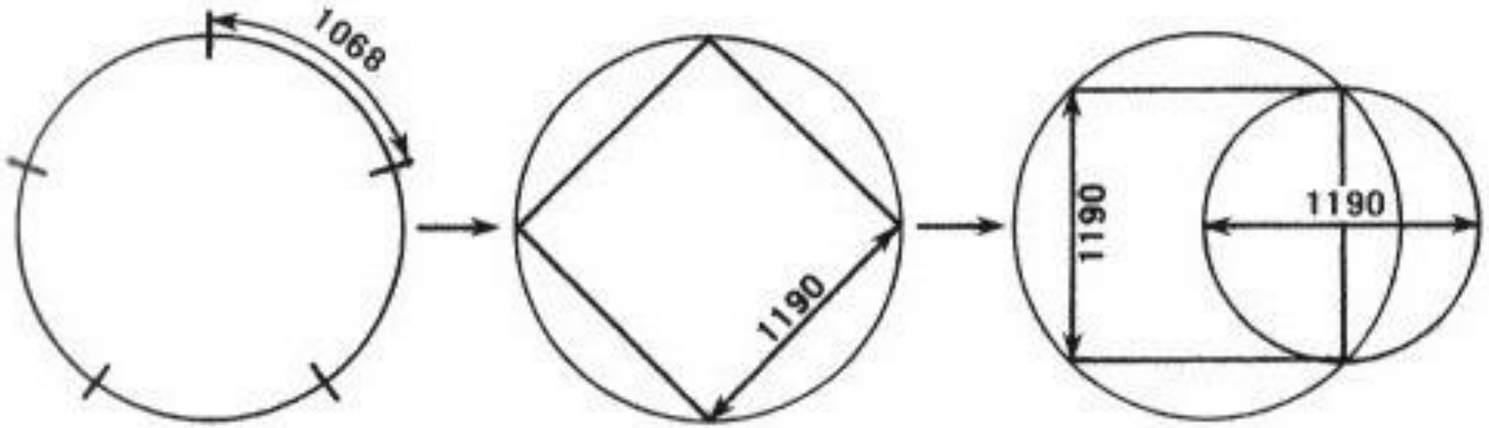


Works East Large Circle



Frankfort Large Circle

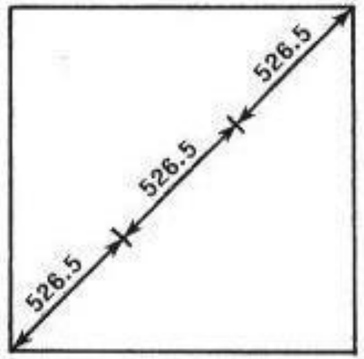
Fourth Order Enclosures



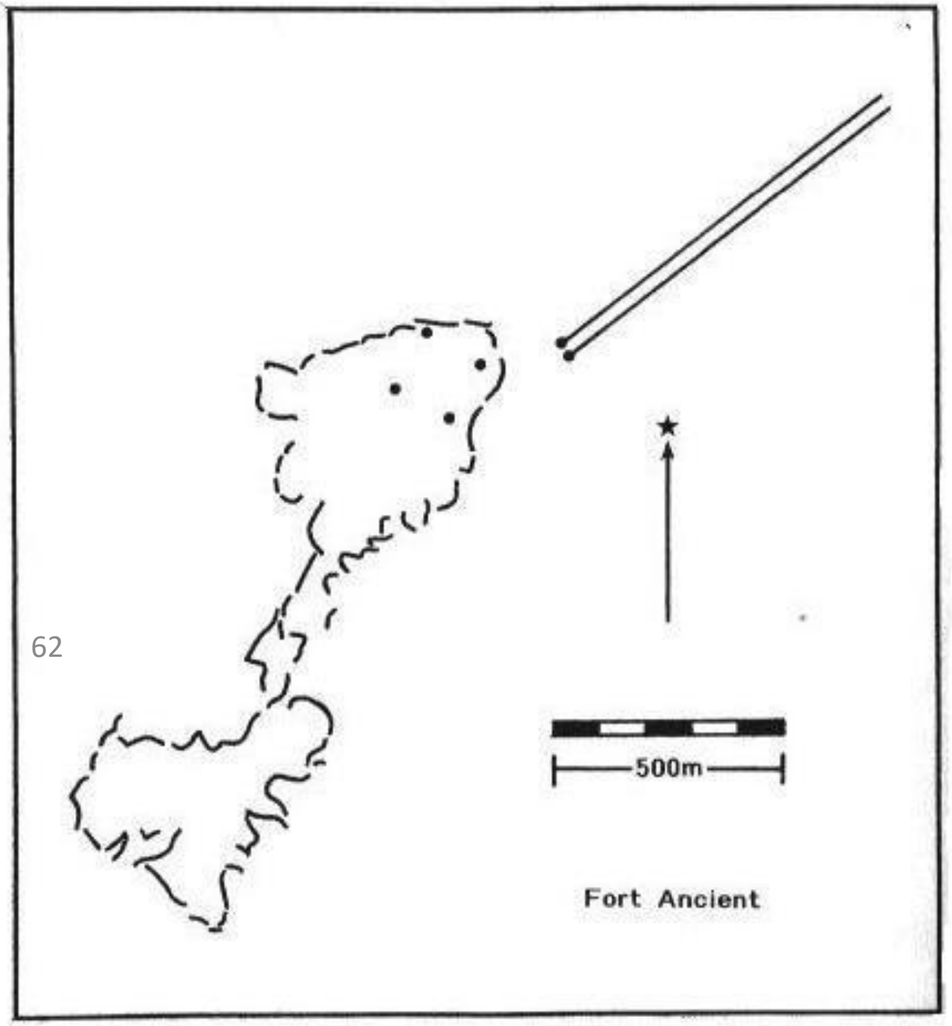
Newark Fairground Circle and Circleville Outer Circle

Fifth Order Enclosures

FIFTH-ORDER EARTHWORKS



Liberty Square
and
Baum Square



Fort Ancient

Serendipitous Learning
Riparian and Littoral Rights

Under English Common Law
Submerged lands beneath tidal waters belonged to the Crown.

Anglo-American Common Law
Ownership of the beds under navigable waters is held by the public of each state, with the boundary being the mean high-tide mark
Taking into account an average of 18.6 years.

