



Workshop 1

(Prague, 30/Sep - 01/Oct 2019)

New geophysical and geochemical data
at the archaeological site of Zaldua
(Auritz/Burguete, Navarre)

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Philippe DE SMEDT, Eneko IRIARTE, Roger SALA, Armin SCHMIDT,
Clare WILSON

Topic 2: Integrated approaches combining geophysics and soil science at archaeological sites

Introduction

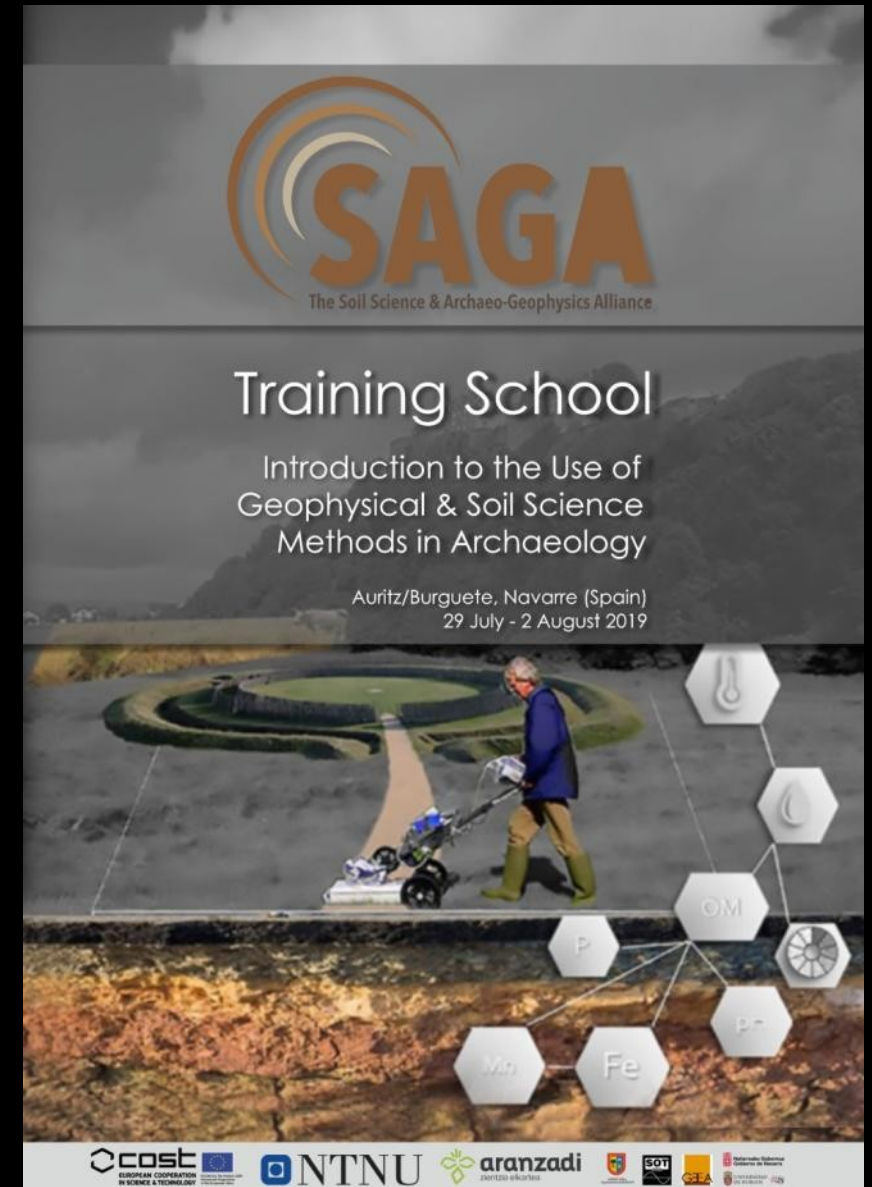
The First SAGA Training School

*Introduction to the Use of
Geophysical & Soil Science Methods
in Archaeology*

Roman site of Zaldua

(Auritz/Burguete, Navarre)

