GeoTechnologies making sketches of the past landscapes

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Geo-Technologies as a means for the Study and Reconstruction of the Archaeo-environment

Experimentation with new algorithms

Spatial analyses and new parameters

Interpretation models

Reconstruction of the Archaeo-environment

- Decoding of the memoirs of Archaeolandscapes
  [memories of past events, routes, habitation, activities, territories, ancestry, etc]

GEOPHYSICAL APPROACHES IN ARCHAEOLOGICAL RESEARCH

- For the last 20-25 years geophysical techniques have been advanced in terms of

time

- sensor technology (faster response, higher sensitivity, less power consumption, storage capacity, …)
- mobility of instrumentation (higher portability)
- semiautomatic navigation
- speed of coverage of the sites / fast reconnaissance

- Recent emphasis to the multi+ sensor component of research:
  - multi-magnetometer systems
  - multi-antenna GPR platforms
  - multi-electrode soil resistance configurations

BUT we also notice an overwhelming trust on using only one of these methods with emphasis to the quantity of data and coverage area.

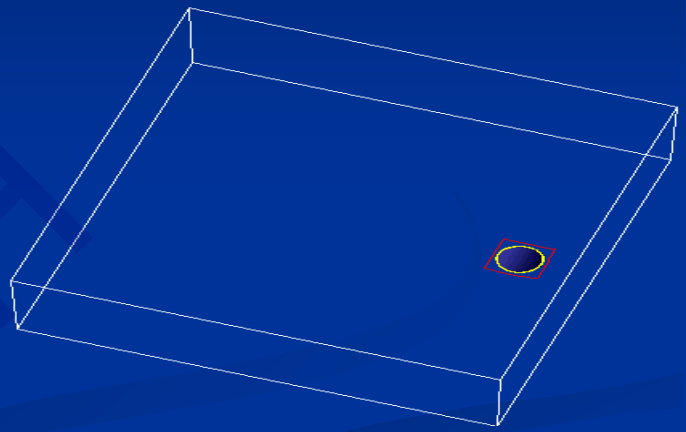
"Why is it that you physicists always require so much expensive equipment?

Now the Department of Mathematics requires nothing but money for paper, pencils and waste paper baskets and the Department of Philosophy is better still. It doesn't even ask for waste paper baskets."

Anonymous University President
(Barrow & Tipler, 1988:185)

THE "MANIFOLD" GEOPHYSICAL UNIVERSE:

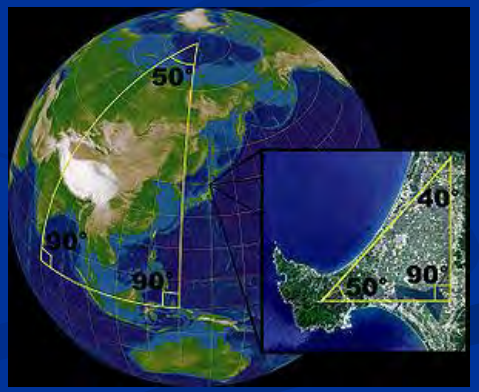
In topological terms, a manifold is a topological space that has a local diffeomorphism (differences in distances and angles) with respect to the usual Euclidian space. At a small scale, a manifold bears a resemblance to the actual Euclidean topology, but in terms of a more global scale a manifold can be much more complicated.



It is like we imagine a sphere, each small tangential section of which can be represented In a 2D surface, the mosaic of which can provide a representation of the surface of the sphere.

Manifold geophysics employs a variety or diversity of methods to approach a variety of archaeological questions and topics (Sarris, 2012).

In our case MORE is with respect to the wealth of information



http://en.wikipedia.org/wiki/Manifold

http://www.research.ibm.com/people/h/henderson/Continuation/Torus/Torus.html

Habitation Patterns of the Neolithic Agricultural Villages in Eastern Thessaly (Greece) Through Remote Sensing Applications

IGEAN (Innovative Geophysical Approaches for the Study of Early Agricultural Villages of Neolithic Thessaly) project, is implemented under the "ARISTEIA" Action.

A multi-year geophysical and remote sensing project for the study the physical landscape and social dynamics of Neolithic settlements within the coastal hinterlands of eastern Thessaly (Greece).

www.igean.ims.forth.gr

AIMS: Application of non-destructive, remote sensing techniques to explore multiple settlements & extract new archaeological data on an extensive scale, to analyze the broader characteristics of Neolithic habitation in Thessaly.

THE SIGNIFICANCE OF THE AREA NEOLITHIC THESSALY (6800-3200 BC)

Sesklo

Early Neolithic (7th millennium BC) - Middle Bronze Age, with its peak in Middle Neolithic (5th millennium BC)

Dimini

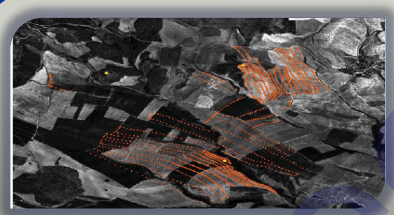
Late Neolithic period (end of the 5th millennium BC) - Late Bronze Age

Chronology of Research in Neolithic Thessaly

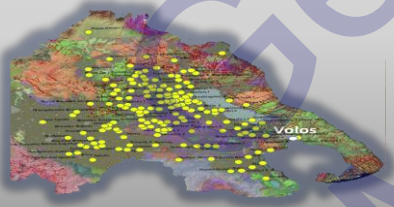
1901-1903: Excavations at Sesklo and Dimini
1908: Excavations at Zerelia

1960-1977: Trial Excavations at several neolithic sites by D.R. Theocharis and Vl. Milojcic
1977-1979: Excavations at Dimini by G. Hourmouziades

1984: Halstead's catalogue of prehistoric sites in Thessaly, based on a survey made by French
1992: Gallis' catalogue of sites in E. Thessaly.



1990-present: Field survey in Almiros plain 13th EPCA & the Netherland Institute at Athens
1990-2005: Rescue excavations (national road, Lake Karla)



2005-present: Extensive satellite R.S. & geophysical surveys by GeoSat ReSeArch Lab of IMS (FORTH). PENED (2005-2007), INSTAP (2006-2010), ARISTEIA (2013-2015)

Status of knowledge of the Neolithic Landscape in Thessaly

http://neolithicthessaly.ims.forth.gr/

Registration and GPS mapping of Neolithic settlements in Thessaly

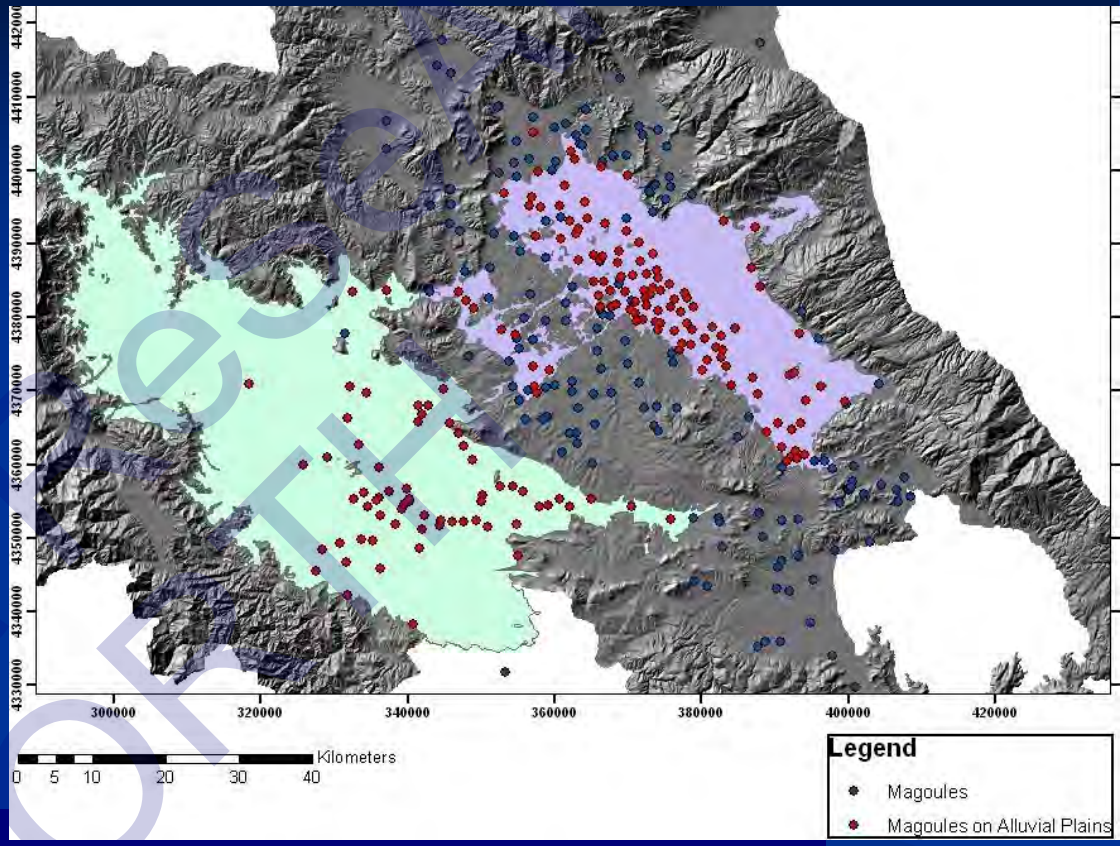
&

GIS analyses for :

the management of the natural landscape

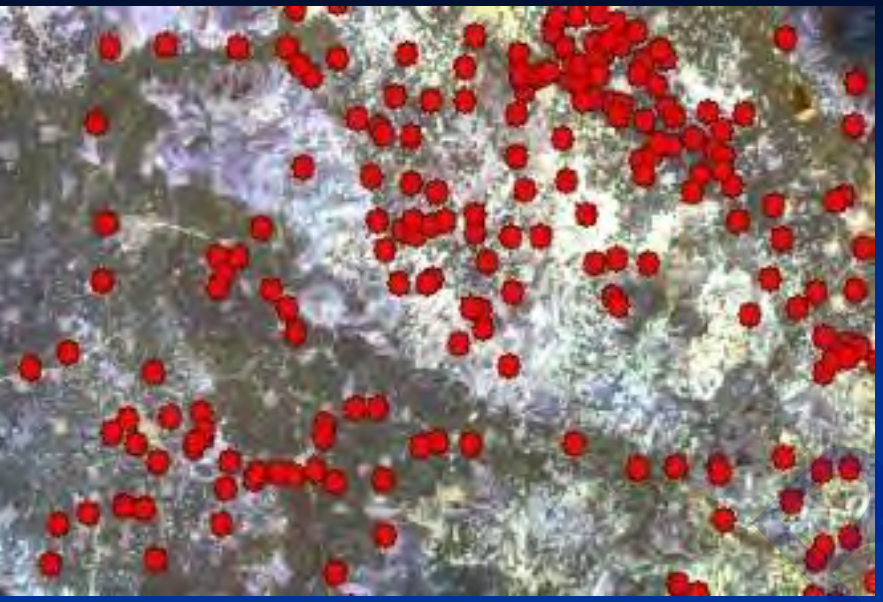
&

site distribution patterns among ecological and topographic zones of Thessaly.

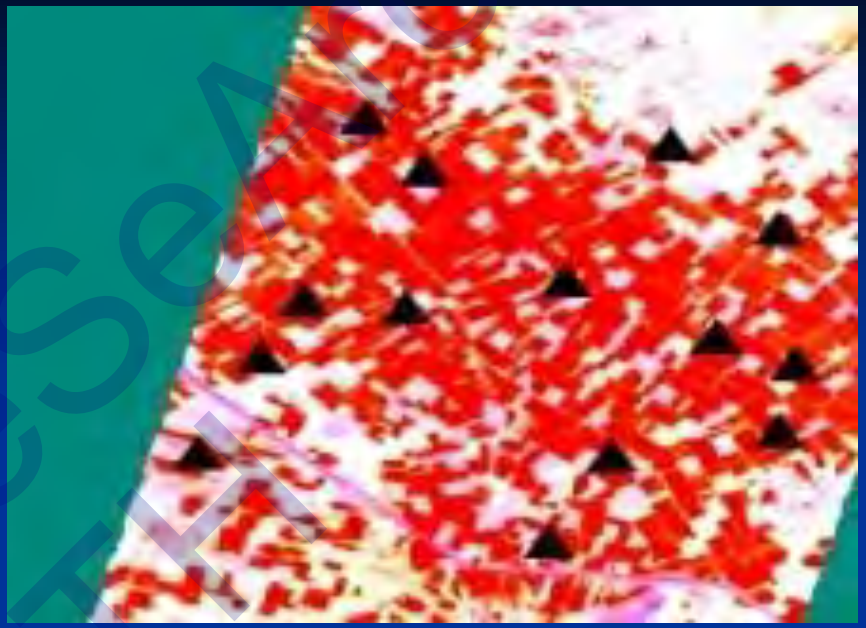


- 342 documented magoulas
- 181 sites (53% of the total) are established on alluvial deposits & 81 sites on fluvial deposit areas.
- These formations are of low altitude & are ideal for cultivation.