From Brown, Robillard and Wilson,
Boundary Control and Legal Principles

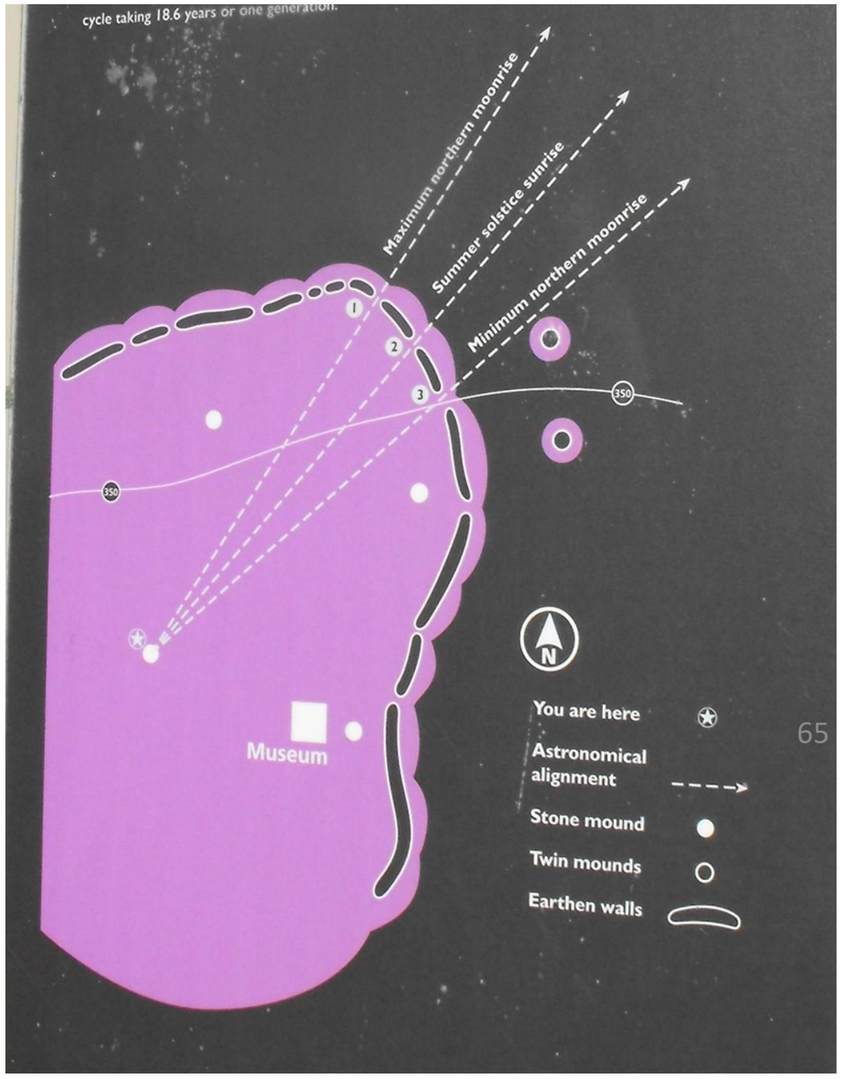
ASTRONOMICAL ALIGNMENTS

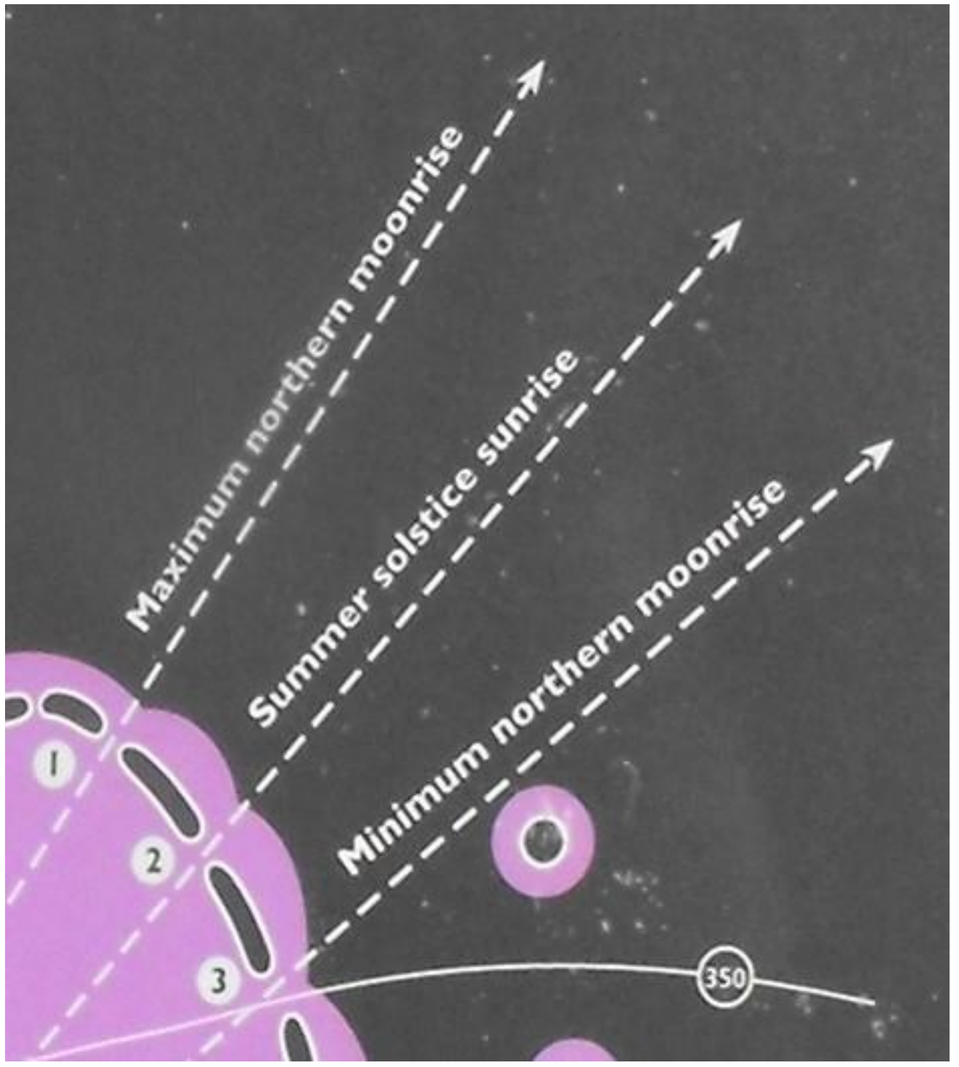
American Indians who built Fort Ancient used the sun and moon to measure time. By observing the rising location of these celestial objects they knew when to gather together for religious or social events or when to plant crops. They used sunrise locations to predict annual events and moonrise location to measure intervals of several years' duration.

You are at the southwest corner of a nearly perfect square made by four mounds. Three astronomical alignments have been demonstrated from this point.

On the summer solstice, usually June 21, the sun rises in the gap just north of Rt. 350. (2)

The maximum northern moonrise (1) occurs approximately 9.3 years after the minimum northern moonrise (3) with this complete lunar cycle taking 18.6 years or one generation.


cycle taking 18.6 years or one generation.
Maximum northern moonrise
Summer solstice sunrise
Minimum northern moonrise
1
2
3
350
350
N
Museum
You are here
Astronomical alignment
Stone mound
Twin mounds
Earthen walls


Maximum northern moonrise
Summer solstice sunrise
Minimum northern moonrise
1
2
3
350

THE EARTHWORKS

The earthworks in front of you stretches around the irregular shape of the natural hilltop for over 3½ miles, and varies from 4 to 23 feet in height. Prehistoric Hopewell Indians used sharpened sticks and other simple tools to dig up the earth to construct this earthwork. In some places they added limestone slabs to stabilize the walls. Enclosing over 100 acres of land, the walls are interrupted by 70 openings or gateways.

Originally considered to be a fort, archaeologists now believe that Fort Ancient was primarily a center for religious and social activities. Evidence for this view includes: the difficulty of defending an enclosure with over 70 openings; the presence of internal borrow pits rather than exterior "moats"; and the presence of parallel walls, mounds, and other features that do not have any apparent strategic purpose.

PREHISTORIC EARTHWORKS
PLEASE STAY OFF

NATURE PRESERVE

DO NOT REMOVE FLINT

"DISTURBING ANY LIVING THING, OR ANY NATURAL OR

ARCHAEOLOGICAL

FEATURE IS

PROHIBITED." O.R.C.

155.99 Hz.

Hopewell Basic Unit of Measure

A 1053 foot device would be unwieldy

Romain used a formula

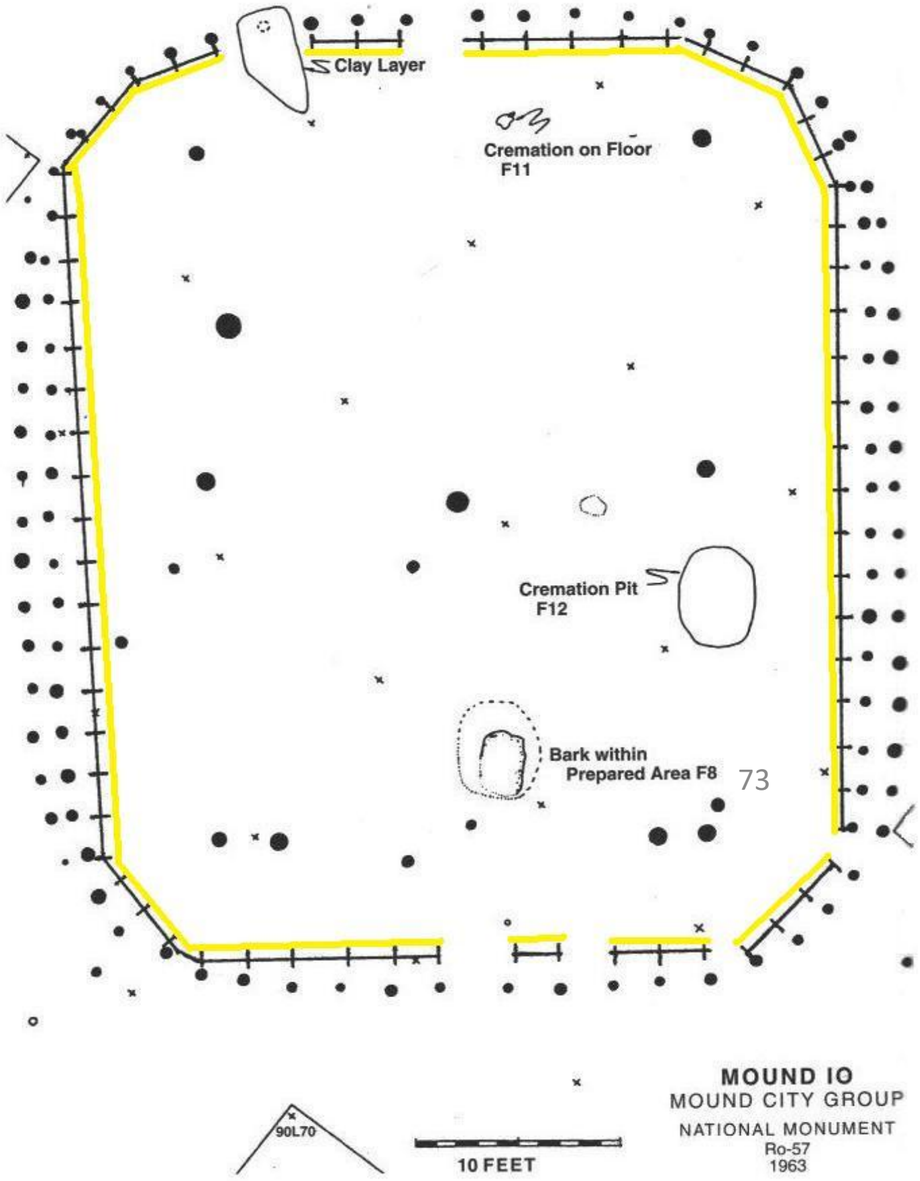
$$X = UxY, \text{ or } X/Y = U$$

Where X is the dimension, U is the unit of measure, and Y is some number of units; to derive a value of 2.106 feet.

$$1053 / 500 = 2.106$$

Romain emphasizes it’s a derived,
approximate number, despite apparent precision.

Comparison made to a future
derived number of 16.000 inches
between wall studs,
with the archeologist having
found measurements
from 15.75” to 16.5”



He then demonstrated this measurement appeared to be common between post holes in excavated charnel houses.

Ohio Archeological and Historical Society excavations in 1920’s at Mound City, beside WW1 Camp Sherman barracks

How Did They Choose This Standard?

Romain concludes, based on skeletal measurements, that the average height of adult male Hopewell was 5'6", with an arm length, using standard forensic formulas, of 25.27", or 2.106',

and points to Cree Indian use of this unit in canoe building.

How Would They Have Measured?

... To lay out ... a line that is 1,053 feet in length, a Hopewell geometer would simply step off five hundred of the arm length units ...[76]

How Might They Have Counted the Units?

Fingers and toes

20 fingers and toes = 1 right finger

5 right fingers = 1 left finger

5 left fingers = 500 basic Hopewell units

= 1,053’

The same base 20 system is known to have been used by the Aztecs, Maya and Eskimos

But Let's Be More Precise!