29 July – 2 August 2019



The poster features the SAGA logo at the top, which consists of three concentric orange arcs to the left of the word "SAGA" in a bold, orange, sans-serif font. Below the logo is the text "The Soil Science & Archaeo-Geophysics Alliance". The main title "Training School" is in a large, white, sans-serif font. Below it, the subtitle "Introduction to the Use of Geophysical & Soil Science Methods in Archaeology" is in a smaller, white, sans-serif font. The location and dates "Auritz/Burguete, Navarre (Spain) 29 July - 2 August 2019" are listed in a small, white, sans-serif font. The central image shows a person in a blue jacket and green boots pushing a small, blue, wheeled device on a dirt path. The background is a landscape with a circular stone structure. On the right side, there is a network of white hexagons connected by lines, containing various symbols and chemical symbols like "OM", "P", "Mn", "Fe", and "pH". At the bottom, there are logos for COST (European Cooperation in Science & Technology), NTNU, aranzadi (Basque Research Centre for Agriculture, Food and Environment), and other institutions.

SAGA
The Soil Science & Archaeo-Geophysics Alliance

Training School
Introduction to the Use of
Geophysical & Soil Science
Methods in Archaeology

Auritz/Burguete, Navarre (Spain)
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OM
P
Mn
Fe
pH

COST
EUROPEAN COOPERATION
IN SCIENCE & TECHNOLOGY

NTNU

aranzadi
Basque Research Centre for
Agriculture, Food and Environment

SOI
Basque Research Centre for
Soil Science and Land Use

CSA
Basque Research Centre for
Soil Science and Land Use

**Basque Research Centre for
Soil Science and Land Use**

Introduction

- 21 Trainees (12 affiliation countries)
11 Trainers (6 affiliation countries)
- Fundamentals of routine geophysical and soil science methods used in archaeological investigations

Theoretical and Hands-on sessions



Introduction

➤ New data acquired during the TS



Aim & Objectives

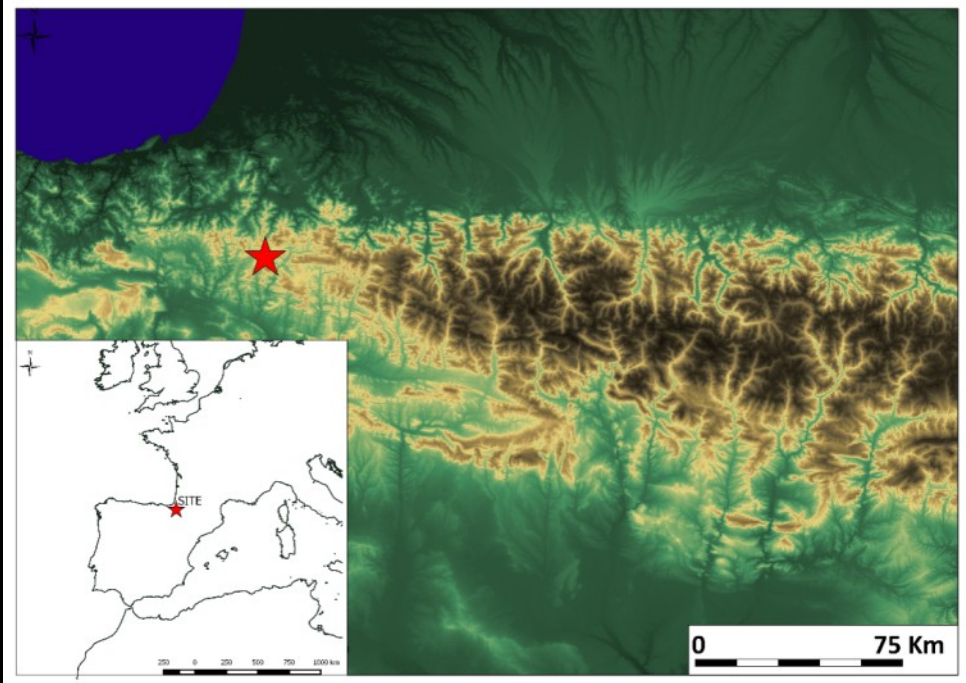
□ To show the new acquired data.