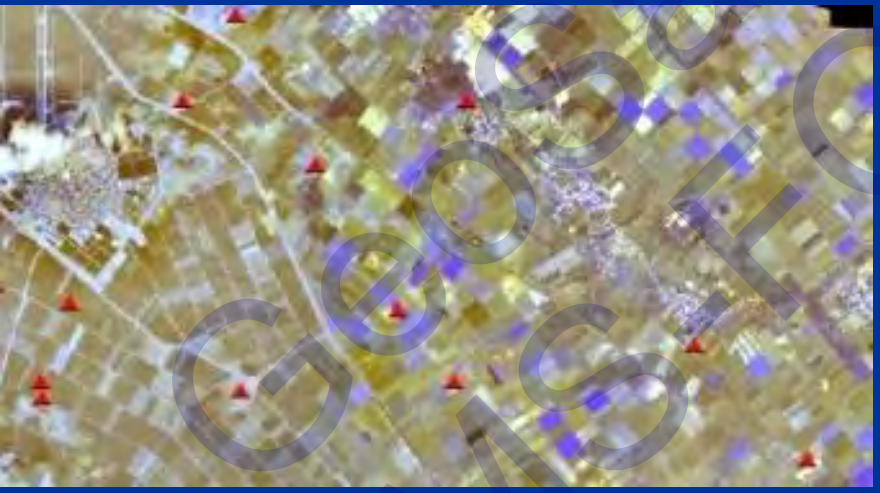
Satellite Remote Sensing



Color composite RGB → 1,2,3 of Landsat image



PCA product of Hyperion image



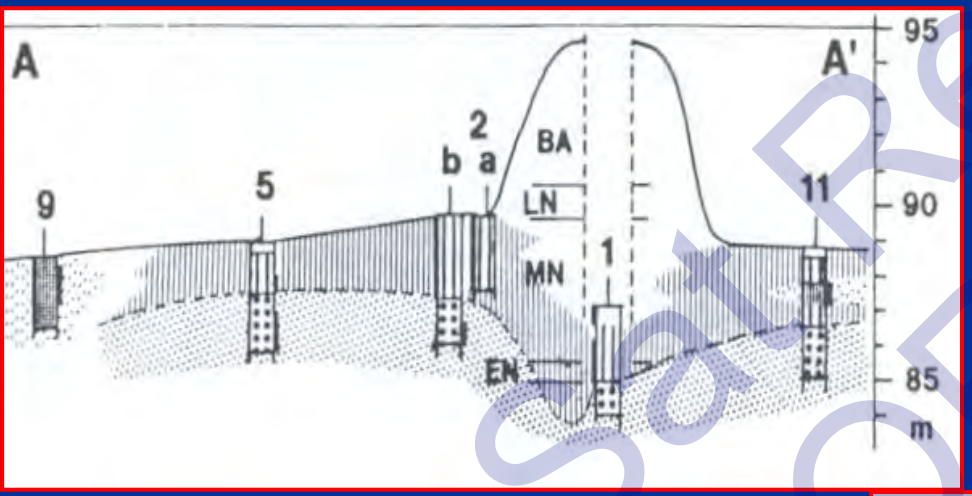
Mosaic of IKONOS images.

Mosaic of aerial - photo images.

Landscape Reconstruction /Geomorphological Regime

Microtopography Elevation Model around the "Magoules"

- Height of "Magoules"
- Cross section of Platia Magoula Zarkou from V. Andel et all.



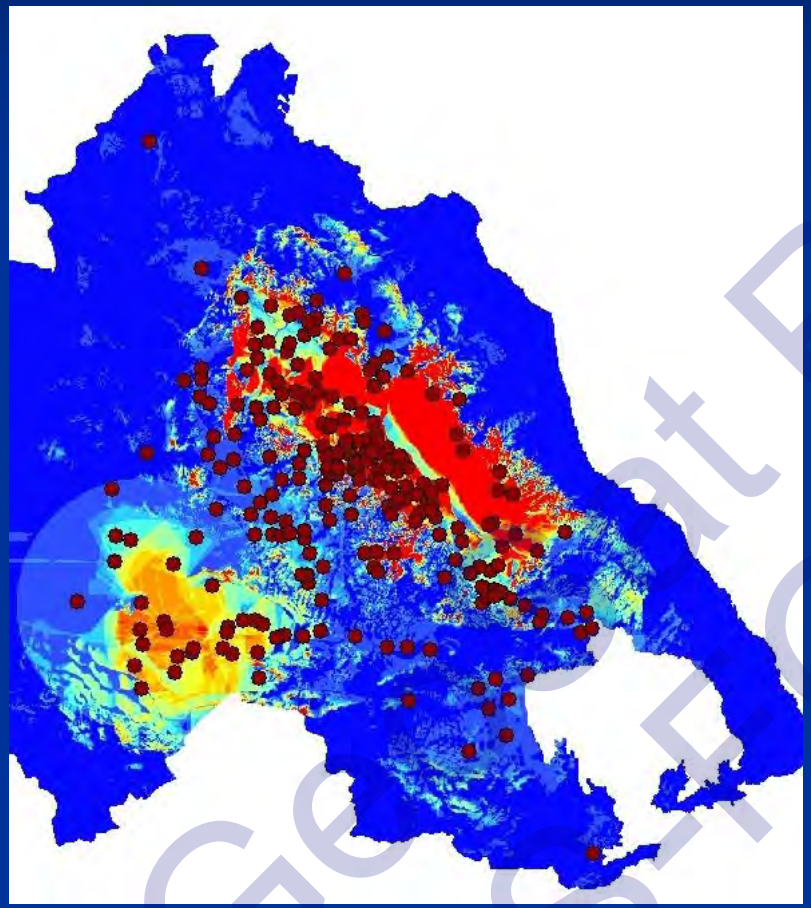
Combining the alluvial deposits height with the relief height of drill cores

	Karditsa Basin			Larisa Basin	
Villages	dy =deposits height	y= drillcore relief height		dy =deposits height	y= drillcore relief height
Nomi	15	91	Stefanovikeion	60	56
Palaiohorion	13	97	Lofiskos	40	57
Ypereia	5	97	Eleutherion	56	60
Magoulitsa	13	110	Falanna	12	64
Lofos	22	112	Giannouli	19	70
Krinoi	18	155	Dendra	11	84

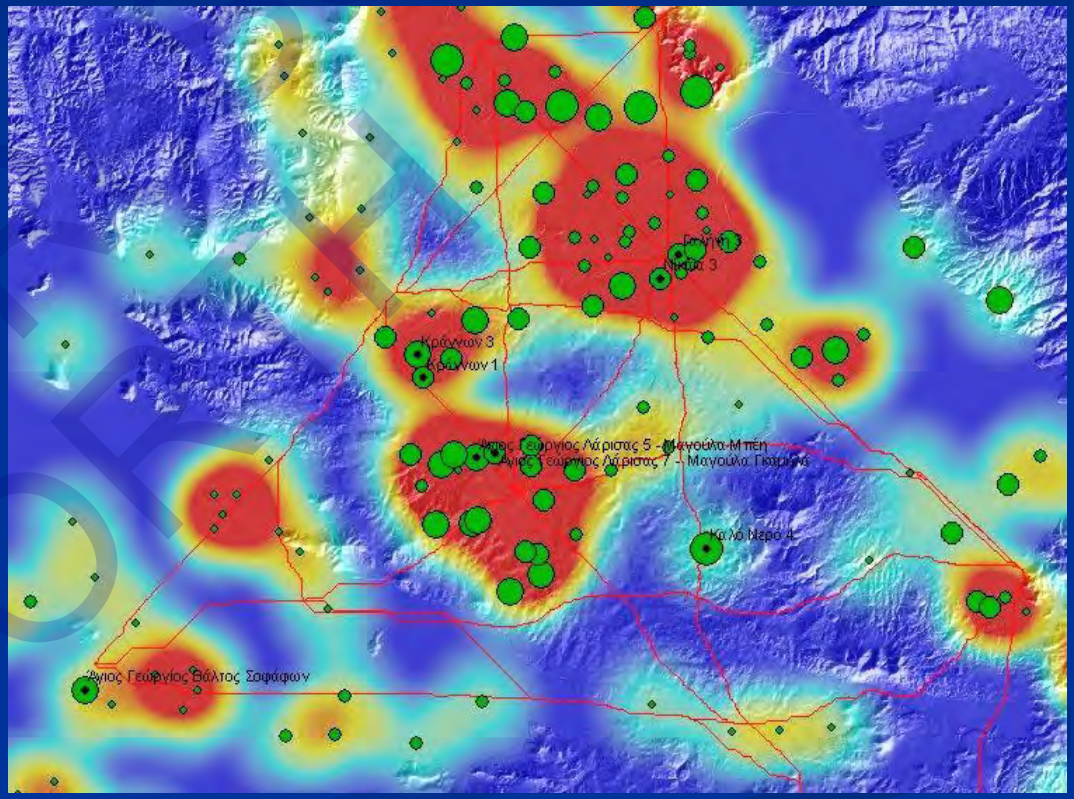
GIS Analysis

On the reconstructed DEM

Viewshed maps



Persistence in habitation by examining Clustering, Viewsheds & Communication



Moving from the regional scale to the local scale

Area of interest

Manifold Remote Sensing Approach

Methodologies – Multi-magnetometer & Single sensor magnetometer Techniques

Sensorik & Systemtechnologie (SENSYS) MX Compact system

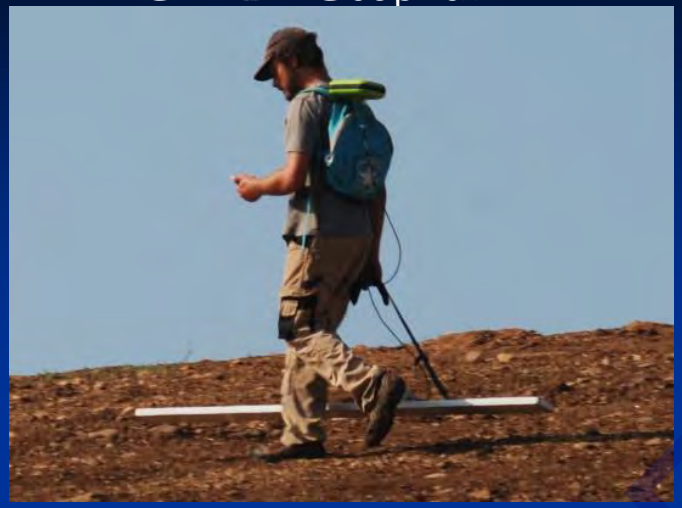
8 multi-channel measurement system Equipped with FGM600 fluxgate gradiometers separated by 0.25-0.5m & connected to a DGPS navigation system

Ideal for large-scale scanning

Bartington single sensor unit also in use in thick vegetation areas

Methodologies – Electromagnetic Techniques

GEM2 - Geophex



CMD Mini explorer– GF Instruments

Depth of investigation

	GEM2		CMD Mini explorer			
Electrical conductivity	HCP	2.5 m	HCP	0.5 m	1 m	2 m
			VCP	0.3 m	0.7 m	1.3 m
Magnetic susceptibility	HCP	1.7 m	HCP	0.2 m	0.5 m	1 m
			VCP	0.3 m	0.7 m	1.3 m

Ideal for large-scale scanning

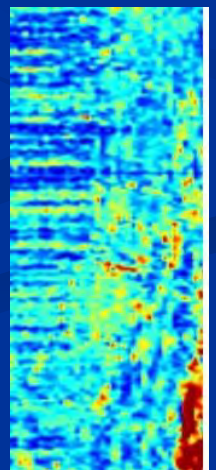
Methodologies – Ground Penetrating Radar (GPR)

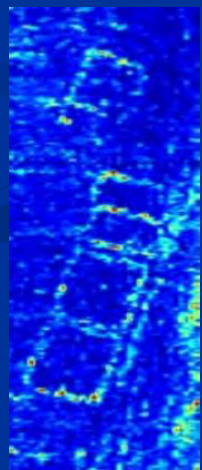
8 channels MALA MIRA GPR,
400 MHz antennas
Sampling 10 cm x 2.5 cm