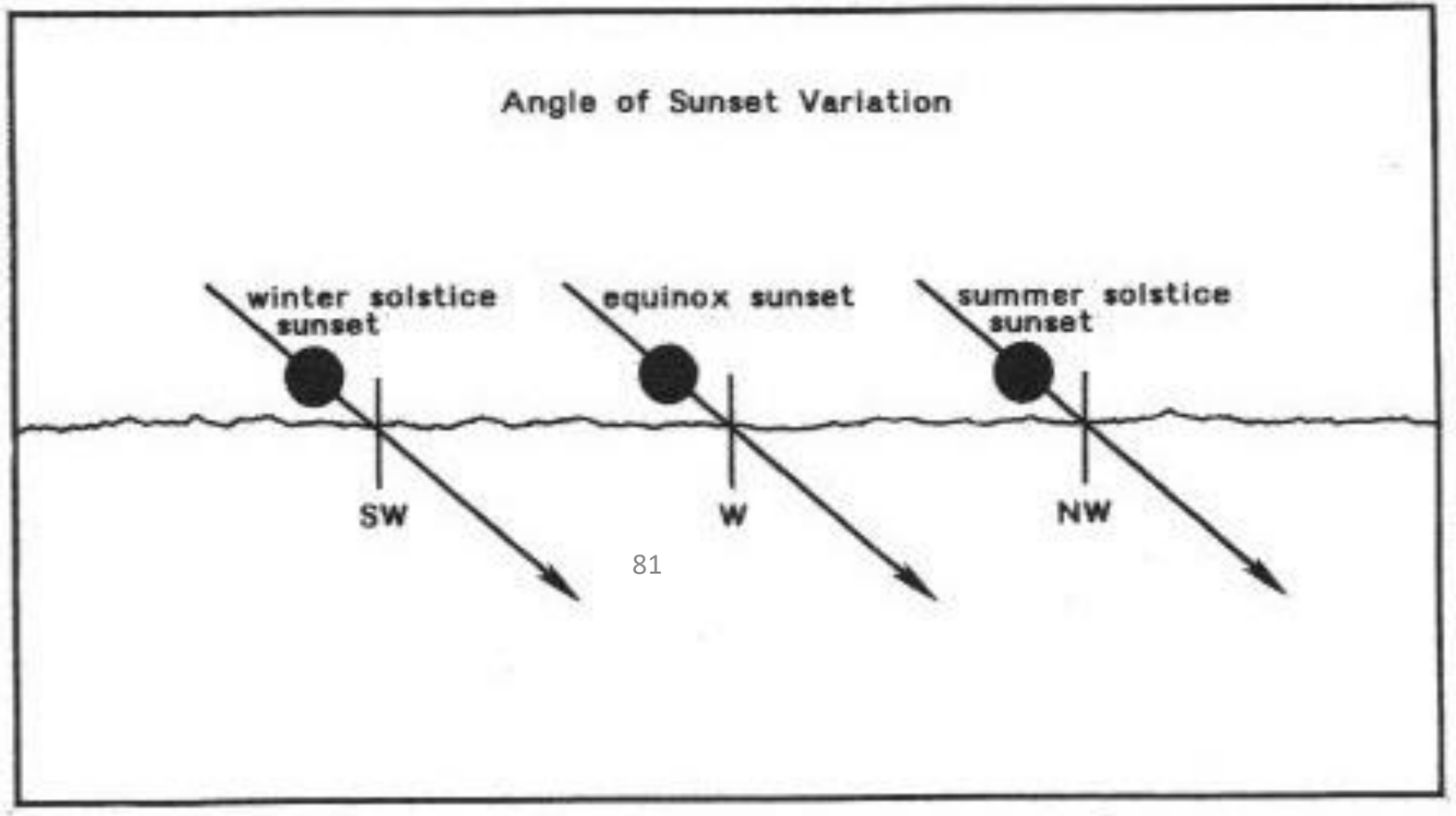
U.S. DEPT. OF THE INTERIOR
UNLAWFUL TO DISTURB
NATIONAL PARK SERVICE

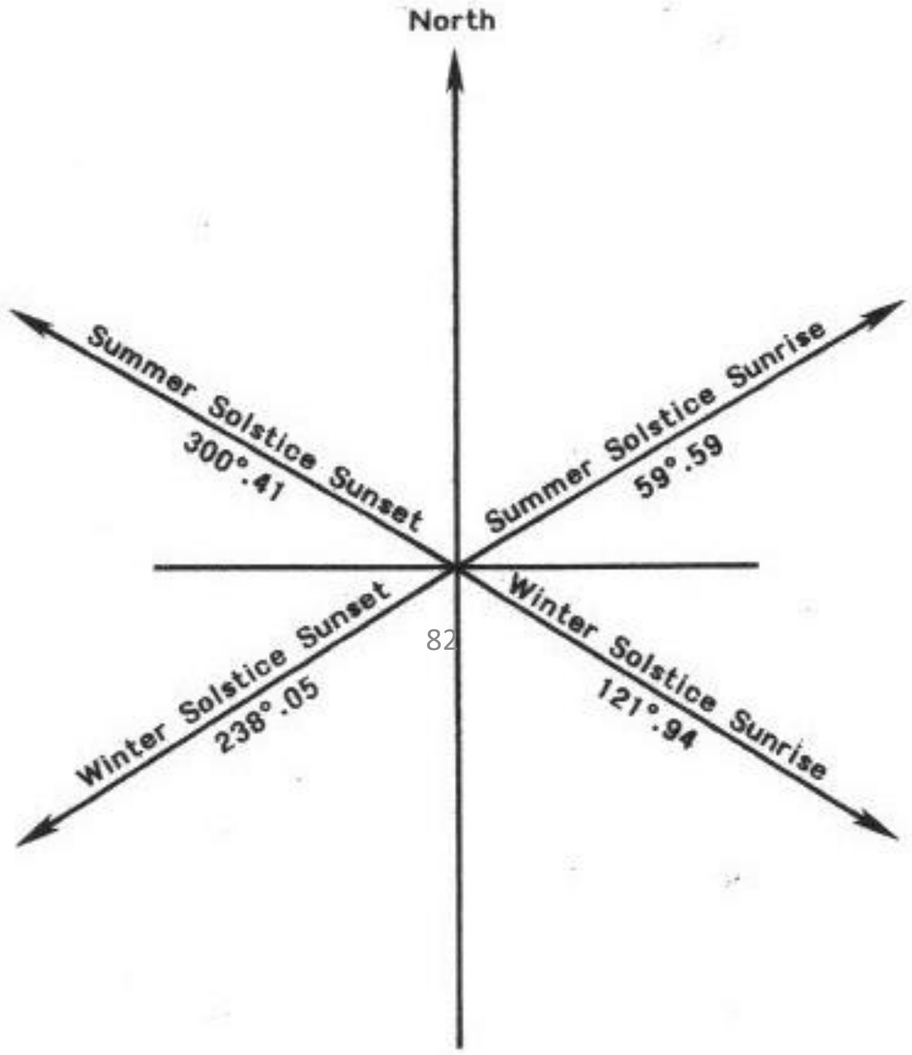
Aligning With Celestial Phenomena

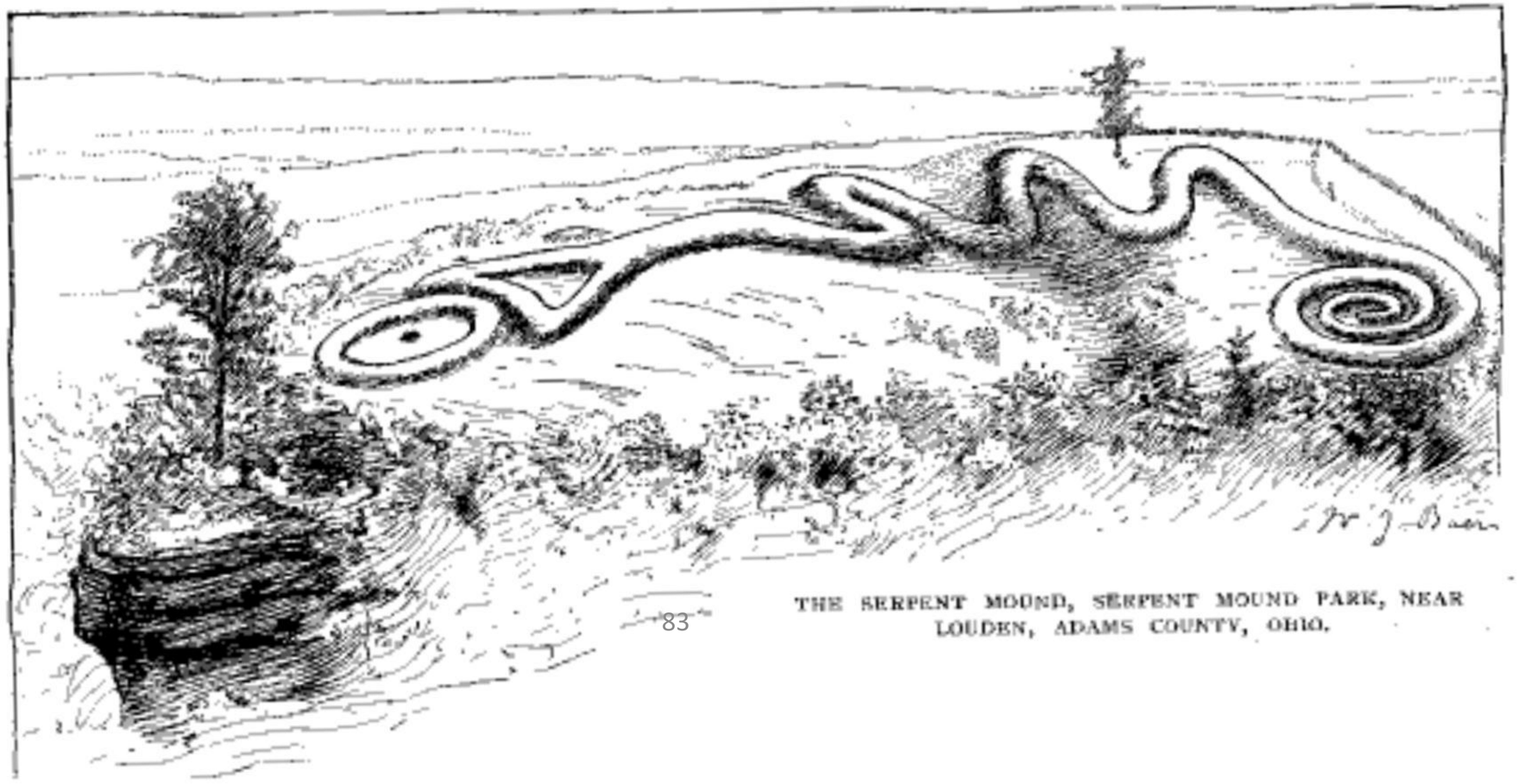
Repetition would have been observable over a few years

At least one work is aligned to cardinal directions, but several are aligned to solstices within less than one degree

Aligning With Celestial Phenomena




North
Summer Solstice Sunset
300°.41
Summer Solstice Sunrise
59°.59
Winter Solstice Sunset
238°.05
Winter Solstice Sunrise
121°.94