Contents:

1. Introduction to the site
2. The new data acquired during the TS
3. Results
4. Conclusions



The site of Zalduua



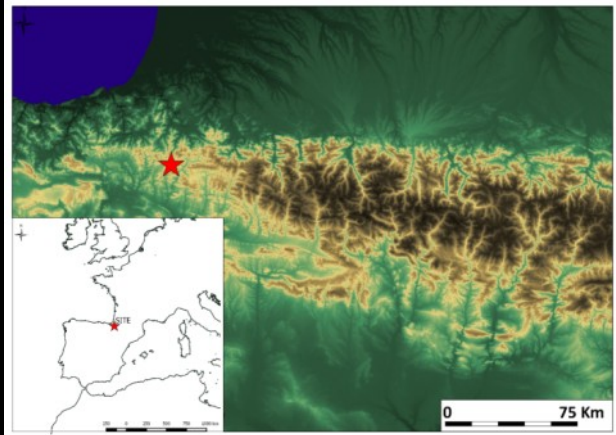
Located in a natural pass in the western part of the Pyrenees

Discovered in the context of a larger project

Related to a roman road

Investigated mainly with geophysics

The site of Zaldua



2012 Archaeological trenches

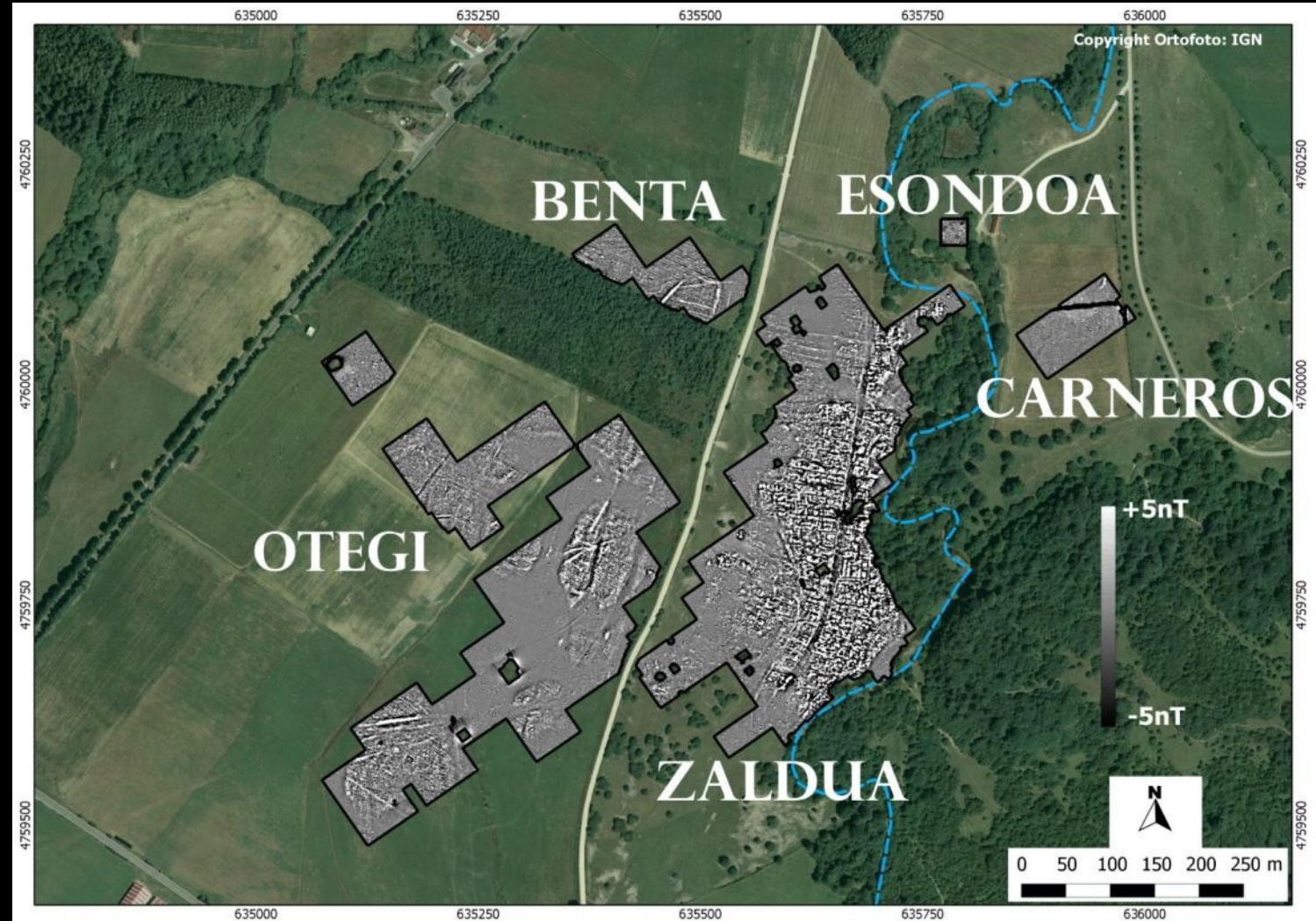
2013 Magnetic survey

2014 Core survey

2015 GPR / RES surveys

2015-2019 Excavations

.Bartington Grad 601-dual fluxgate gradiometer. 18ha at 0.25 x 0.5m resolution. Processed data