Sensors & Software
Noggin Plus System with 250 MHz antennas
Sampling 50 cm x 2.5 cm

Penetration Depth ~2.5m

Before and after processing





Methodologies – Soil Resistance Techniques

Geoscan Research RM85 resistance meter

Twin Probe array of electrodes with spacing a=1m

Penetration Depth ~1.5m

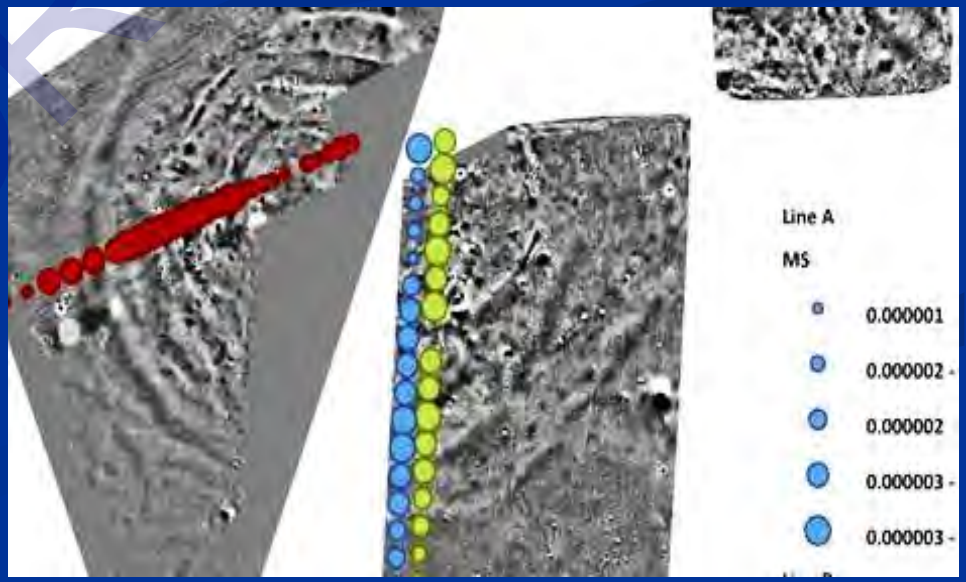
Methodologies – Magnetic Susceptibility Measurements

Coring and soil analysis in the Lab.

Bartington MS2B Double Frequency sensor

Low & High Frequency susceptibility & Frequency dependent susceptibility

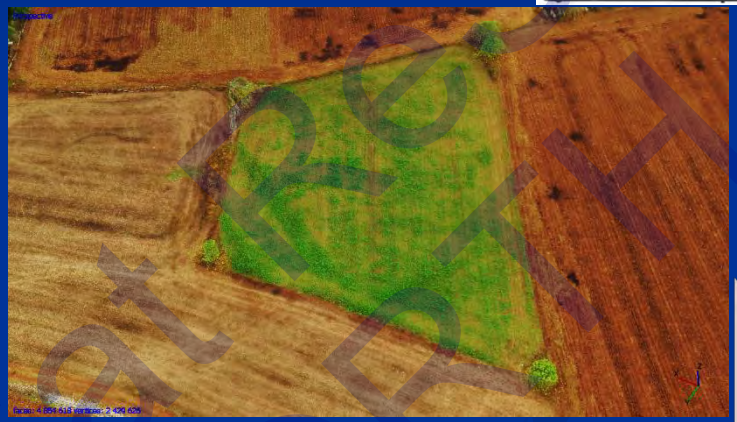
Phosphate analysis / Petrographic



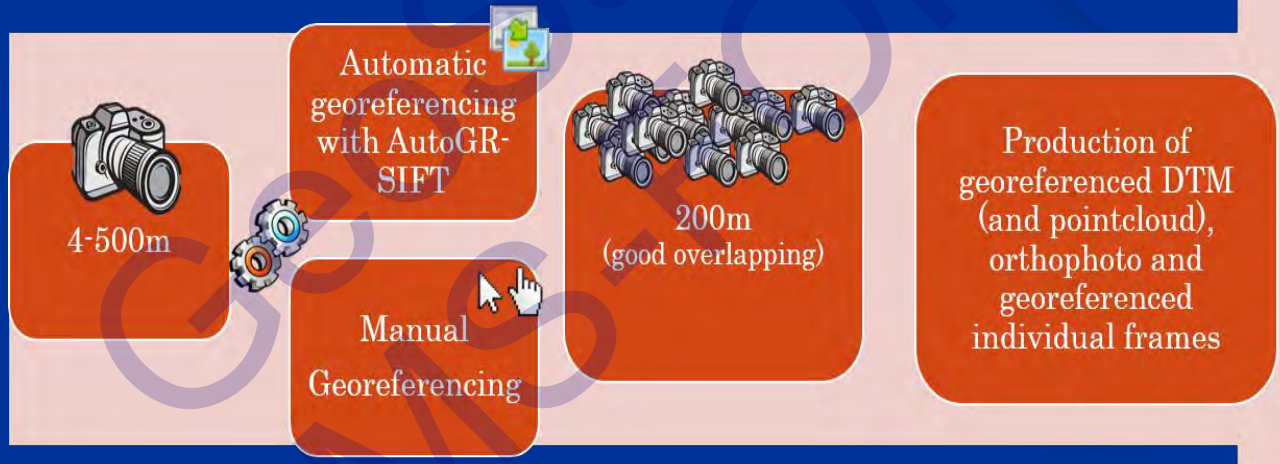
Methodologies – Aerial Photography

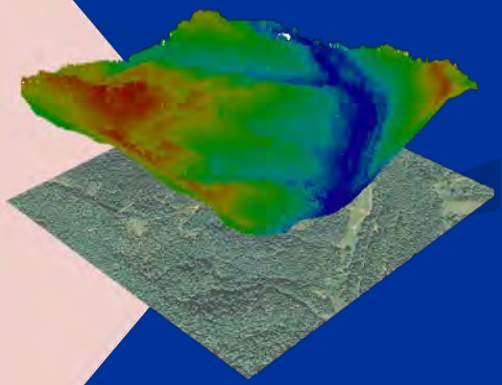
Quadrocopter DroidWorx CX4

- DJI navigation, viewpoint and failsafe
- Average altitude 100-200 m above surface
- Autonomy ~13-15min with camera load



- Canon S100 w/ GPS (or similar)
- Low budget to limit failure costs
- Canon: CHDK hacking system for intervallometer
- Mainly mounted for ortho-view with 2D stabilizing gimbal



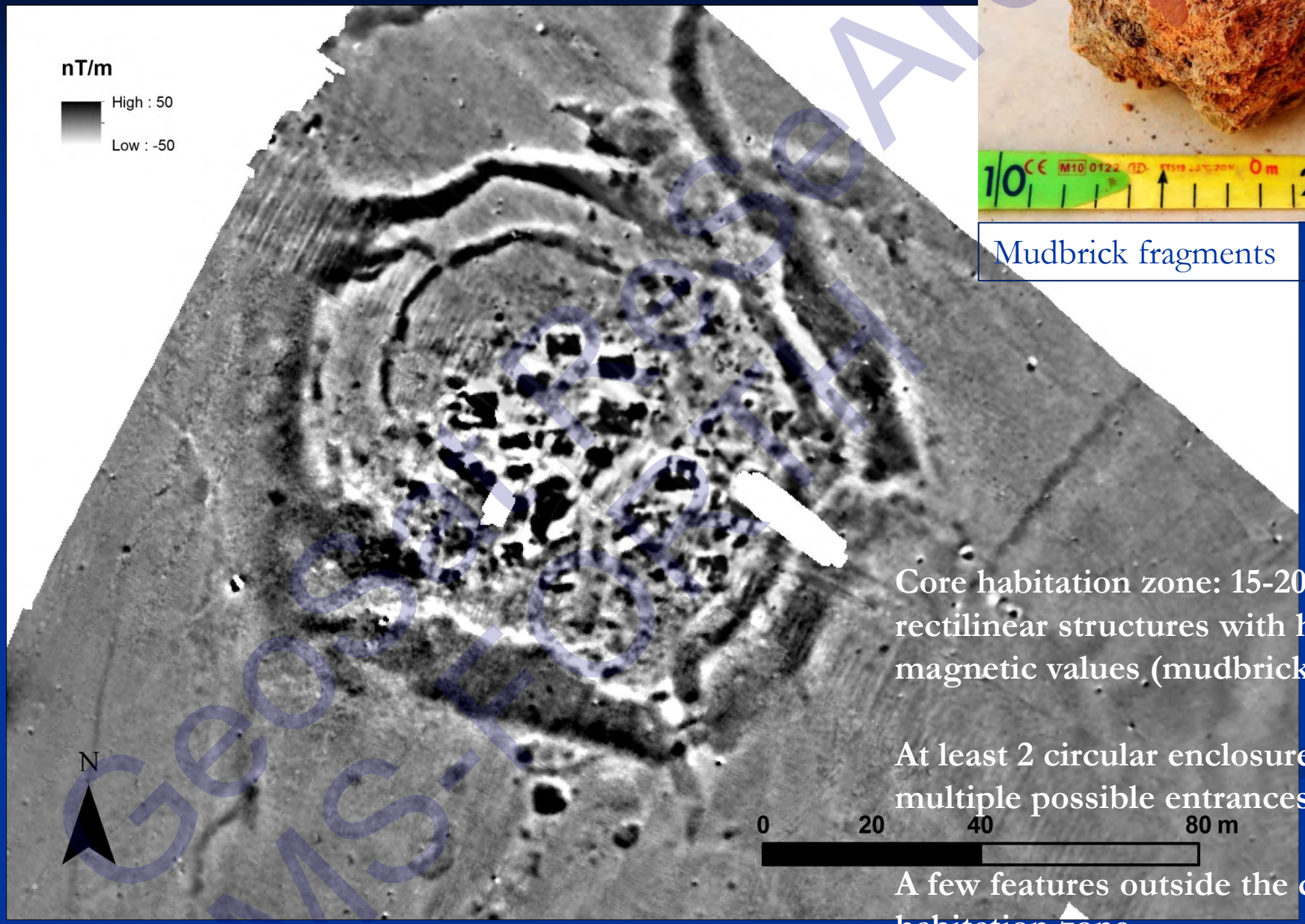


SITE	COVERAGE (in hectares)			
	Magnetics	EM	GPR	UAV
1. Almiriotiki	8.42	7.75	1.28	20.84
2. Almiros 2	6.60	2.39	0.37	7.31
3. Bakalis	0.45	0.36	0.29	-
4. Belitsi	1.32	1.78	0.37	11.74
5. Eleutherochori	-	0.18	0.18	-
6. Kamara	0.88	1.06	0.10	-
7. Karatsangliou	2.96	1.20	0.37	13.22
8. Karatsantagli	2.71	0.58	0.20	12.38
9. Kastro Kokkinas	1.08	0.72	0.09	-
10. Nikonanou	2.91	1.37	-	-
11. Mati	3.33	2.40	0.32	-
12. Perdika 1	5.19	2.32	0.44	-
13. Perdika 2	3.90	2.21	0.32	-
14. Rizomilos 2	10.48	3.16	0.36	-
15. Visviki	5.12	-	1.90	-
16. Zerelia	4.83	1.88	0.72	33.88
TOTAL (<5 weeks fieldwork)	**60.18**	**29.36**	**7.31**	**99.37**