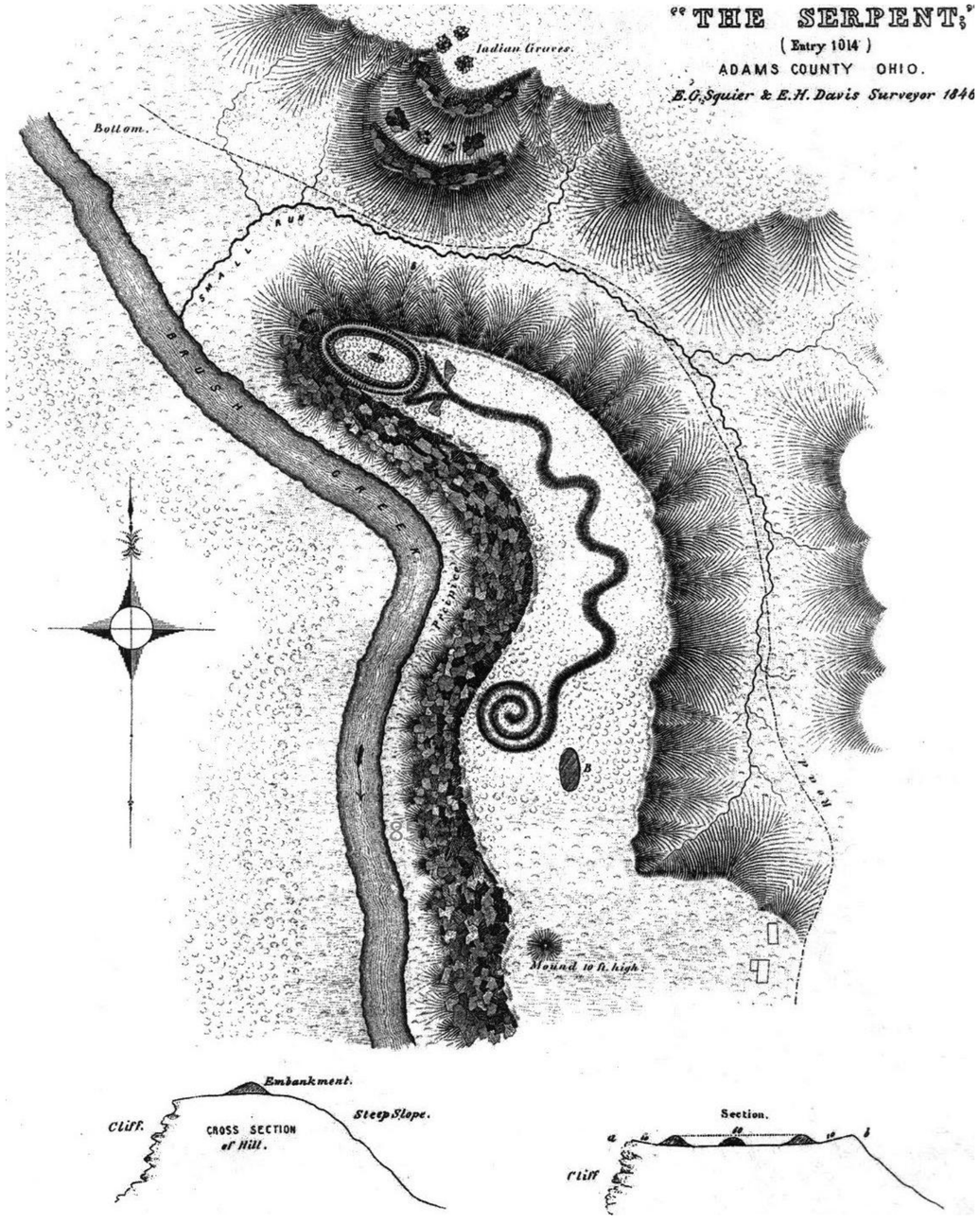


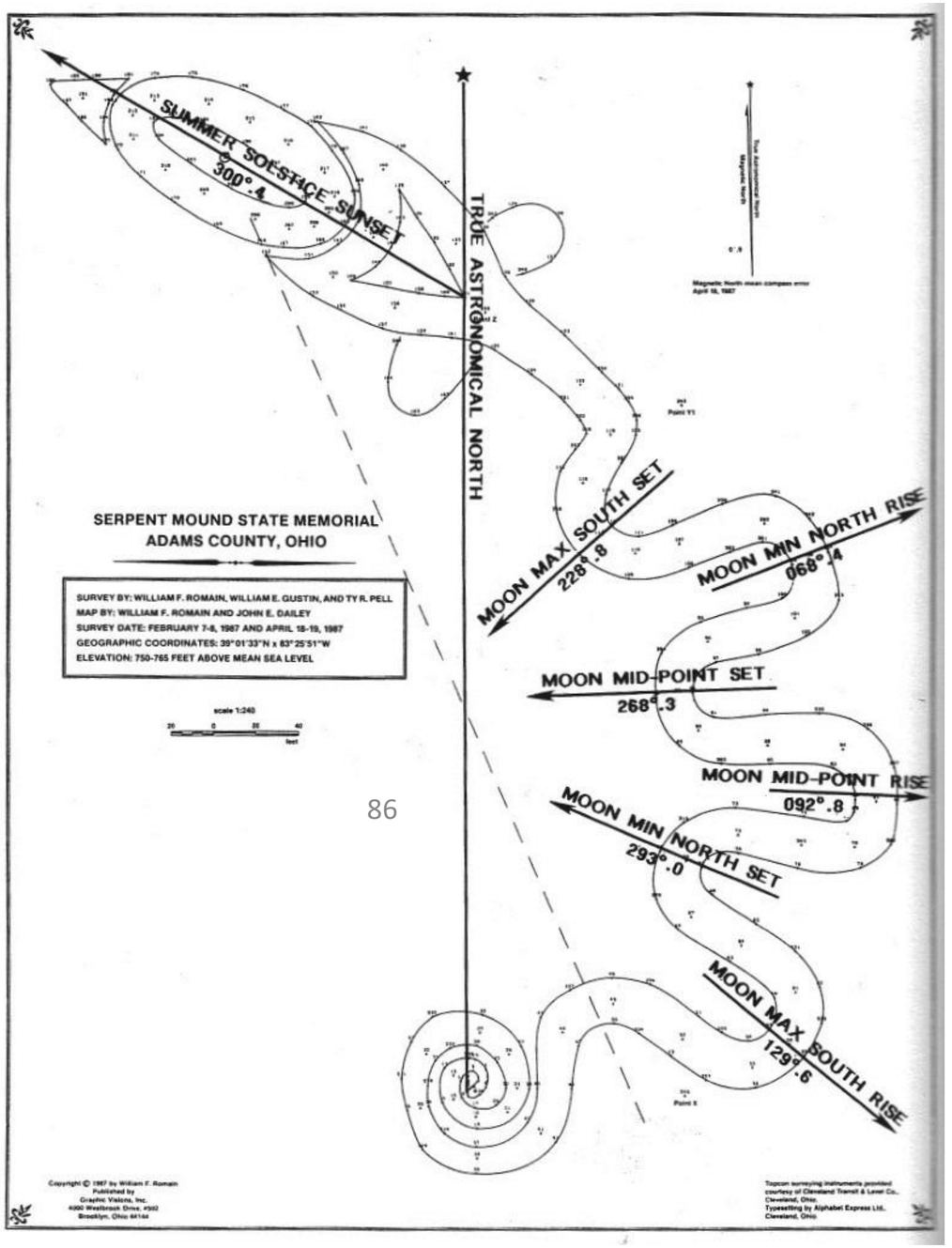
THE SERPENT MOUND, SERPENT MOUND PARK, NEAR LOUDEN, ADAMS COUNTY, OHIO.

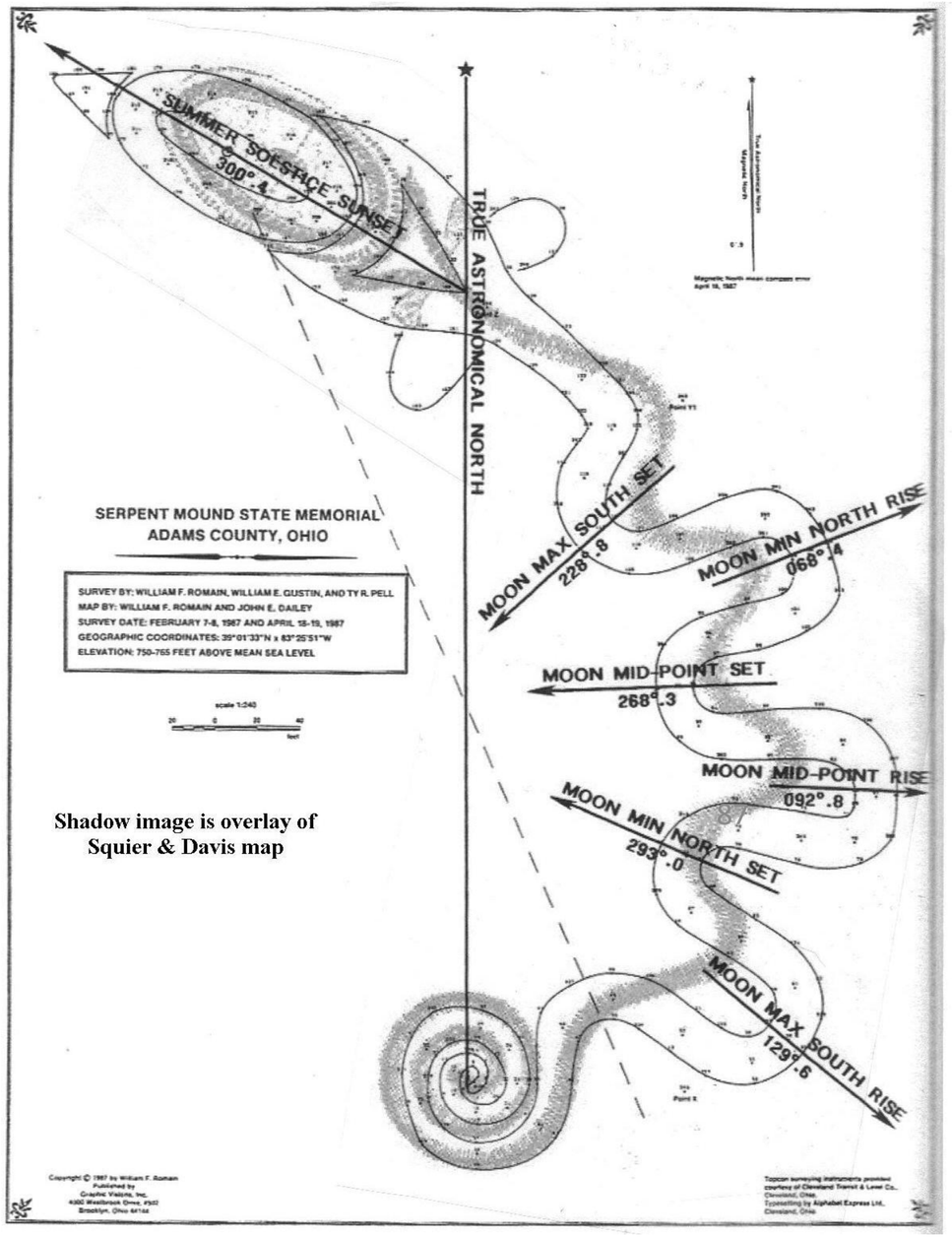
THE SERPENT MOUND OF OHIO.[1]