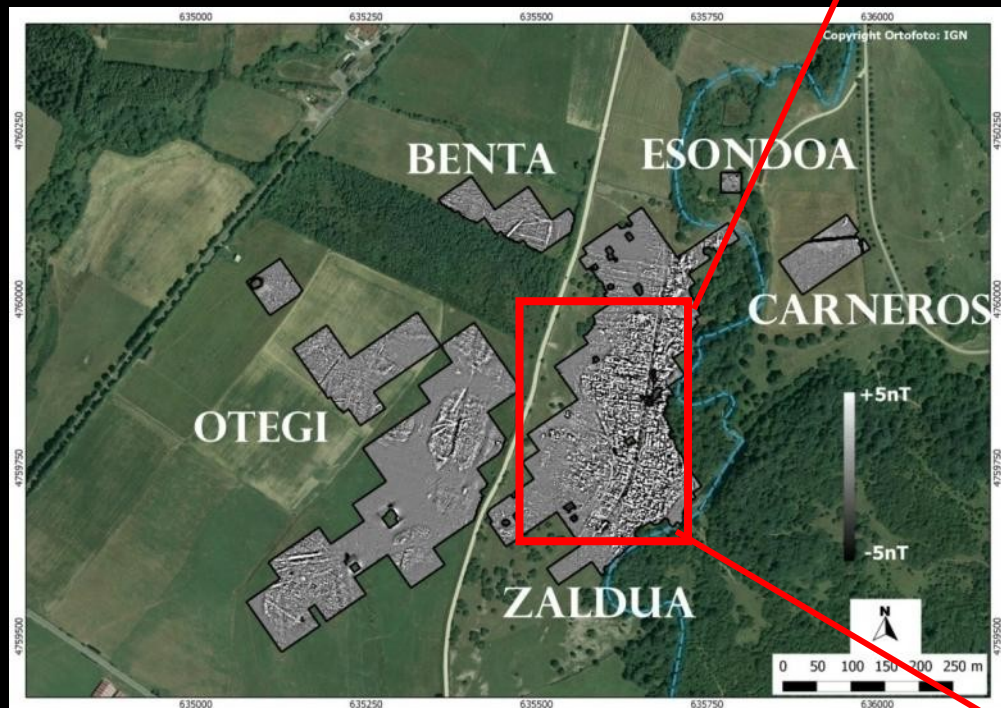


Garcia-Garcia et al. 2016. Magnetometer Survey at the Newly-discovered Roman City of Auritz/Burguete (Navarre). Results and Preliminary Archaeological Interpretation. *Archaeological Prospection* 23(4): 243-256.

The site of Zaldua

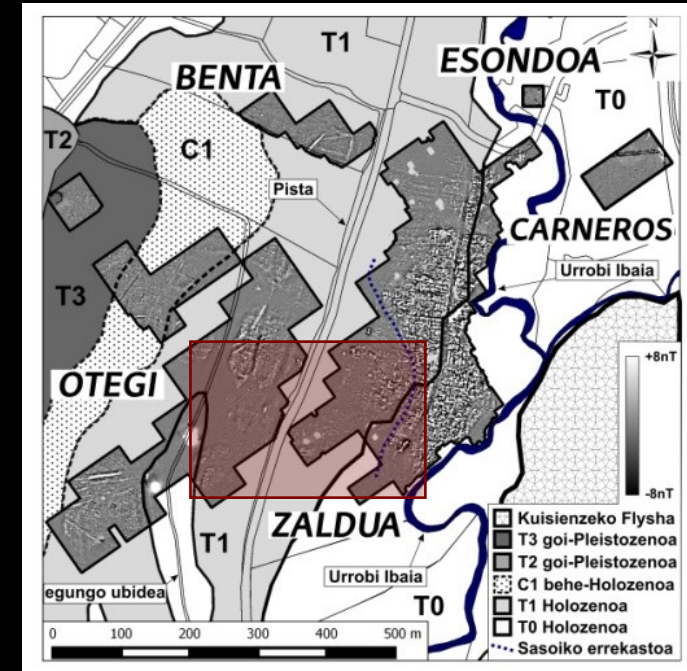
In the main area (circa 4.5 ha)