Almiros 2

Early Neolithic – Middle Neolithic

Almiros 2 – Magnetics



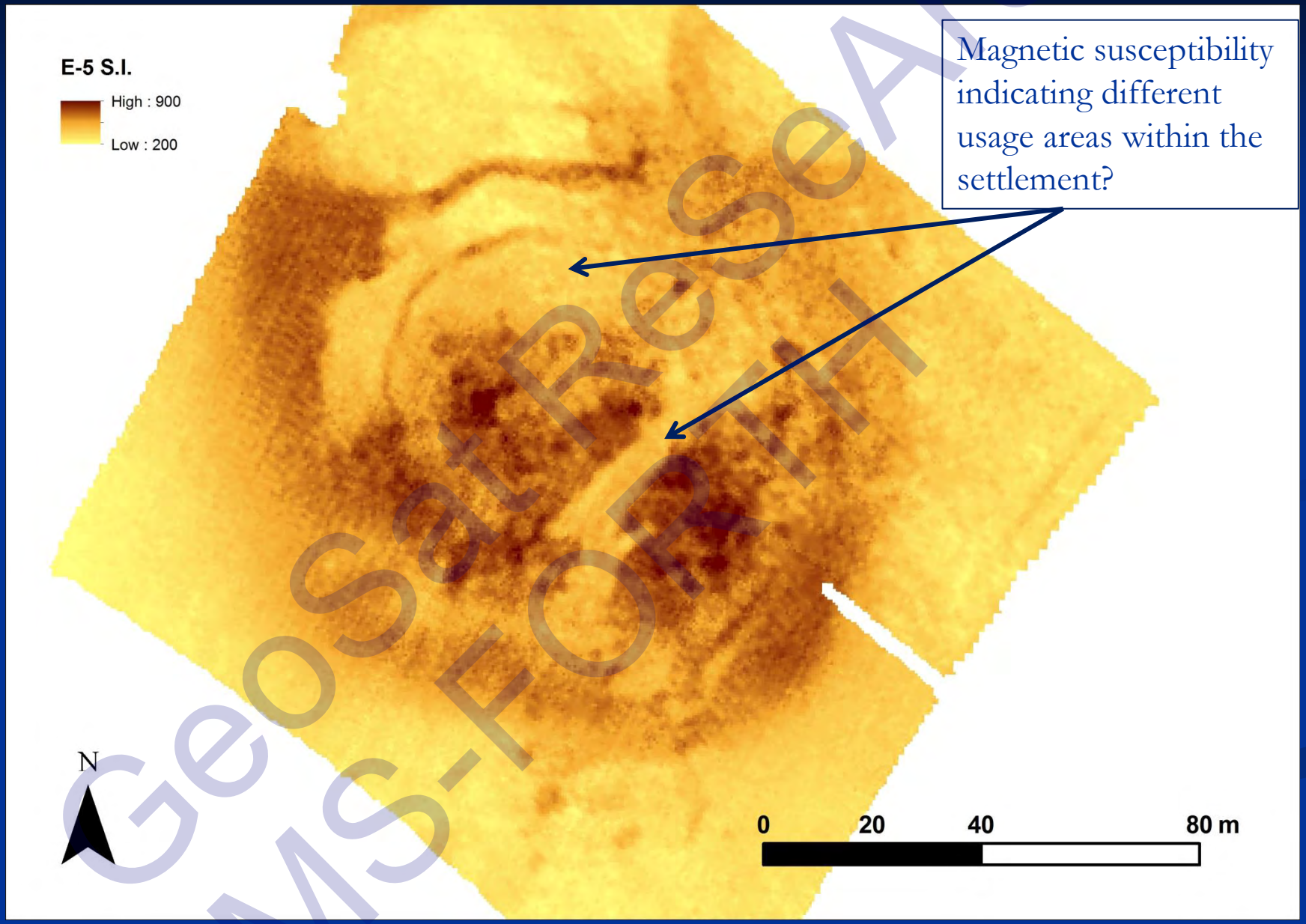
Mudbrick fragments

Core habitation zone: 15-20 rectilinear structures with high magnetic values (mudbrick?)

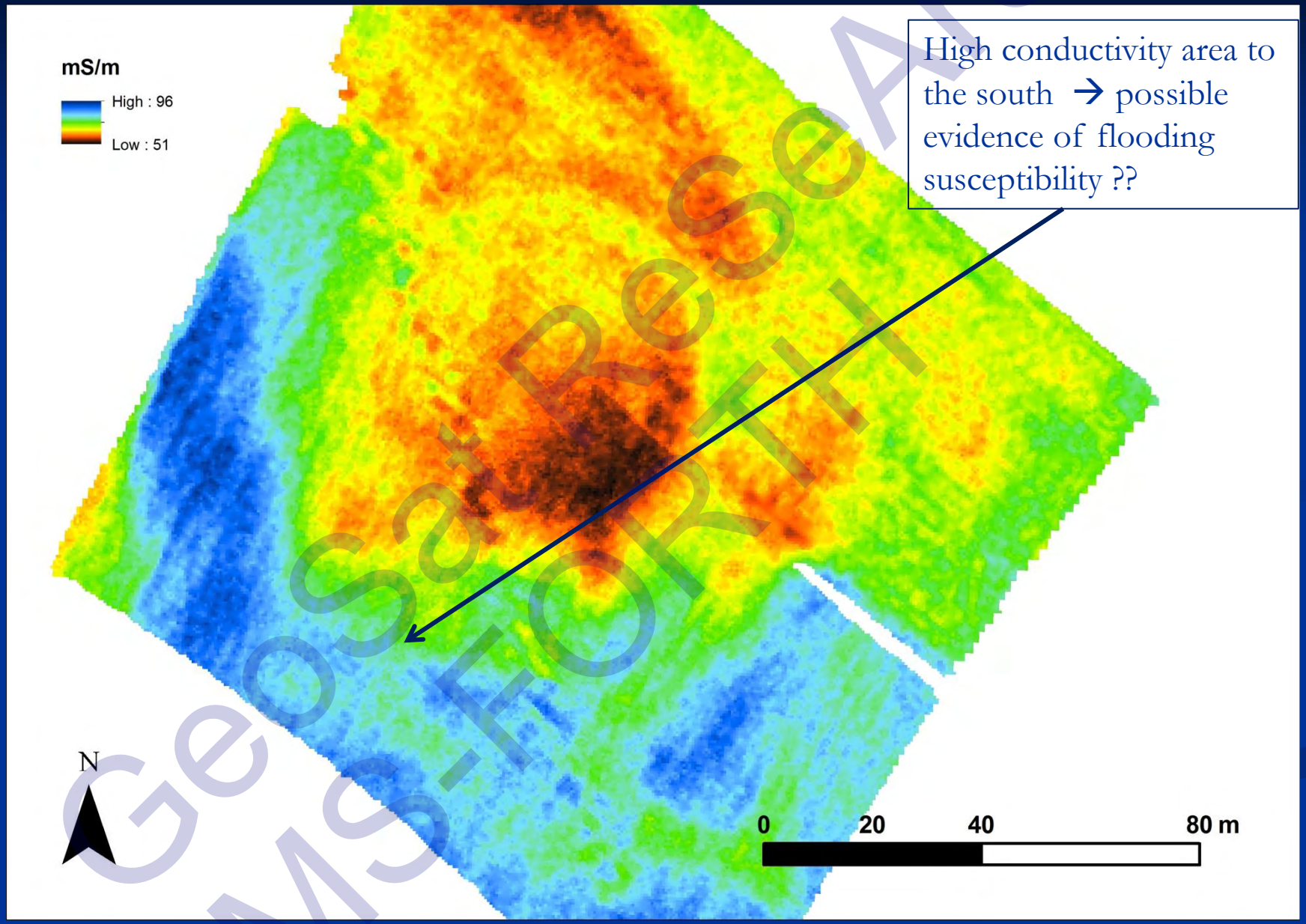
At least 2 circular enclosures & multiple possible entrances

A few features outside the core habitation zone

Almiros 2 – EM Susceptibility (HCP for 0-1.7 m depth)

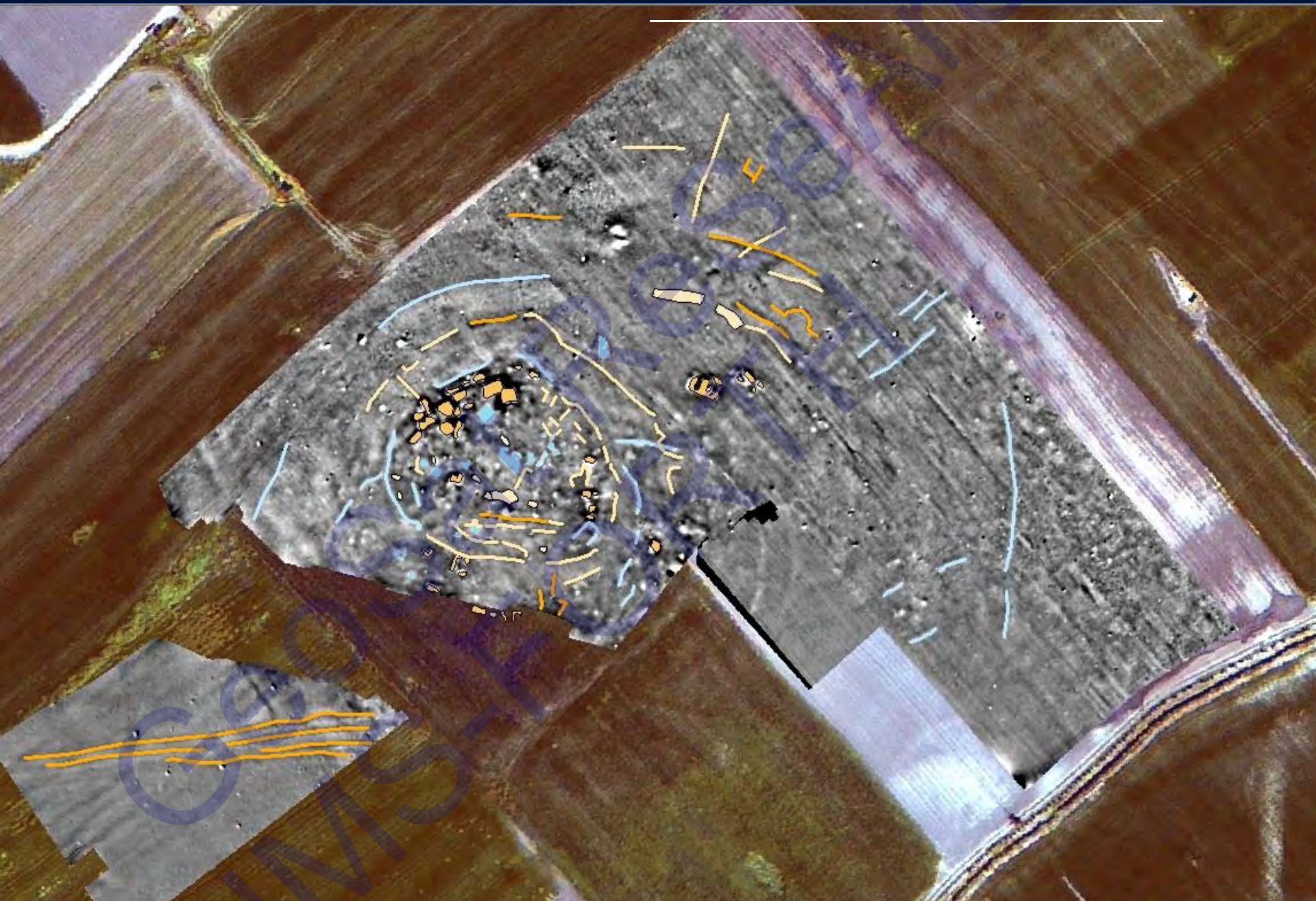


Almiros 2 – EM Conductivity (HCP for 0-2.5 m depth)