Illustration from F.W. Putnam article, *The Century*, April 1890

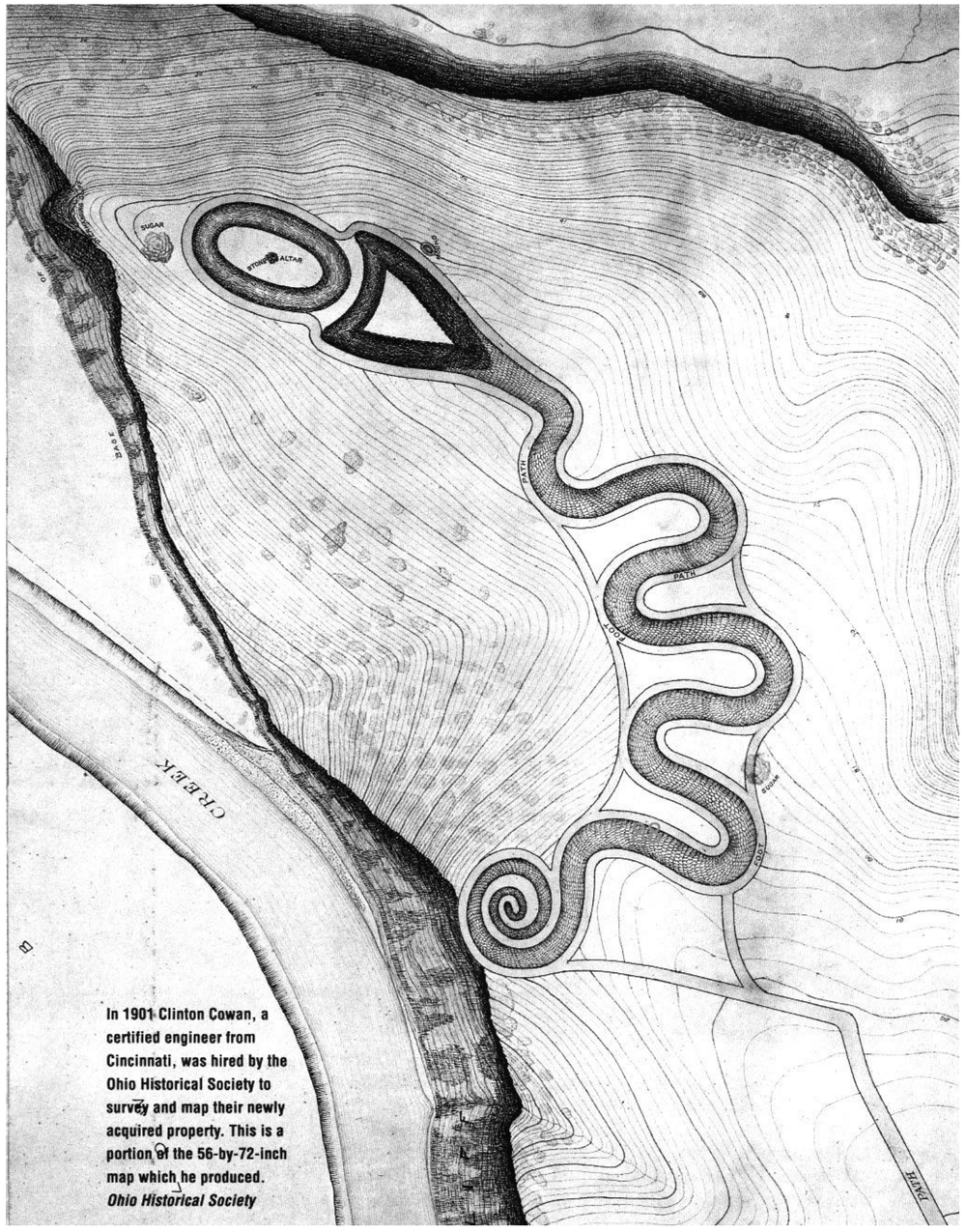
Looking west, toward the head, May 2011


"THE SERPENT."
(Entry 1014)
ADAMS COUNTY OHIO.
E.G. Squier & E.H. Davis Surveyor 1846
Indian Graves.
Bottom.
SMALL RUN
BRUSH CREEK
Mound 10 ft. high
Embankment.
Cliff.
CROSS SECTION of Hill.
Steep Slope.
Section.
Cliff


SUMMER SOLSTICE SUNSET
300°.4
TRUE ASTRONOMICAL NORTH
SERPENT MOUND STATE MEMORIAL
ADAMS COUNTY, OHIO
SURVEY BY: WILLIAM F. ROMAIN, WILLIAM E. GUSTIN, AND TY R. PELL
MAP BY: WILLIAM F. ROMAIN AND JOHN E. DAILEY
SURVEY DATE: FEBRUARY 7-8, 1987 AND APRIL 18-19, 1987
GEOGRAPHIC COORDINATES: 39°01'33"N x 83°25'51"W
ELEVATION: 750-765 FEET ABOVE MEAN SEA LEVEL
scale 1:240
feet
MOON MAX SOUTH SET
228°.8
MOON MIN NORTH RISE
068°.4
MOON MID-POINT SET
268°.3
MOON MID-POINT RISE
092°.8
MOON MIN NORTH SET
293°.0
MOON MAX SOUTH RISE
129°.6
Point Y1
Point X
Magnetic North mean compass error
April 18, 1987
Copyright © 1987 by William F. Romain
Published by
Graphic Visions, Inc.
4000 Westbrook Drive, #302
Brooklyn, Ohio 44144
Topcon surveying instruments provided
courtesy of Cleveland Transit & Level Co.
Cleveland, Ohio.
Typesetting by Alphabet Express Ltd.
Cleveland, Ohio

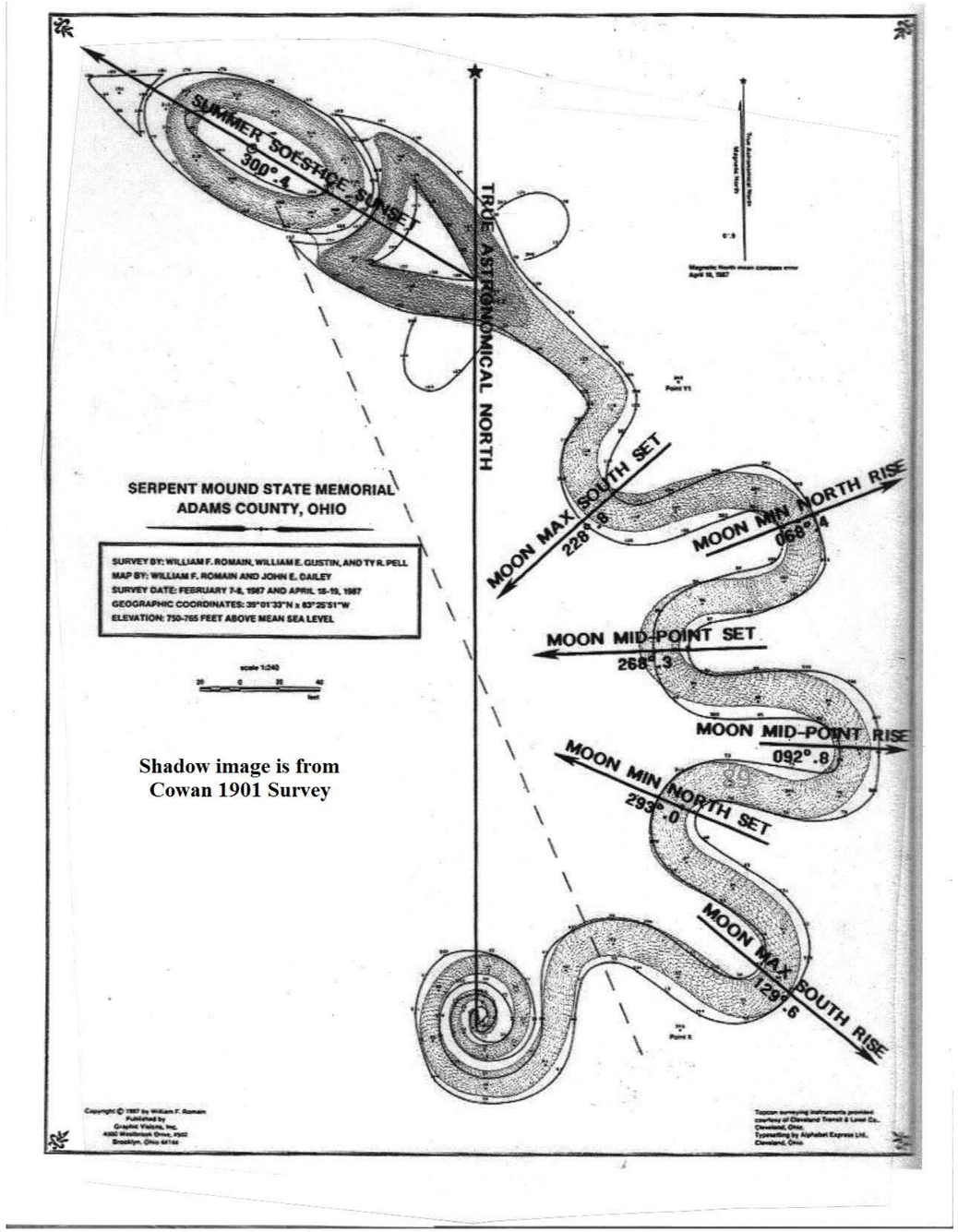


Squier and Davis map overlain onto Romain survey



In 1901 Clinton Cowan, a certified engineer from Cincinnati, was hired by the Ohio Historical Society to survey and map their newly acquired property. This is a portion of the 56-by-72-inch map which he produced.
Ohio Historical Society