- * Good magnetic contrast
- * Organized along the road
- * No clear limits



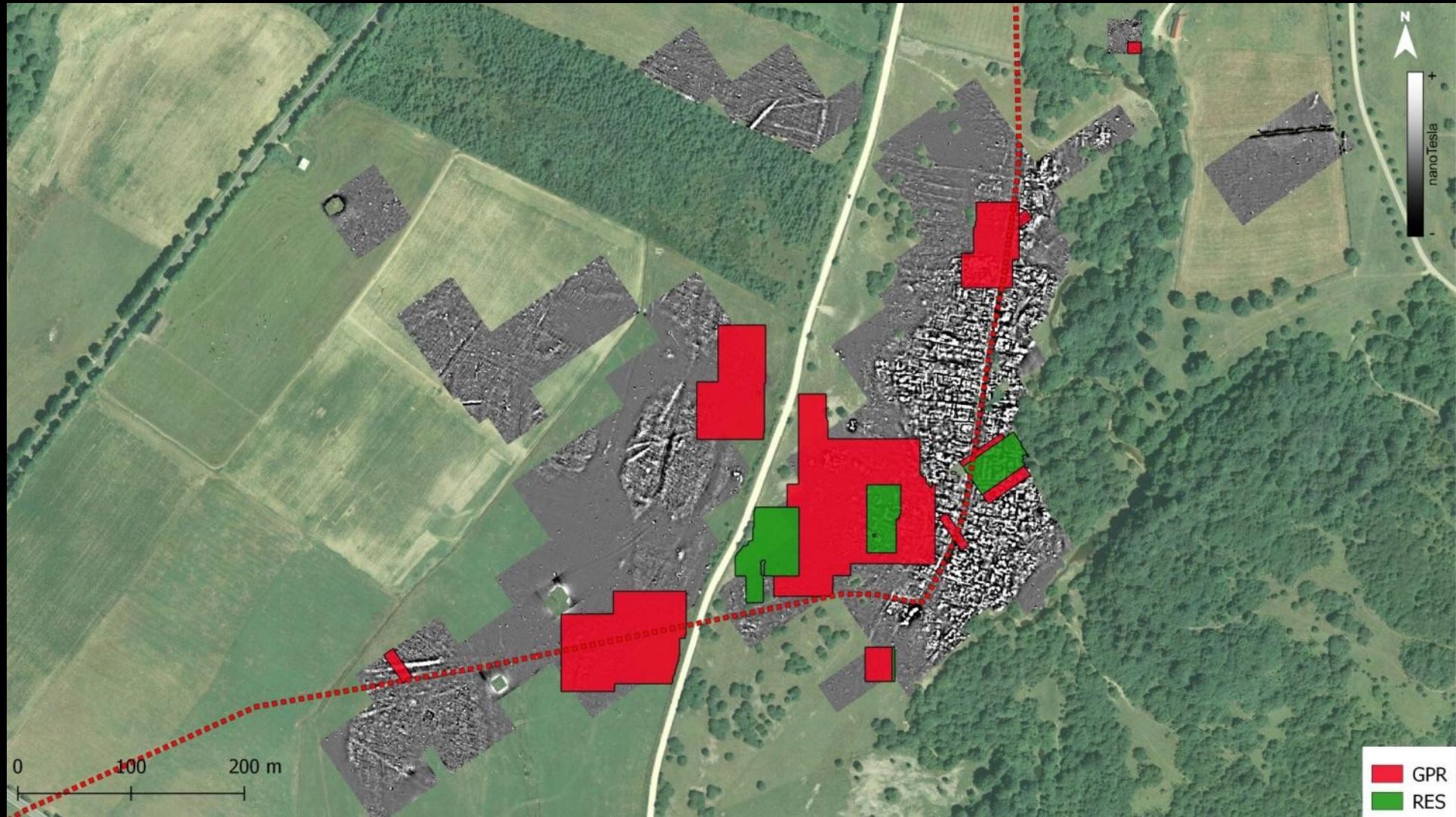
The site of Zaldua

Other areas with poor magnetic contrast



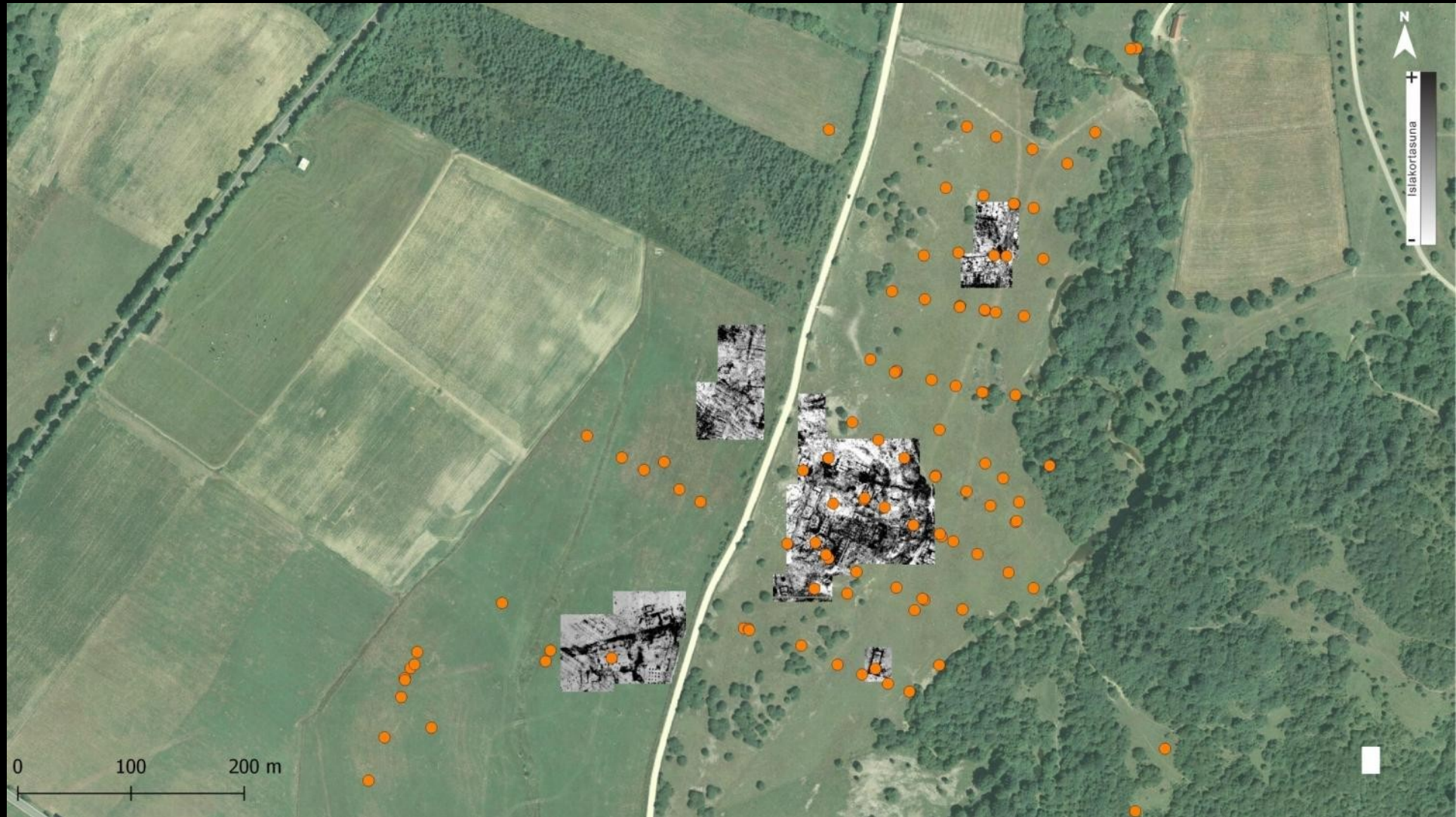
The site of Zaldua

Complementary geophysical surveys








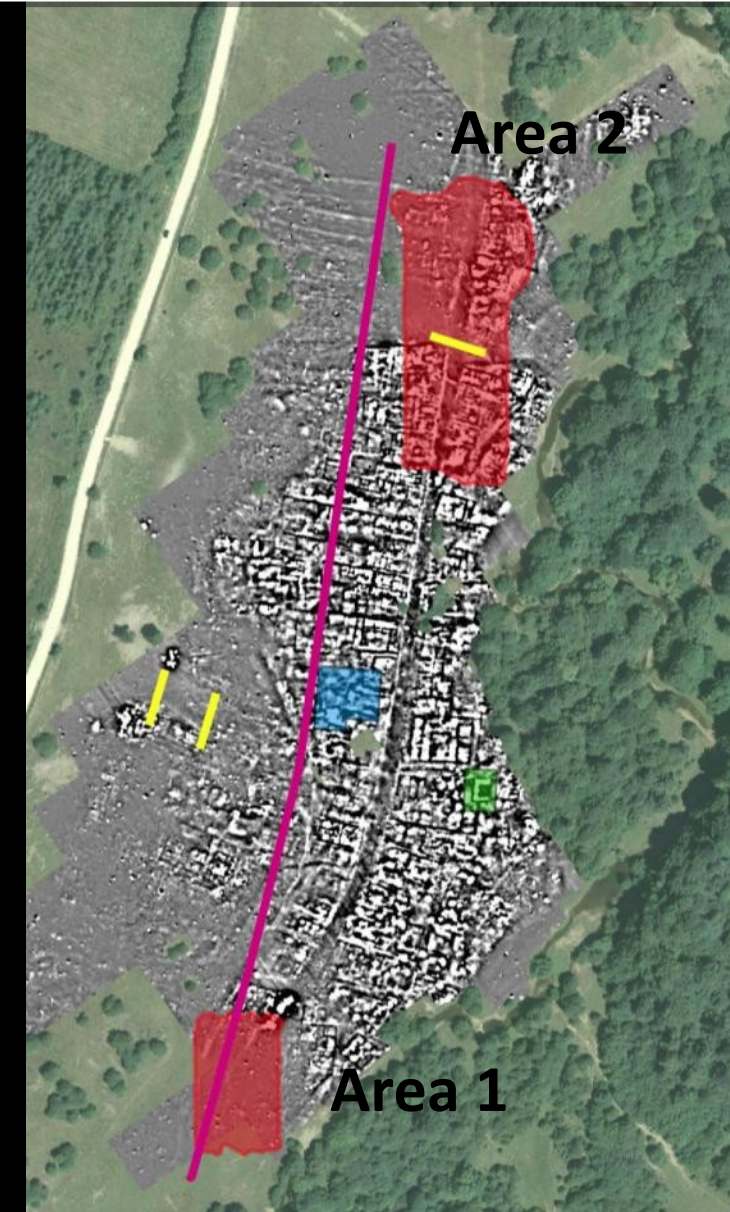
The site of Zaldua

Geoarchaeological core survey