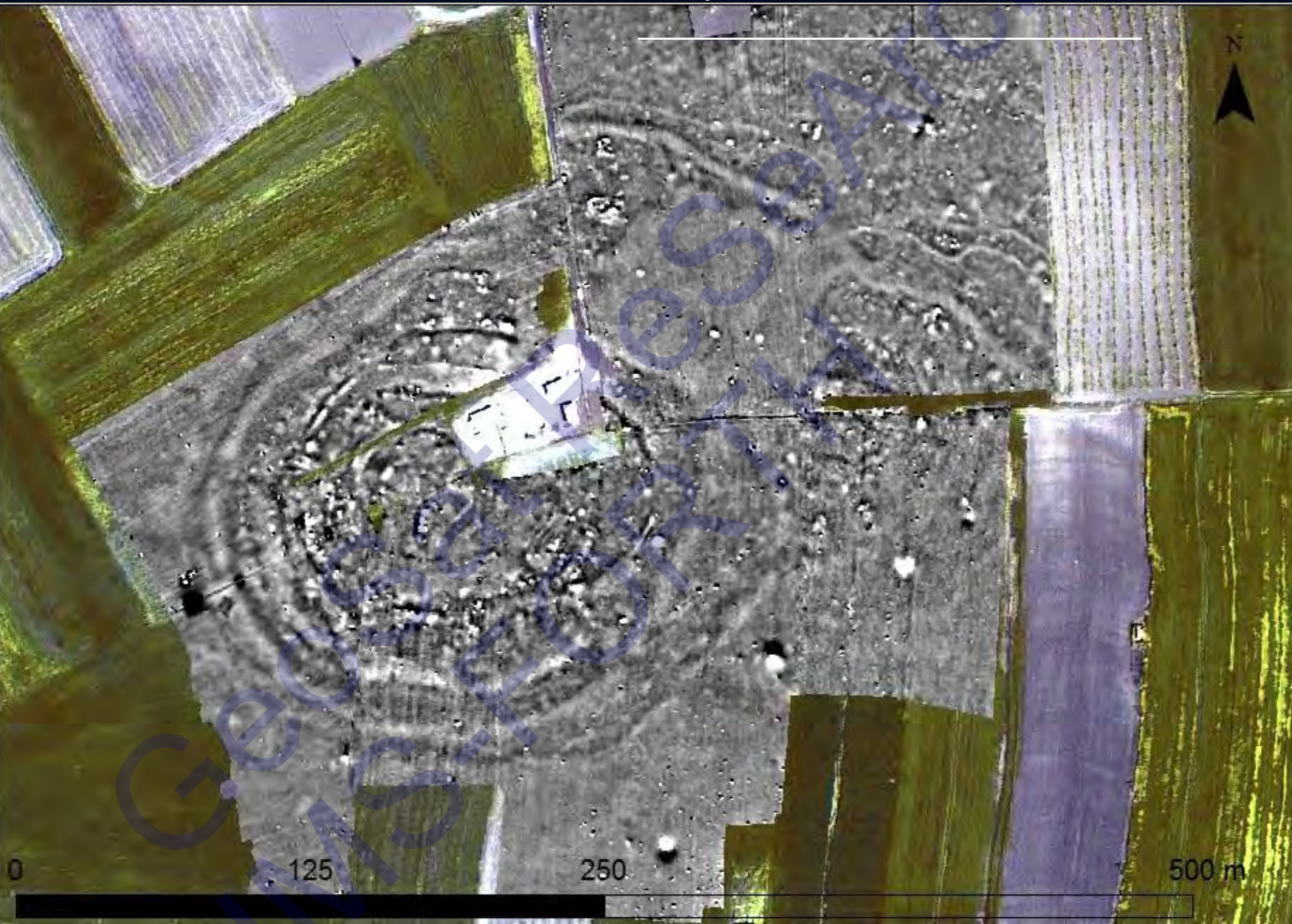
Velestino 4

Early Neolithic – Middle Neolithic Period



Rizomilos

Early Neolithic – Late Neolithic Period

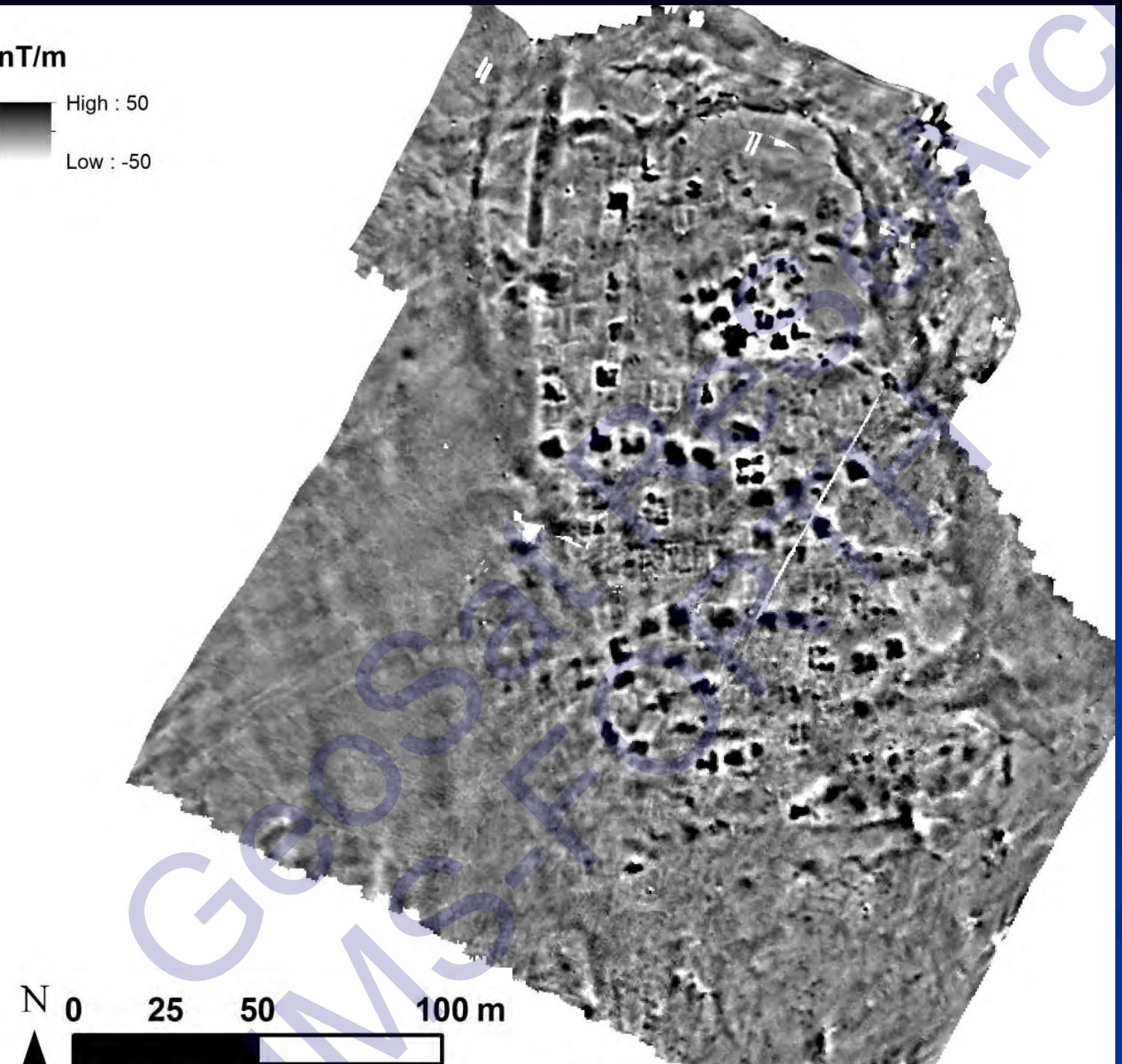


Perdika 1

Early Neolithic – Middle Bronze Age

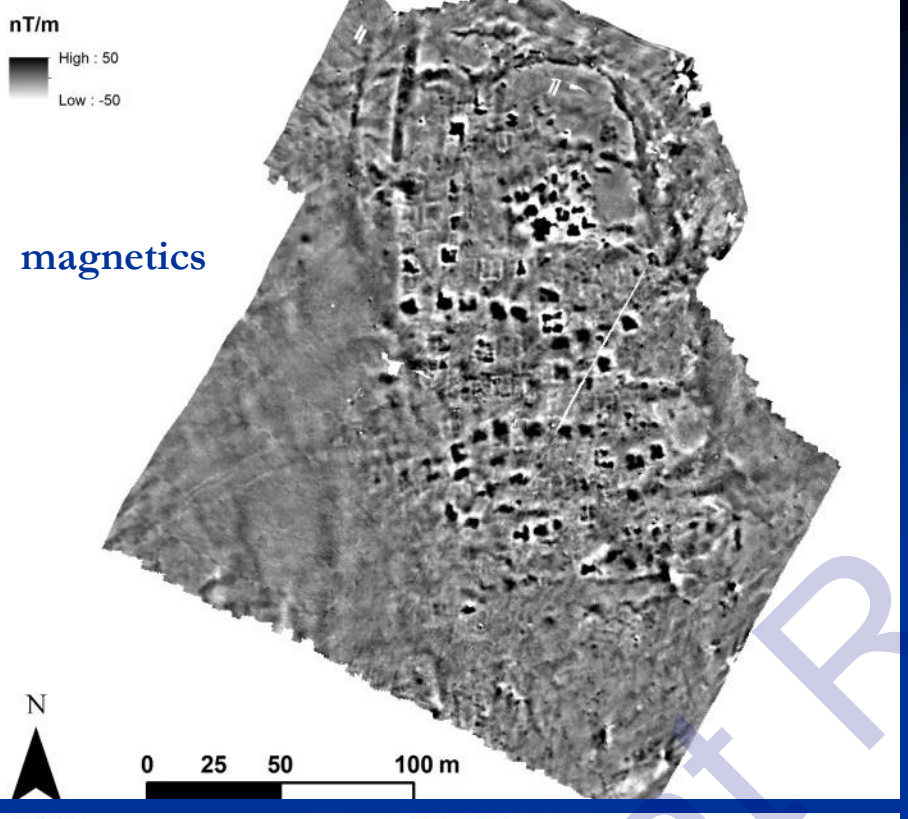
Perdika 1

Magnetics

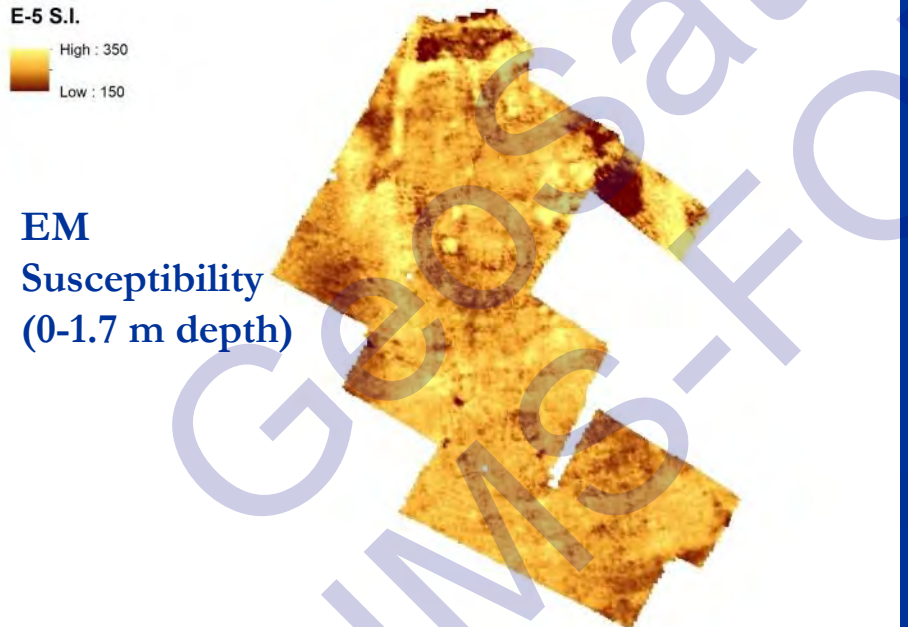


Perdika 1

Early Neolithic – Middle Bronze Age



magnetics



EM Susceptibility (0-1.7 m depth)

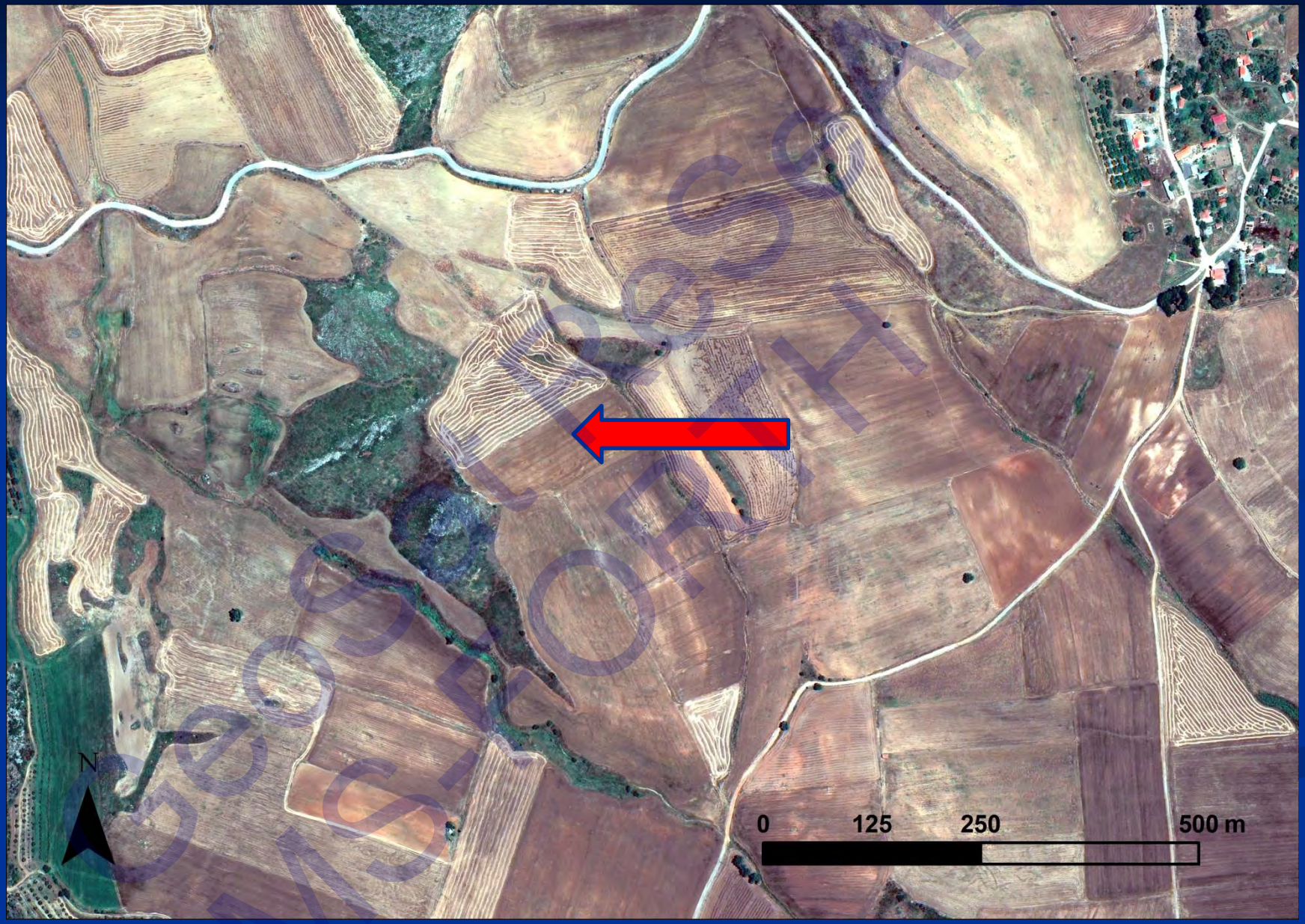
- Extensive settlement (>200x100m) that greatly expands beyond a core habitation zone on the highest level