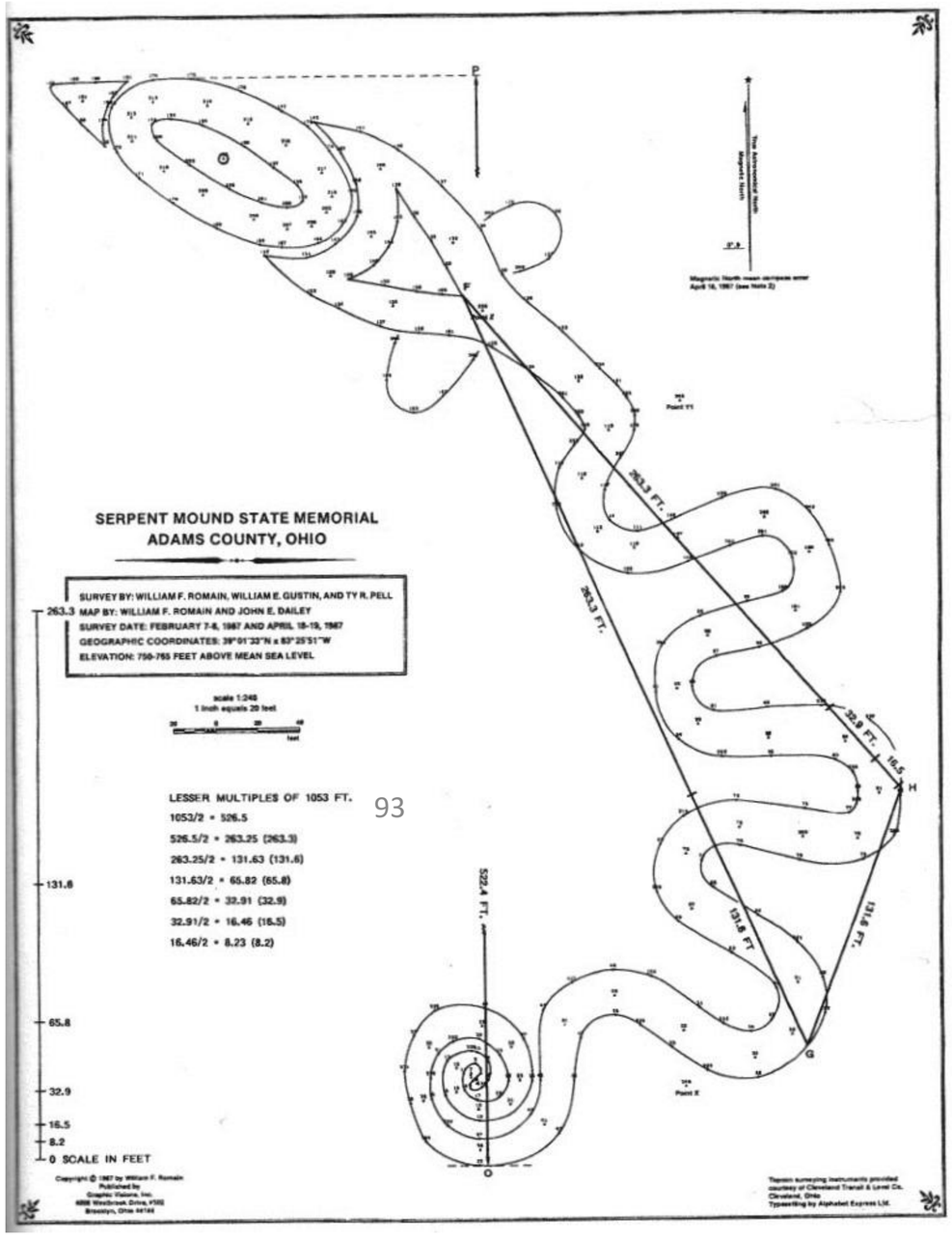
Clinton Cowan Survey, 1901

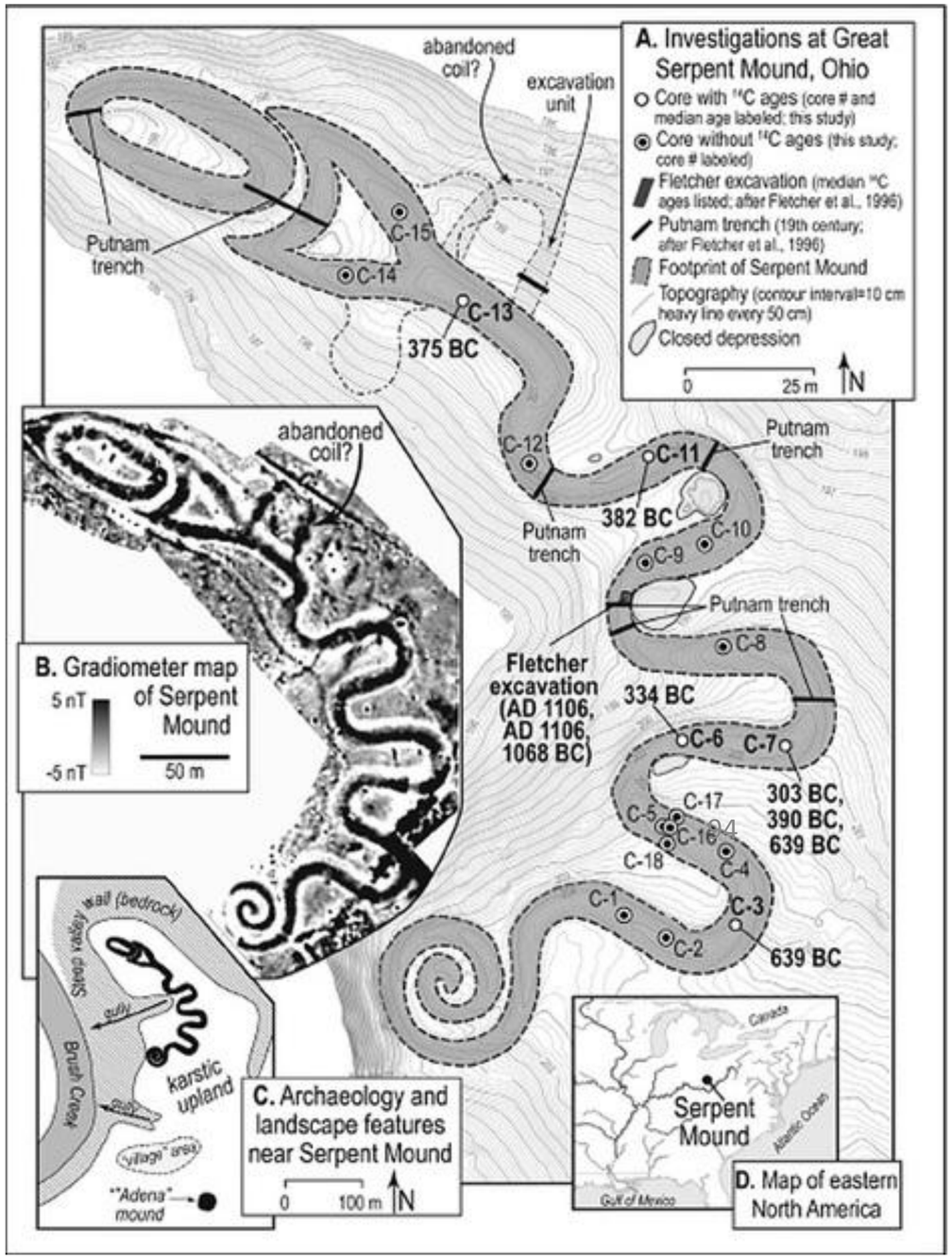


Shadow image is from Cowan 1901 Survey

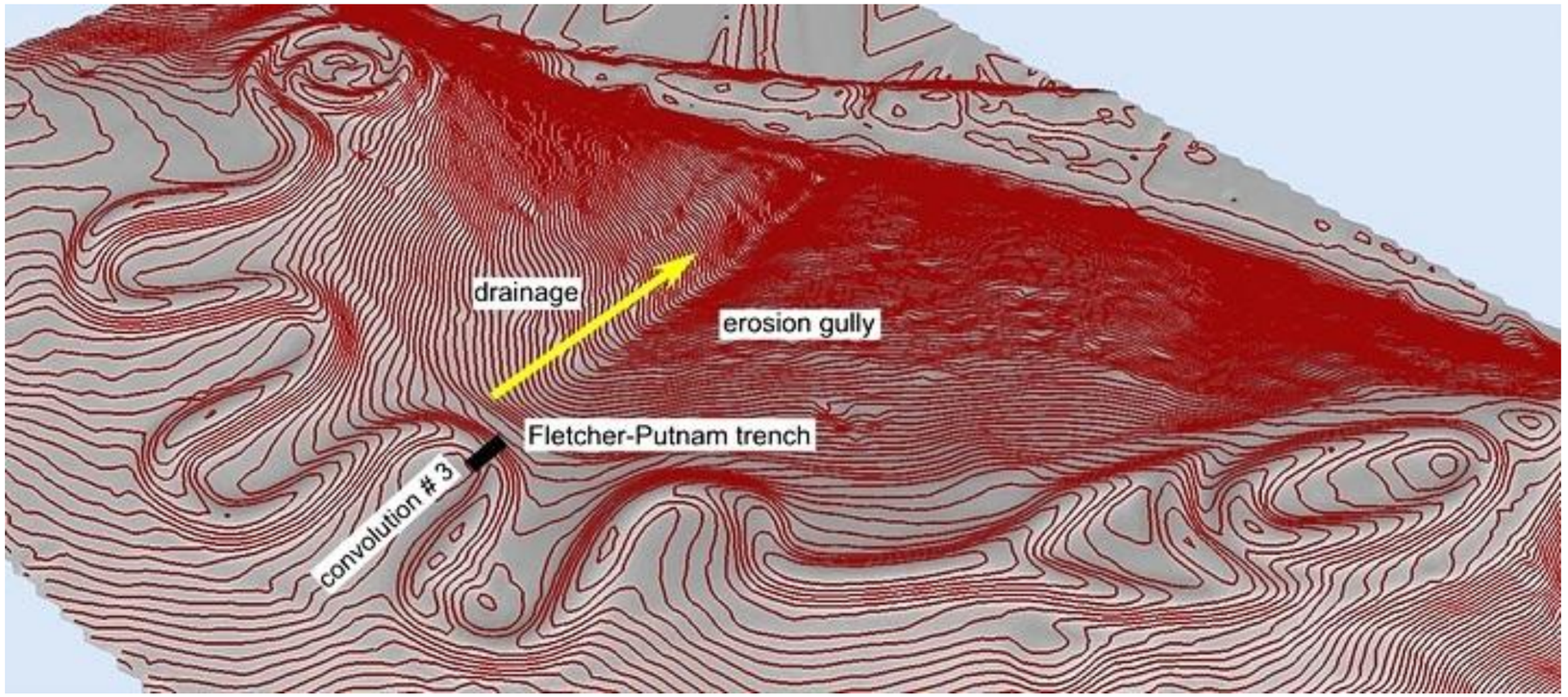
1901 Cowan survey overlain onto Romain survey

SUMMER SOLSTICE SUNSET

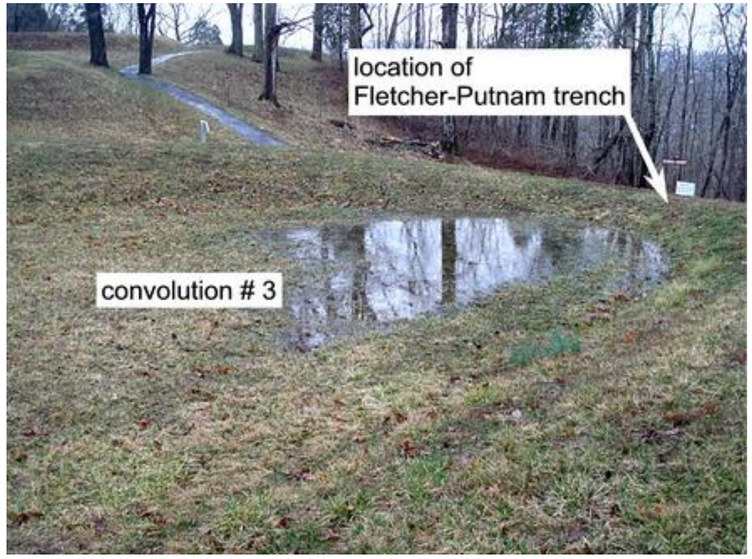

SERPENT MOUND STATE MEMORIAL
ADAMS COUNTY, OHIO
SURVEY BY: WILLIAM F. ROMAIN, WILLIAM E. GUSTIN, AND TY R. PELL
MAP BY: WILLIAM F. ROMAIN AND JOHN E. DAILEY
SURVEY DATE: FEBRUARY 7-8, 1987 AND APRIL 18-19, 1987
GEOGRAPHIC COORDINATES: 39°01'33"N x 83°25'51"W
ELEVATION: 750-765 FEET ABOVE MEAN SEA LEVEL
scale 1:240
1 inch equals 20 feet
LESSER MULTIPLES OF 1053 FT.
1053/2 = 526.5
526.5/2 = 263.25 (263.3)
263.25/2 = 131.63 (131.6)
131.63/2 = 65.82 (65.8)
65.82/2 = 32.91 (32.9)
32.91/2 = 16.46 (16.5)
16.46/2 = 8.23 (8.2)
263.3
131.6
65.8
32.9
16.5
8.2
0 SCALE IN FEET
263.3 FT.
263.3 FT.
32.9 FT.
16.5
131.6 FT.
131.6 FT.
522.4 FT.
P
F
H
G
O
Point Y
Point X
Magnetic North mean compass error
April 18, 1987 (see Note 2)
Copyright © 1987 by William F. Romain
Published by
Graphic Visions, Inc.
Brooklyn, Ohio 44144
Typeset surveying instruments provided
courtesy of Cleveland Transit & Level Co.
Cleveland, Ohio
Typesetting by Alphabet Express Ltd.