The data acquired during the TS

1. Electromagnetic Induction Survey 
2. Electrical resistivity imaging 
3. Earth resistance survey 
4. Ground Penetrating Radar 
5. Geoarchaeological core survey
6. Superficial magnetic susceptibility measurements 
7. Geochemical analyses in open archaeological trench





The data acquired during the TS

1. Electromagnetic Induction Survey
2. Electrical resistivity imaging
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5. Geoarchaeological core survey
6. Superficial magnetic susceptibility measurements.
7. Geochemical analyses in open archaeological trench





Results: Magnetic susceptibility over the site





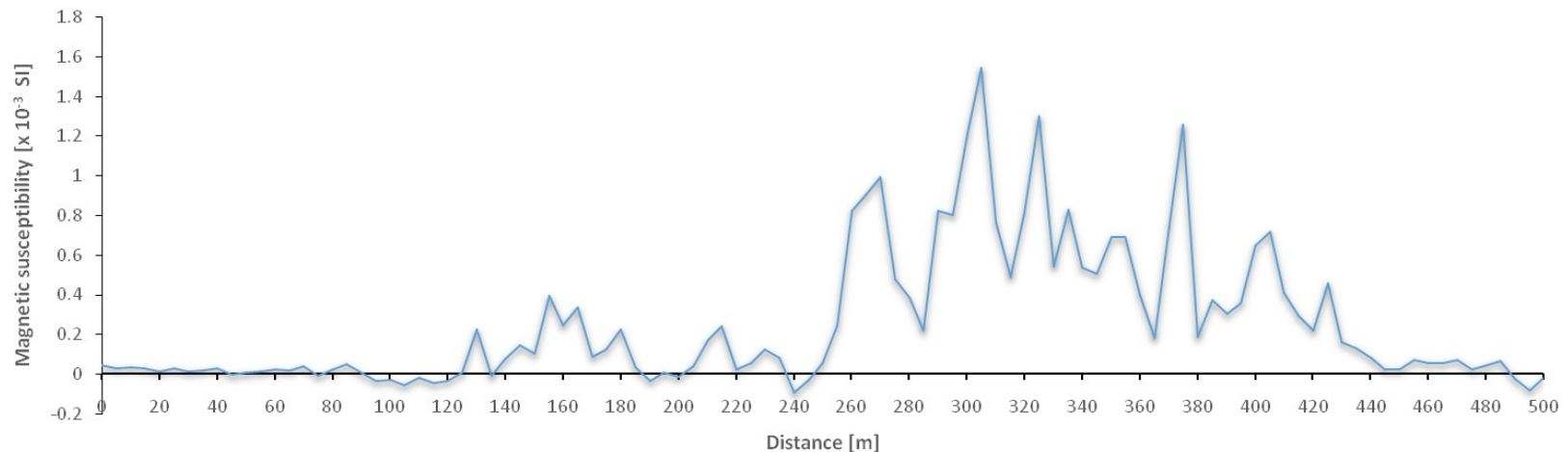
Results: Magnetic susceptibility over the site