- 50+ rectilinear structures

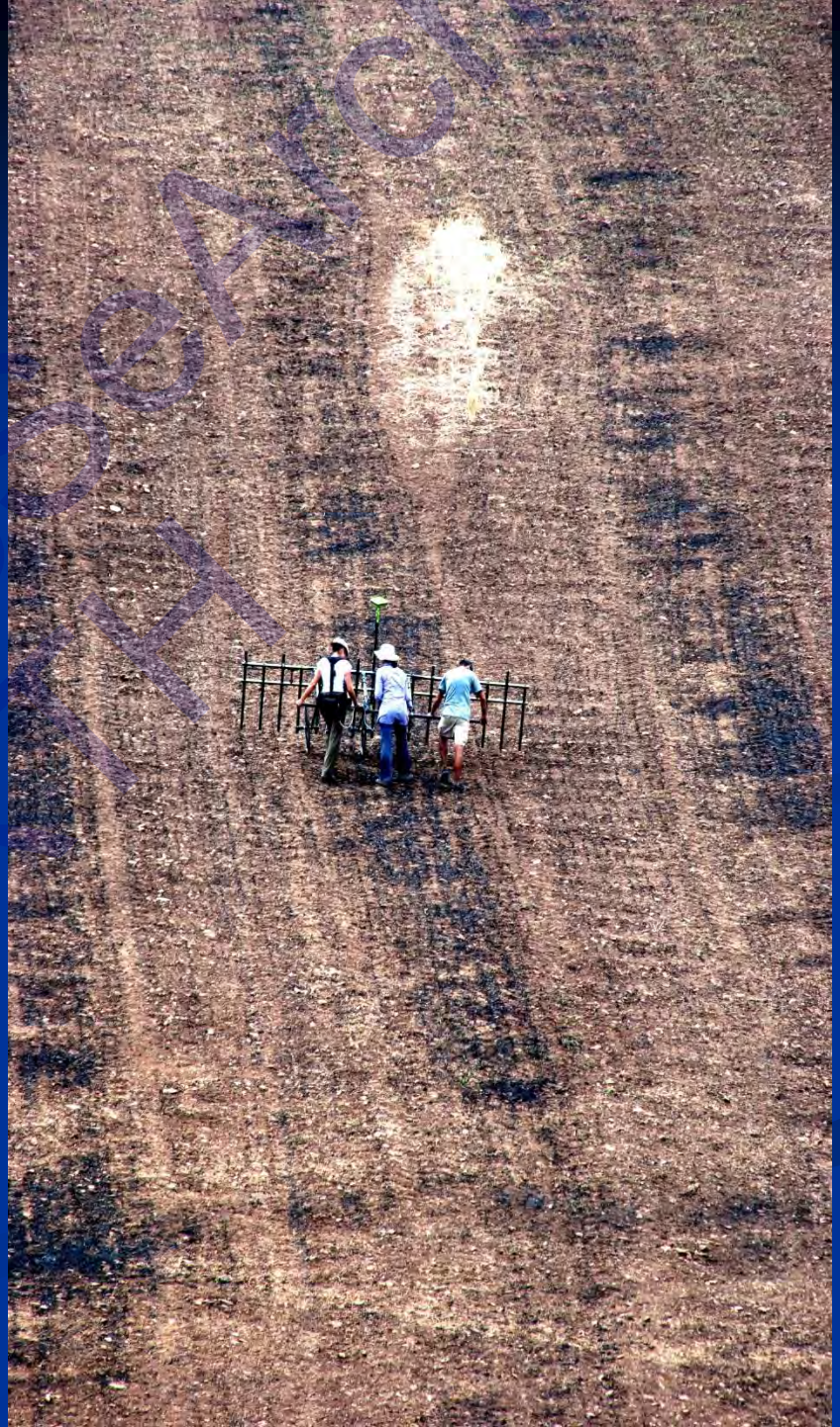
- The majority of structures have high magnetic values (mudbrick), but others have low magnetic values (stone) with 2-3 rooms (similar to Almiriotiki)

- Ditches and or walls preserved on the northern side of the settlement

Perdika 2 Early Neolithic – Middle Neolithic

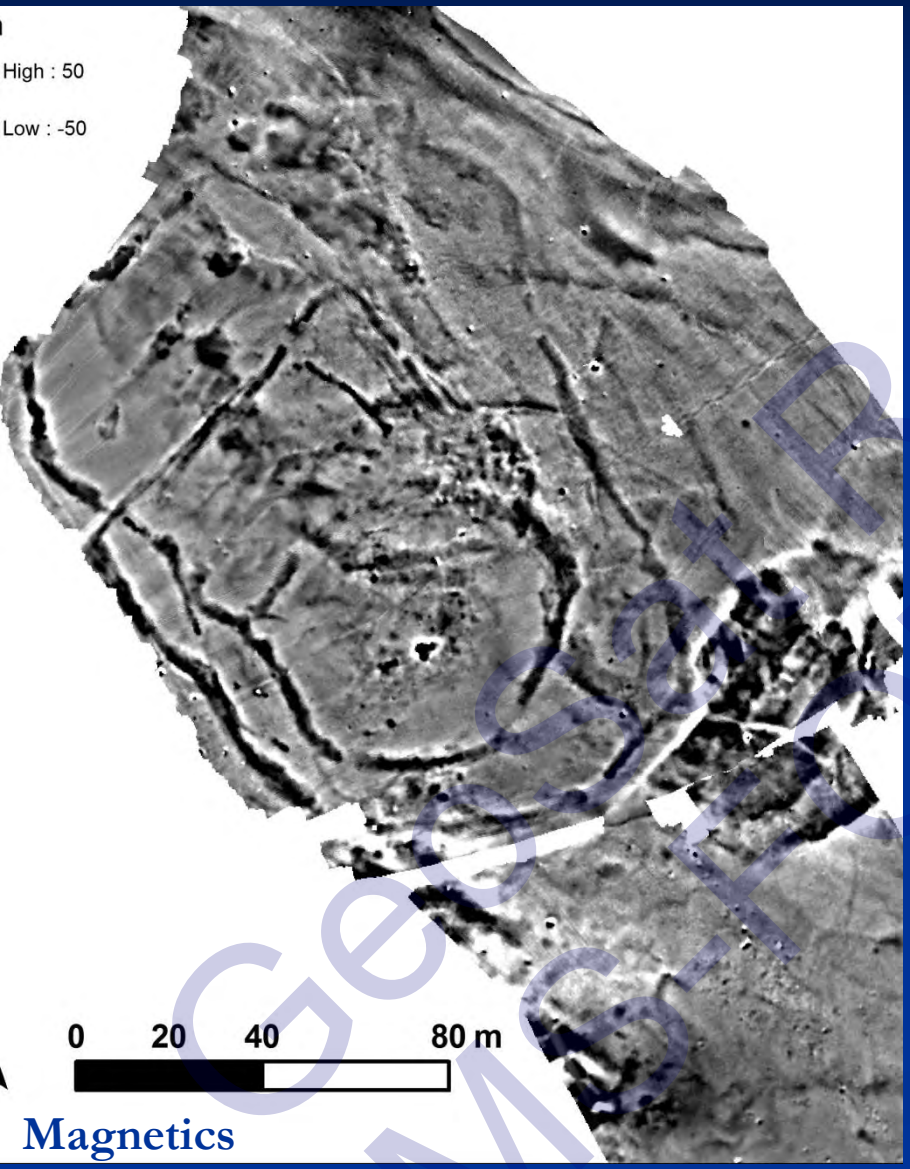


Perdika 2

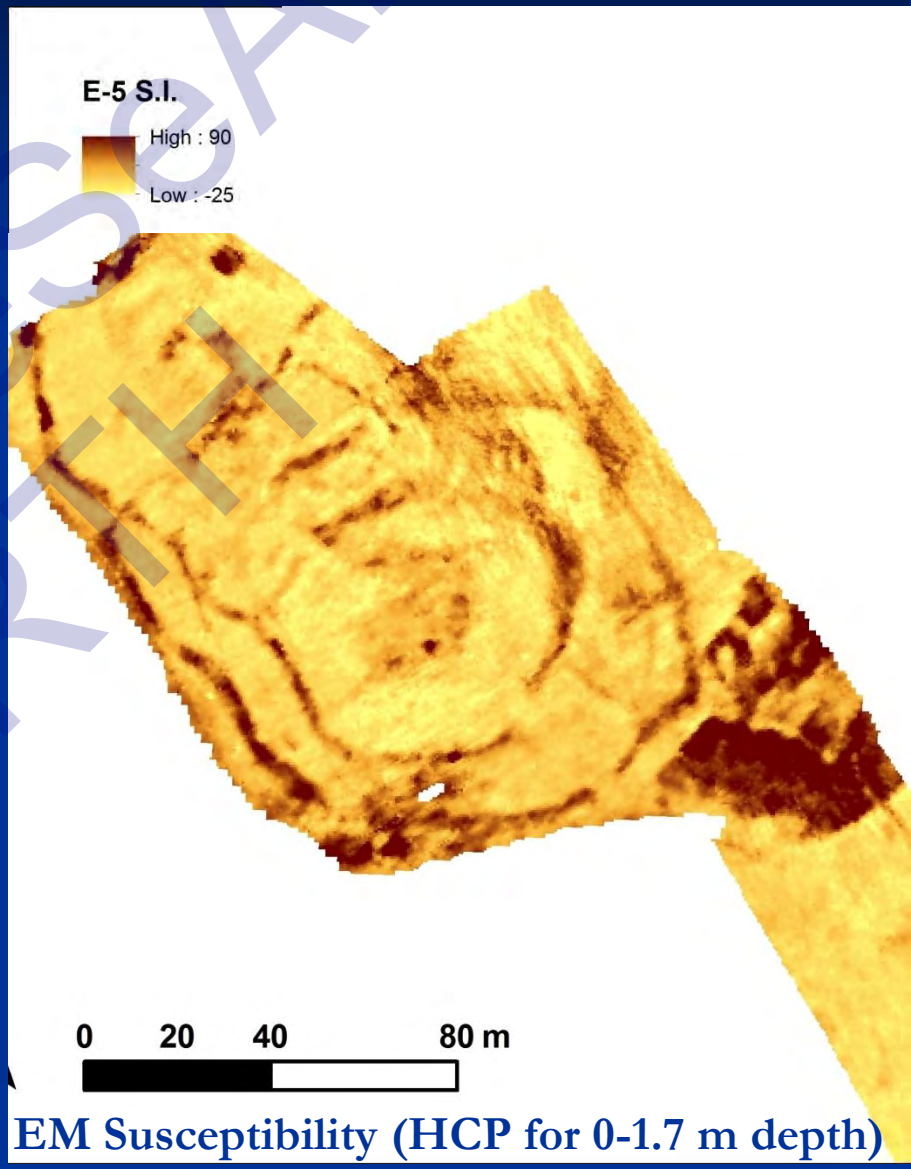


Perdika 2

- Extensive network of enclosures built on a natural hilltop
- A sequence of openings that gave access into the settlement
- Little evidence for individual structures (some have high magnetic values)