G. William Monaghan
Map of coring locations and radiocarbon dates,
Journal of Archeological Science, 2014



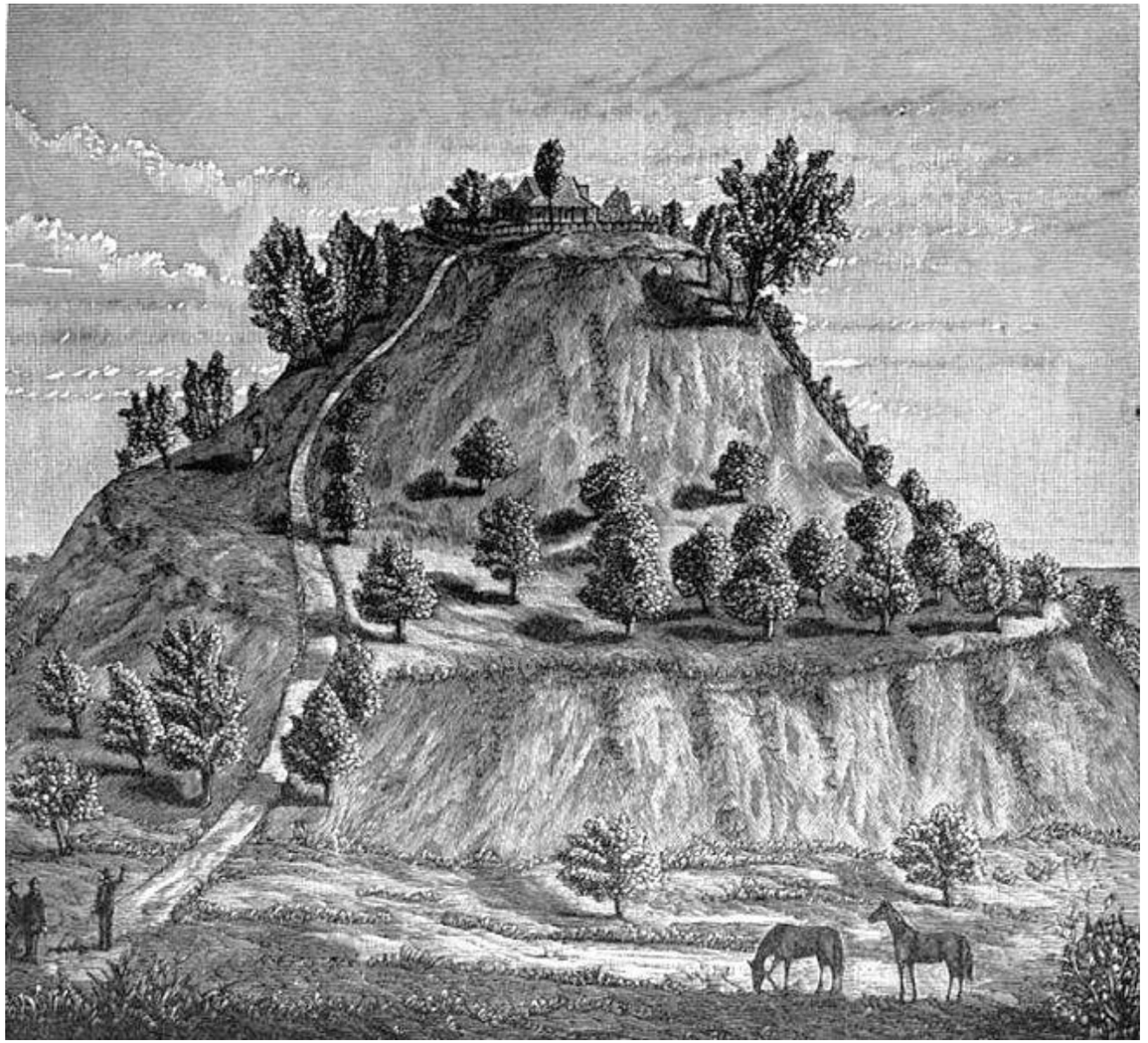
Lidar Contour Map by William F. Romain



Ponding in convolution #3,
photo by William F. Romain

Cahokia Mounds, Mississippian Period

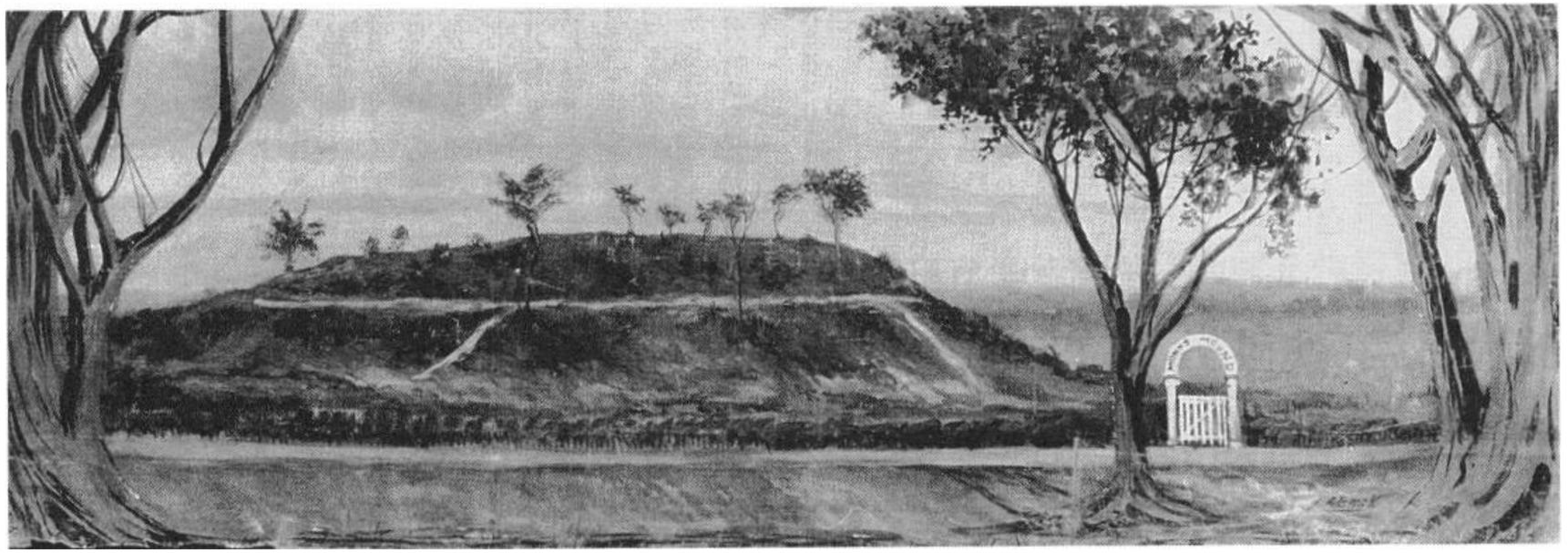
Occupied c.700 A.D. – 1400 A.D.



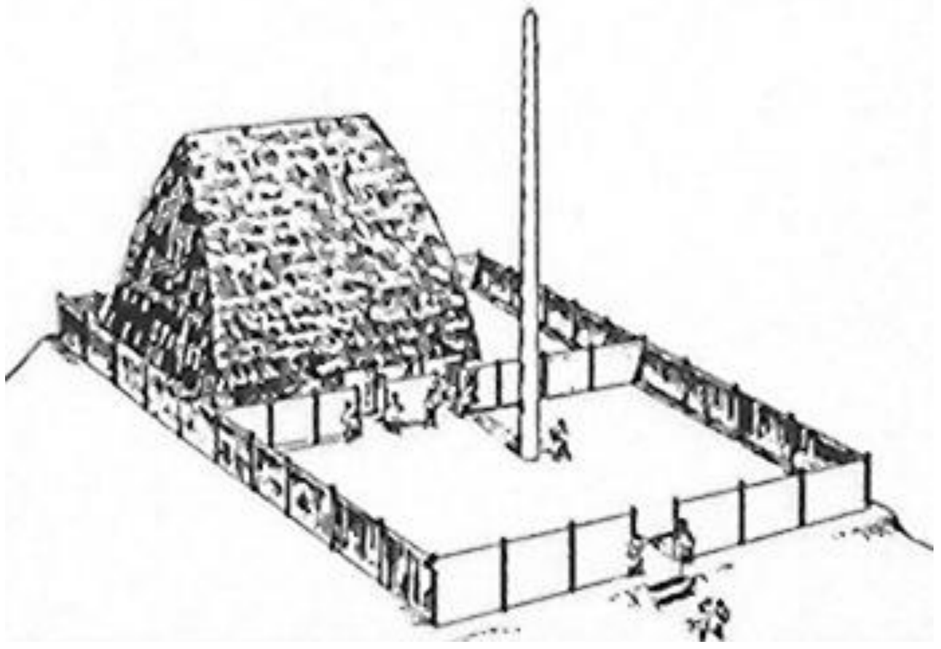
Monk’s Mound by William McAdams, 1887

Cahokia Mounds
Mississippian Period
Occupied c.700 A.D. – 1400 A.D.

Central Cahokia about A.D. 1150-1200



Mural of Monks Mound, c. 1912



The Fourth Terrace building was probably the residence of the leader and the religious/political focus of this urban center. A fenced courtyard with a huge post in the center, enclosed the fourth terrace.

In the 1830s Amos Hill built his farm complex on the Third Terrace and removed a small mound on the southeast corner. He is buried on the northwest corner of the Fourth Terrace.

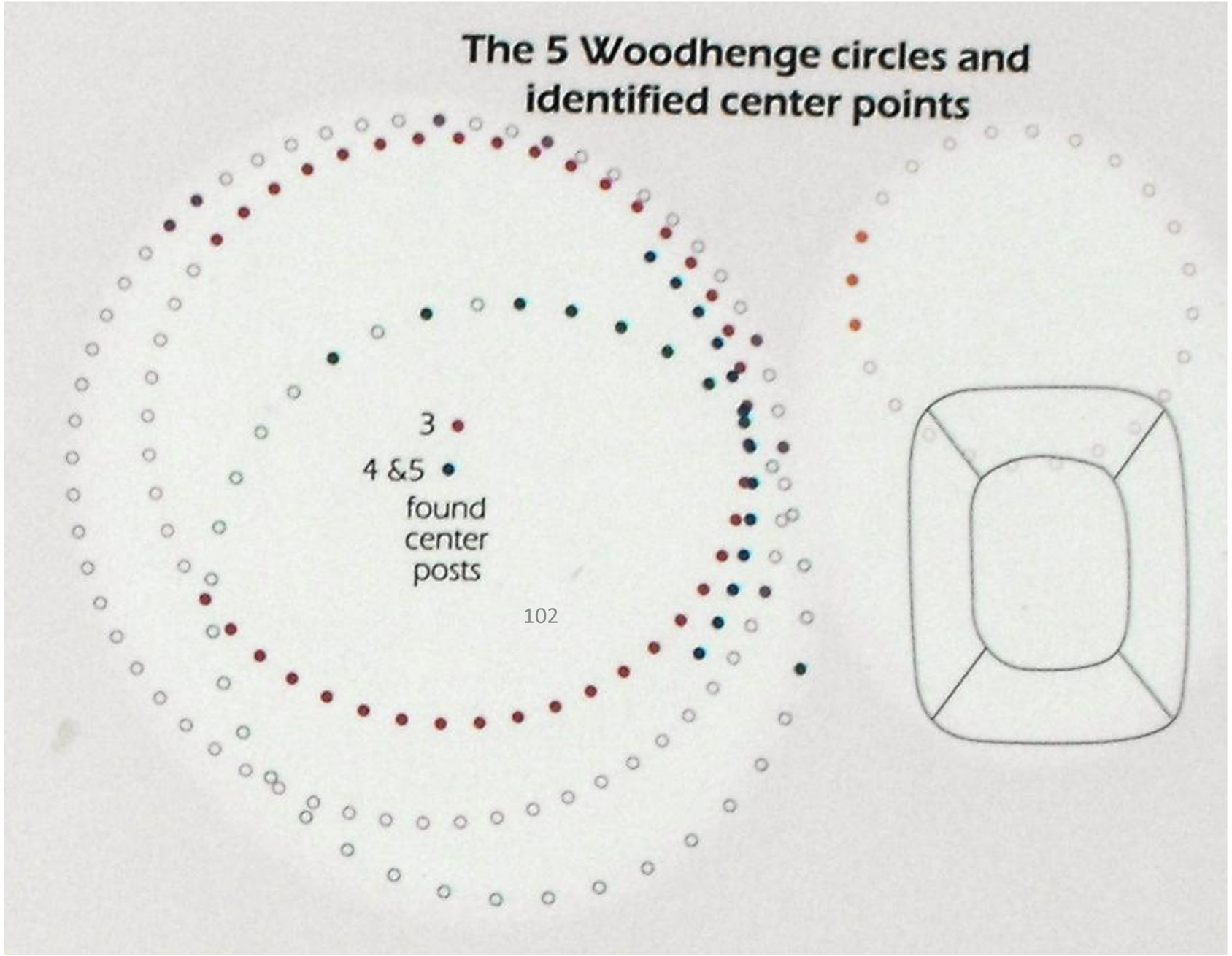
Looking west from atop Monk’s Mound, Feb. 2009

Monk’s Mound from the west, Feb. 2009

Woodhenge

Reconstructed Woodhenge, 2009

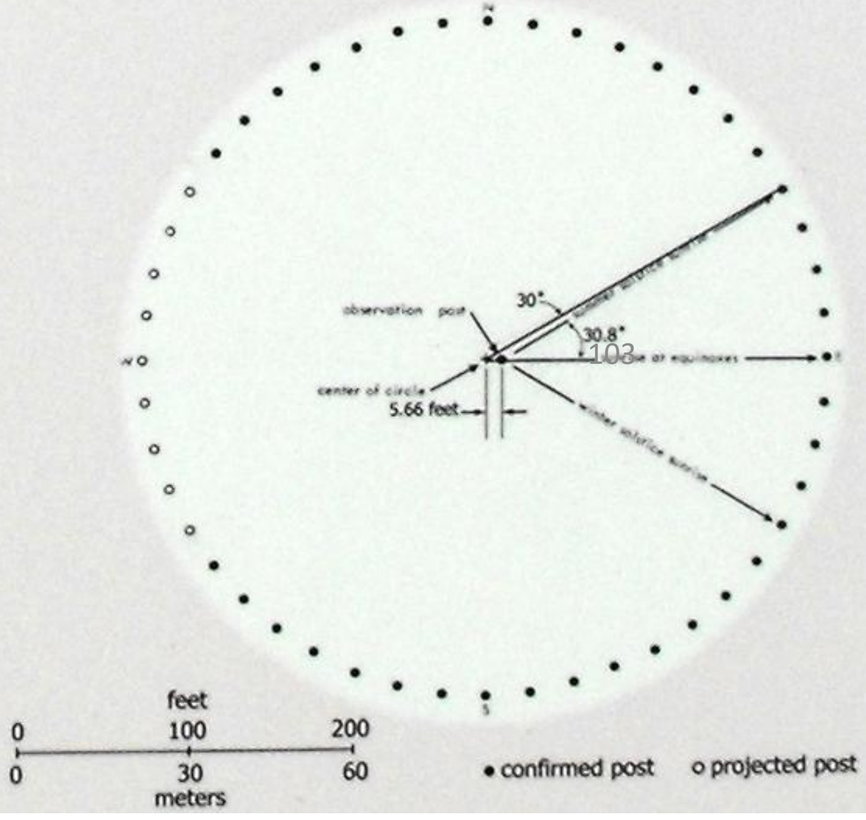
Early 1960's, Dr. Warren Wittry noted
post mold holes in arcs.
Calculated additional theoretical positions,
found numerous additional holes.
Evidence eventually found of
5 different "Woodhenges"


The 5 Woodhenge circles and identified center points
3
4 &5
found center posts

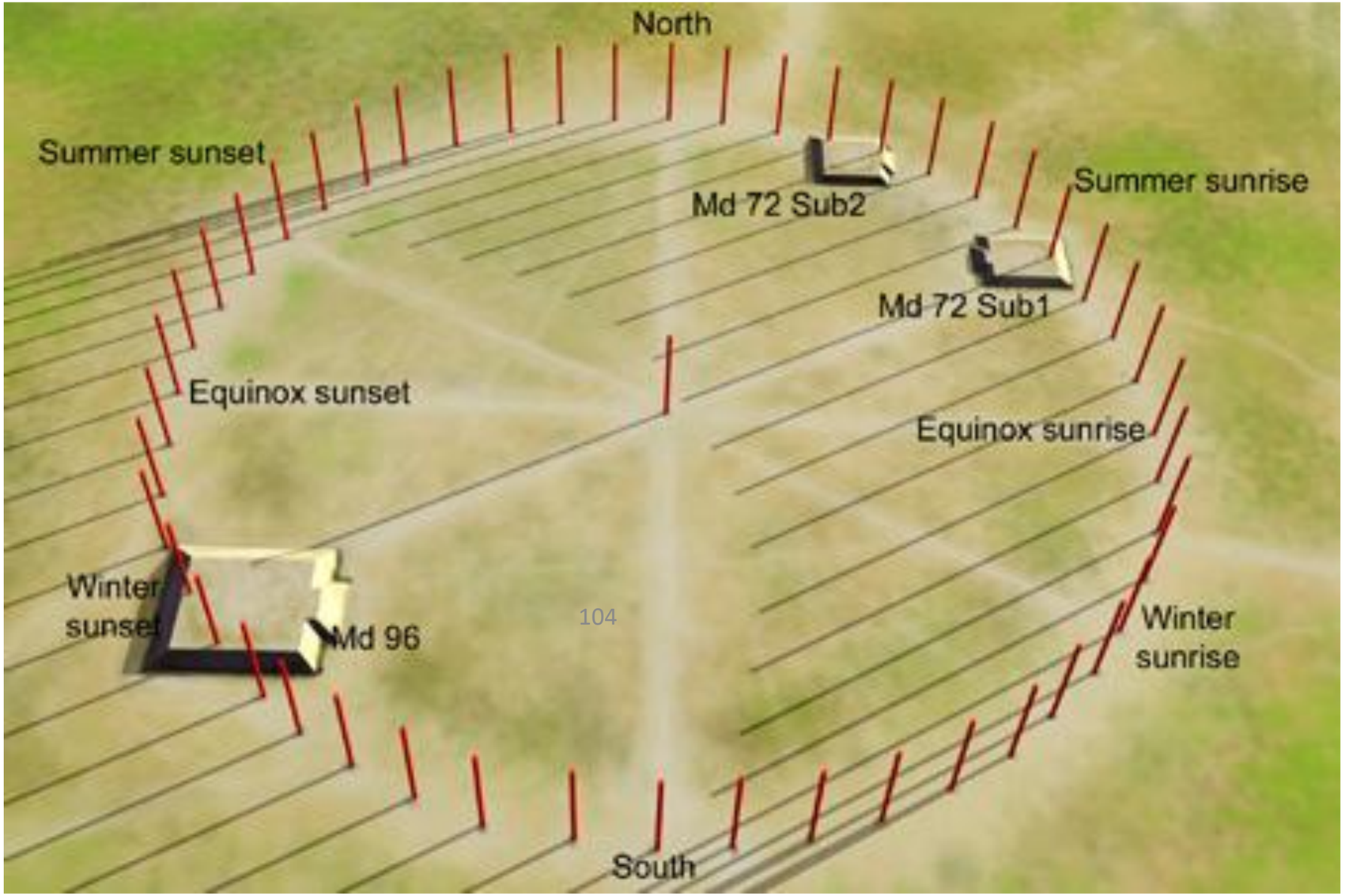
Circle Sequence	Diameter in feet	# of Posts	
Woodhenge I	240	24	
Woodhenge II	408	36	
Woodhenge III	410	48	reconstructed in its original location
Woodhenge IV	476	60	
Woodhenge V	466	13	in the sunrise arc (but if complete, would be 72)

confirmed post ●

projected post ○



Woodhenge III was reconstructed on its original site. Observer's post is slightly east of center point to form an angle of 30.8 degrees needed to sight solstices at this latitude.



Mound 72 Woodhenge, H. Rowe, Wikimedia

That rule ain’t for us, we’re special!

This photo ain’t me!

SESSION EVALUATION

2026 SURVEYORS' Conference

HTTPS://WWW.SURVEYMONKEY.COM/R/PSLS2026EVAL