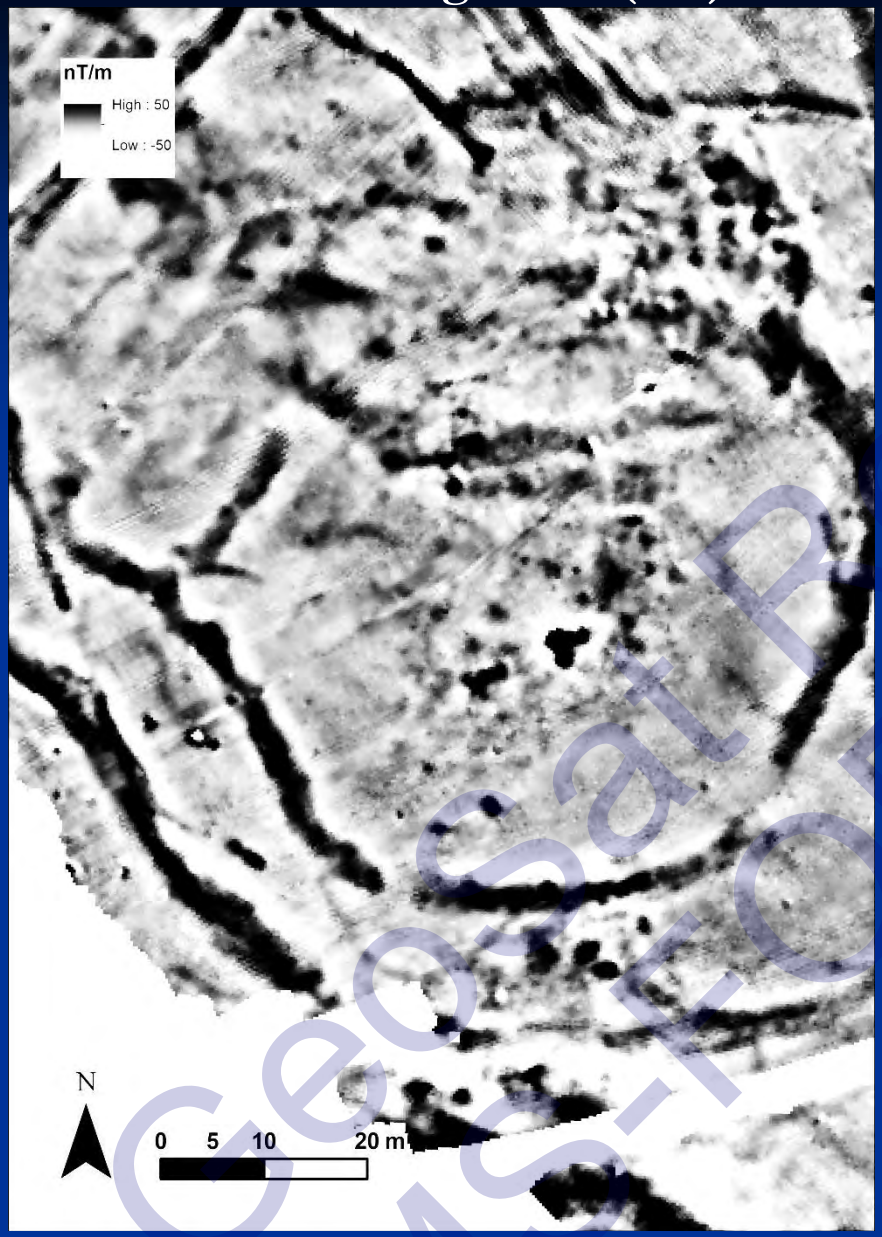


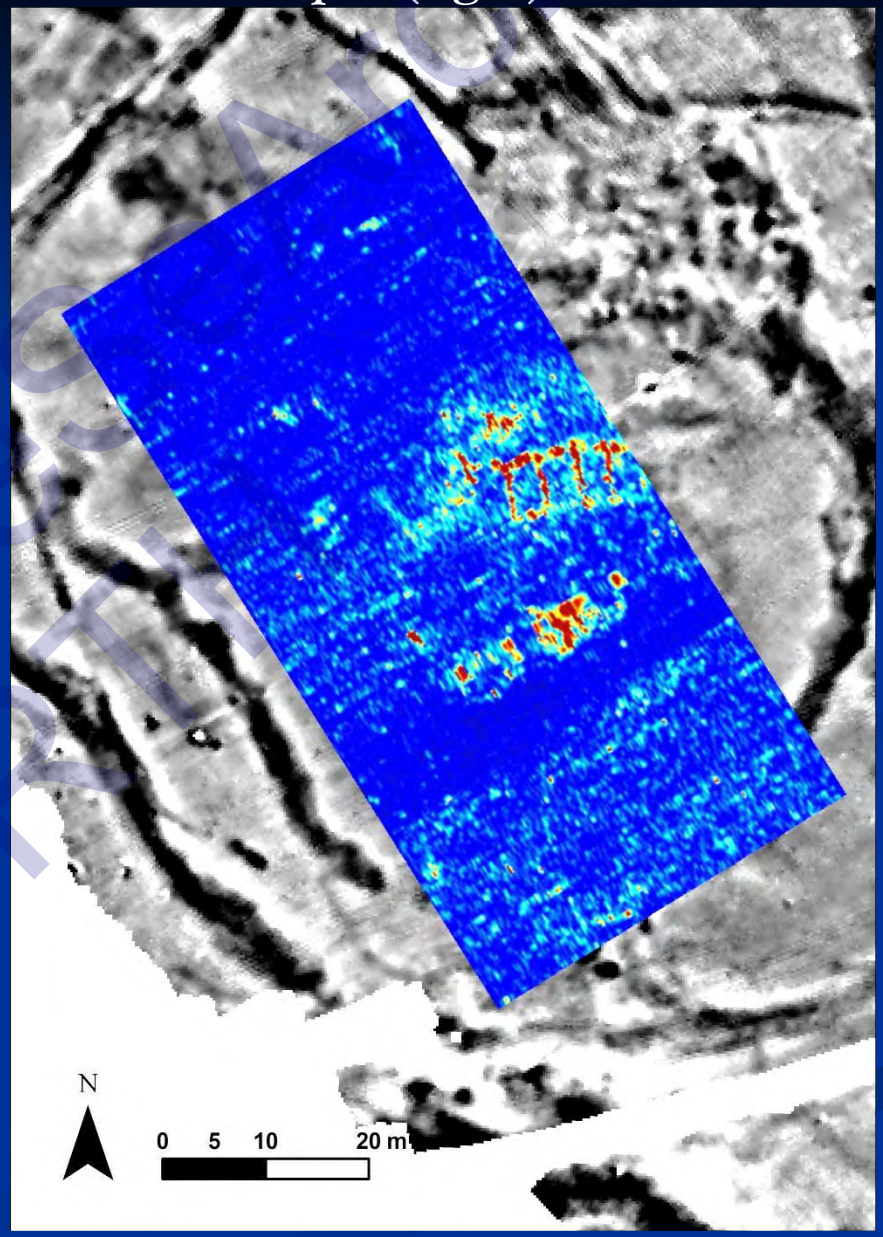
Magnetics



EM Susceptibility (HCP for 0-1.7 m depth)

Perdika 2 – Magnetics (left) and GPR 0.7-0.8 m depth (right)

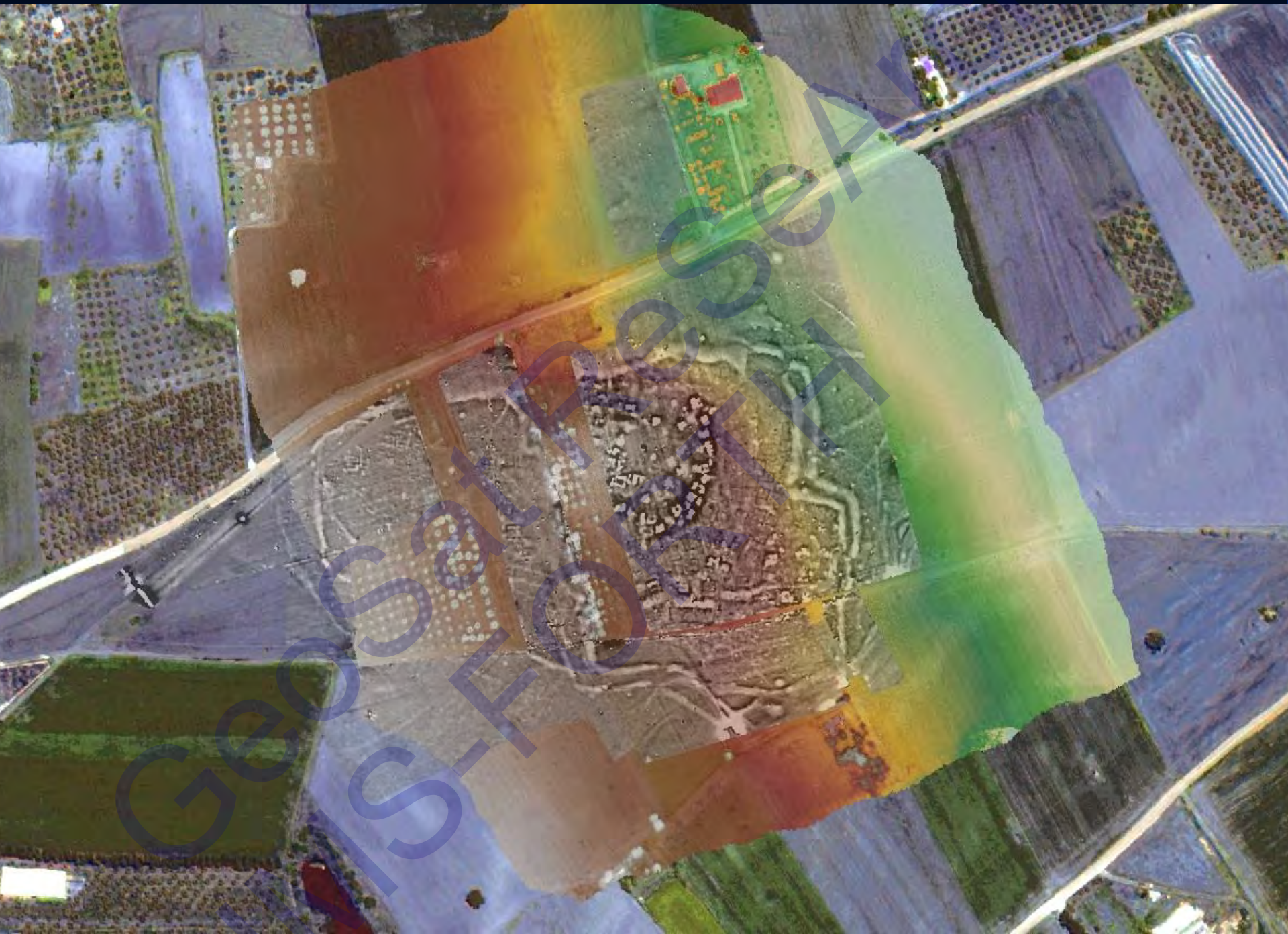




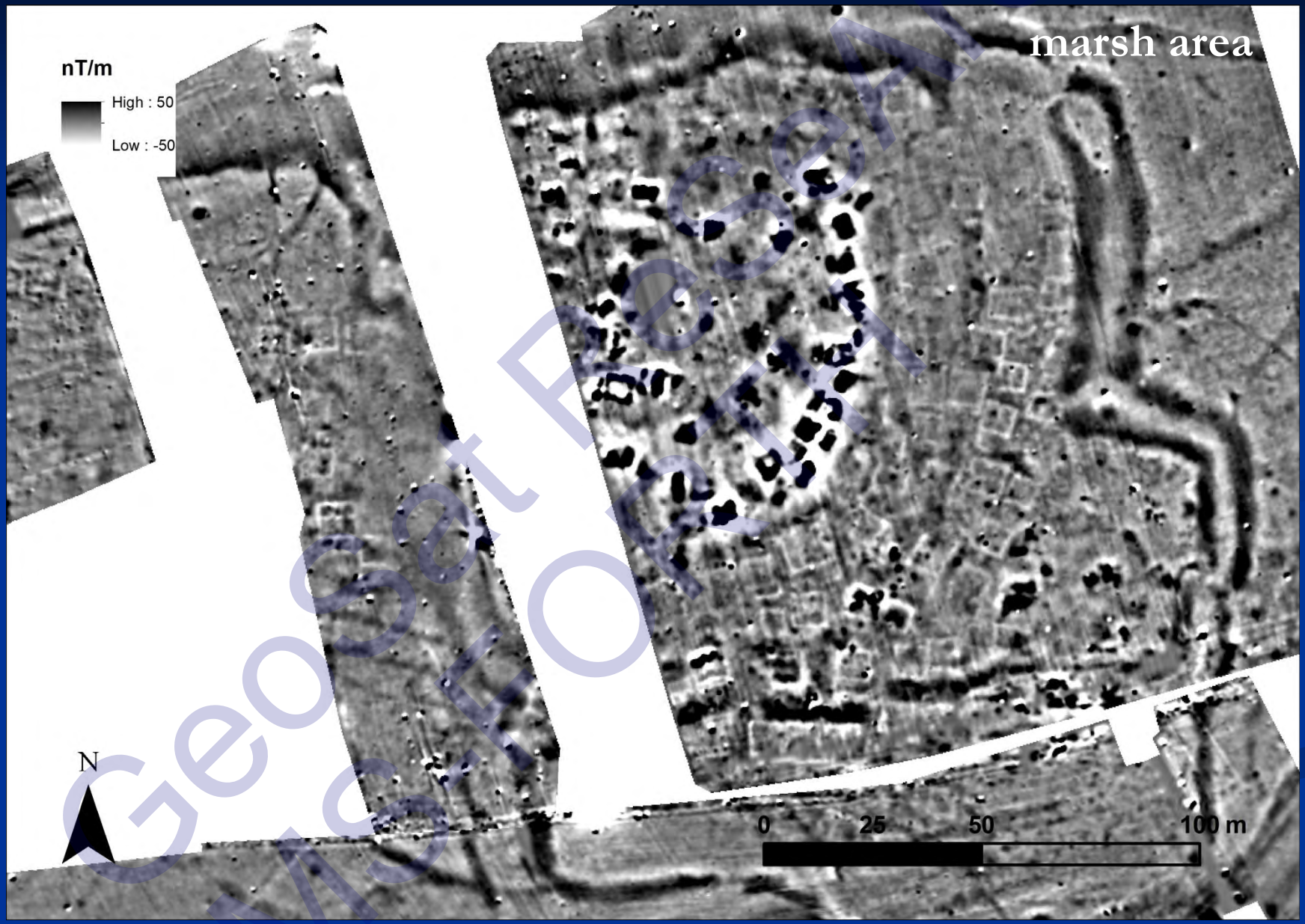
- Large rectilinear structures with low magnetic value (stone structures?) were identified with GPR

Magoula Almiriotiki

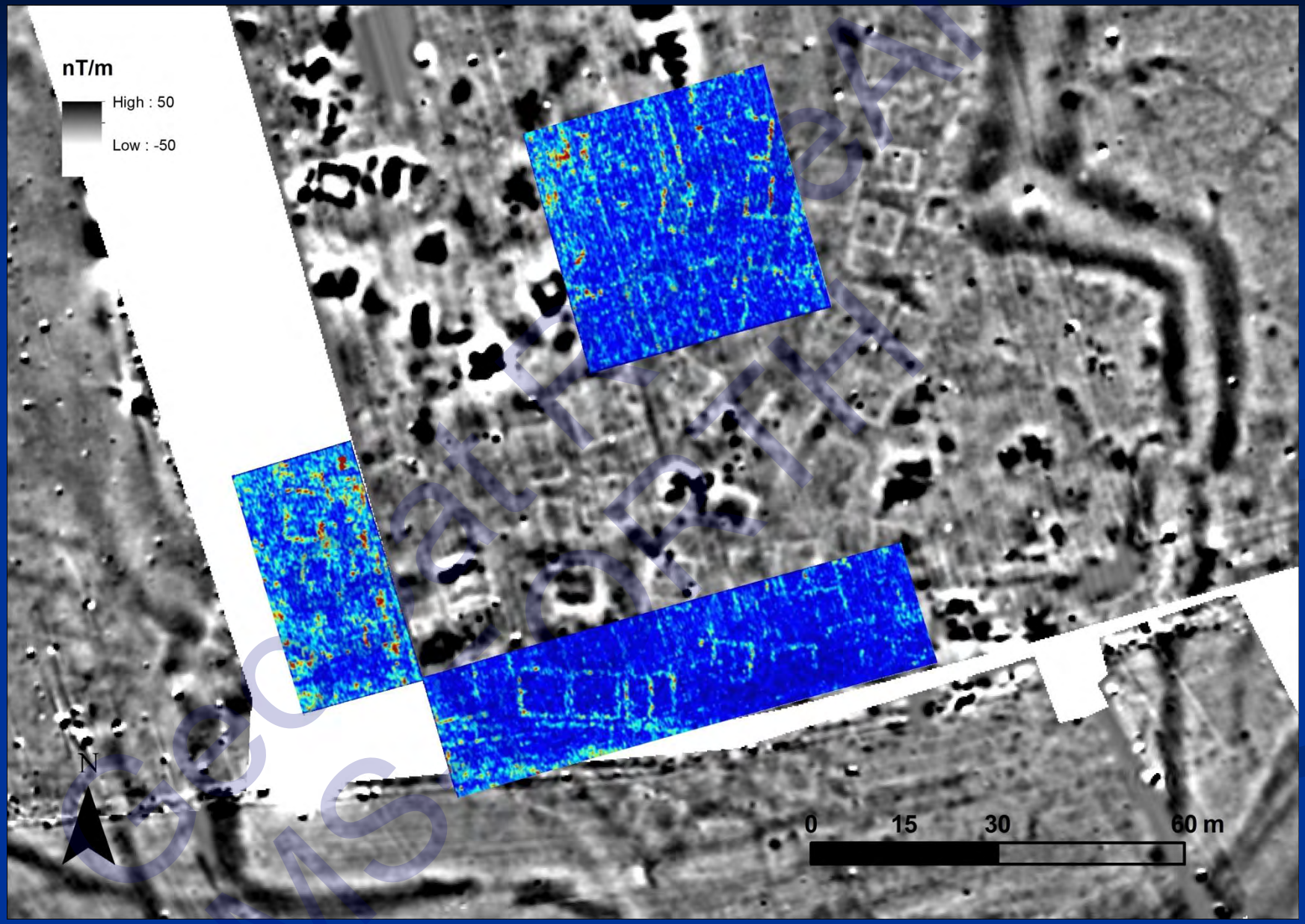
Early Neolithic – Late Bronze Age

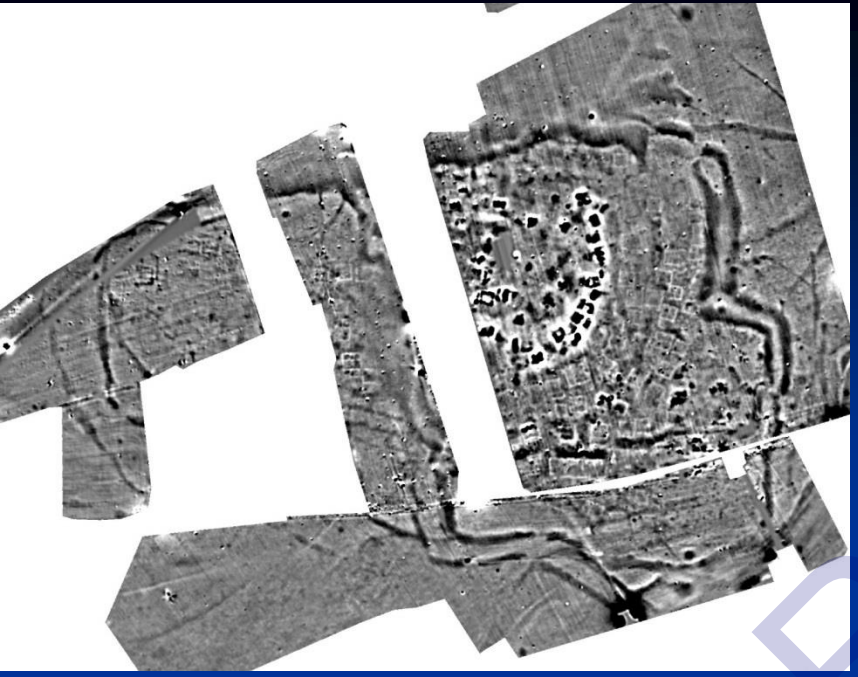


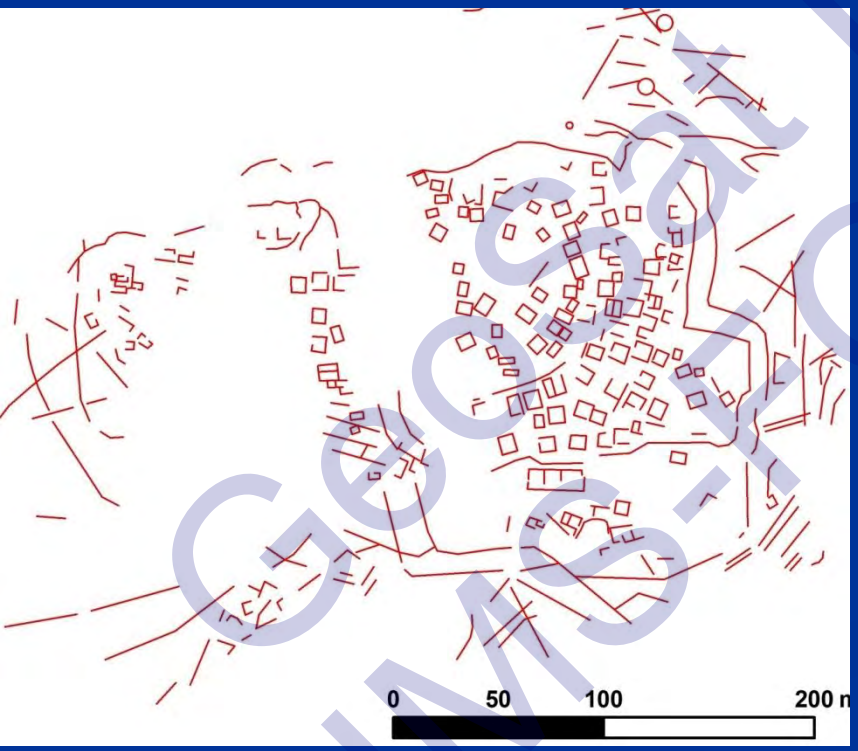
Magoula Almiriotiki – Magnetics



Magoula Almiriotiki – GPR (depth 0.7-0.8 m)







Magoula Almiriotiki

Early Neolithic – Late Bronze Age

- Extensive settlement built around a core habitation zone on the highest topographic level

- 60+ rectilinear structures

- Structures on the top have high magnetic values and are probably built in mudbrick

- Structures with low magnetic values have 2-3 rooms

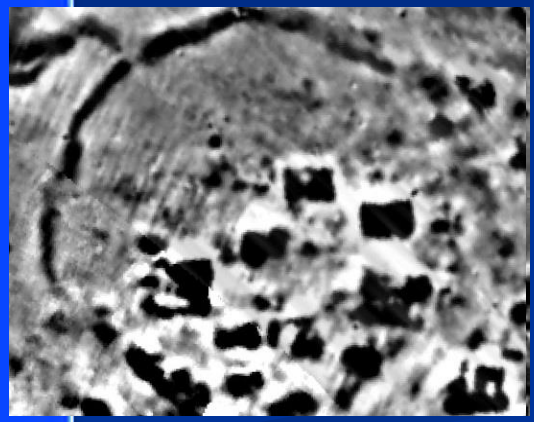
- Large “megaron” structure may be three structures built side-by-side

- Extensive network of ditches (at times double) surround the settlement

Concluding Remarks

- **Successful Employment of remote sensing techniques** – Importance of using an arsenal of various approaches **(manifold geophysics)**

- **Conceptualize a landscape of variation: Similar and divergent characteristics of settlements in planning and structural materials**)
  - Dimension of settlements and structures
  - Internal organization of the structures, clusters of structures
  - open/unbuilt spaces, pits, a.o.
  - burnt and unburnt structures / mudbrick & stone structures?
  - Corridors and entrances
  - Existence of enclosures (ditches/fortifications)



- Existence of ditches in terms to the surrounding geomorphologic features (e.g. proximity to palaeochannels).

- Implications regarding the sustainable population, the study the spatial context and organization – intra site, local and regional level, the chronological continuation of habitation, persistency in occupation, etc.

Geotechnologies making sketches of the past landscapes

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Ευρωπαϊκή Ένωση
Ευρωπαϊκό Κοινωνικό Ταμείο

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