Superficial magnetic susceptibility crossing the site

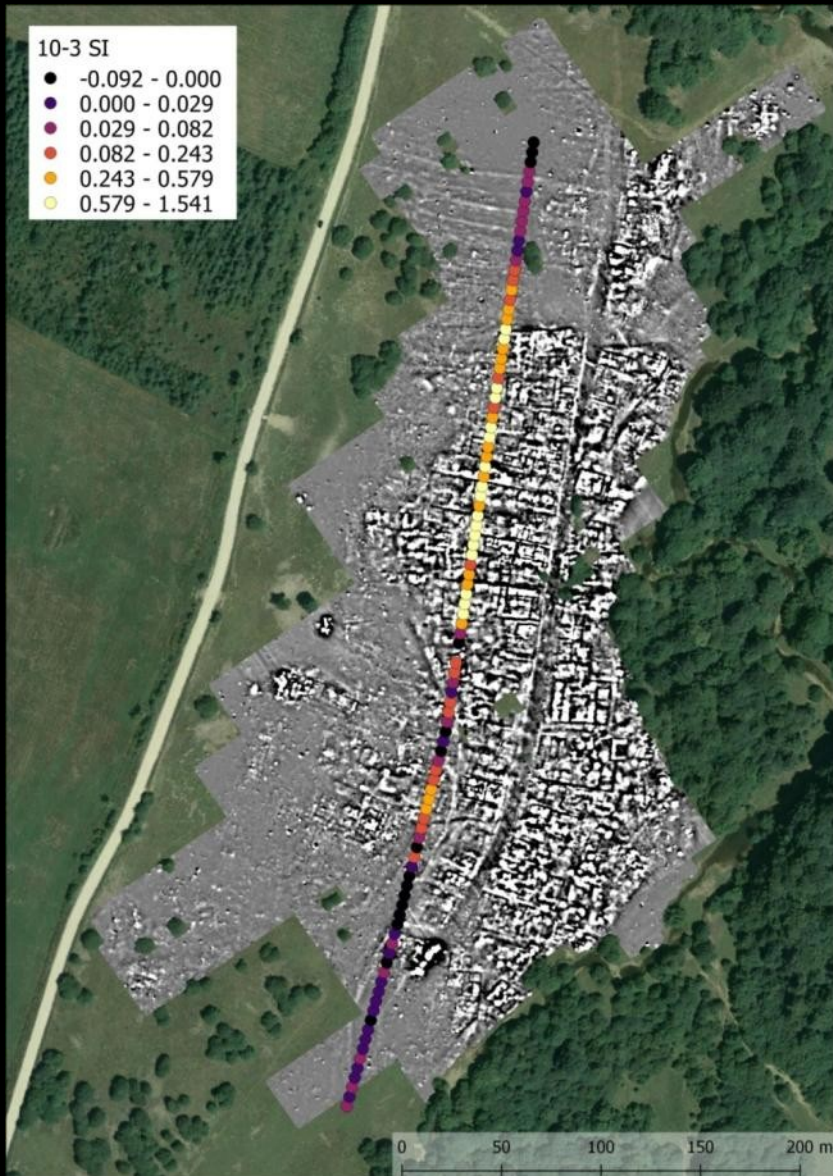
KM-7 Satis Geo kappameter

100 measurements separated by 5m

3 measurements by position. Average taken as a final value



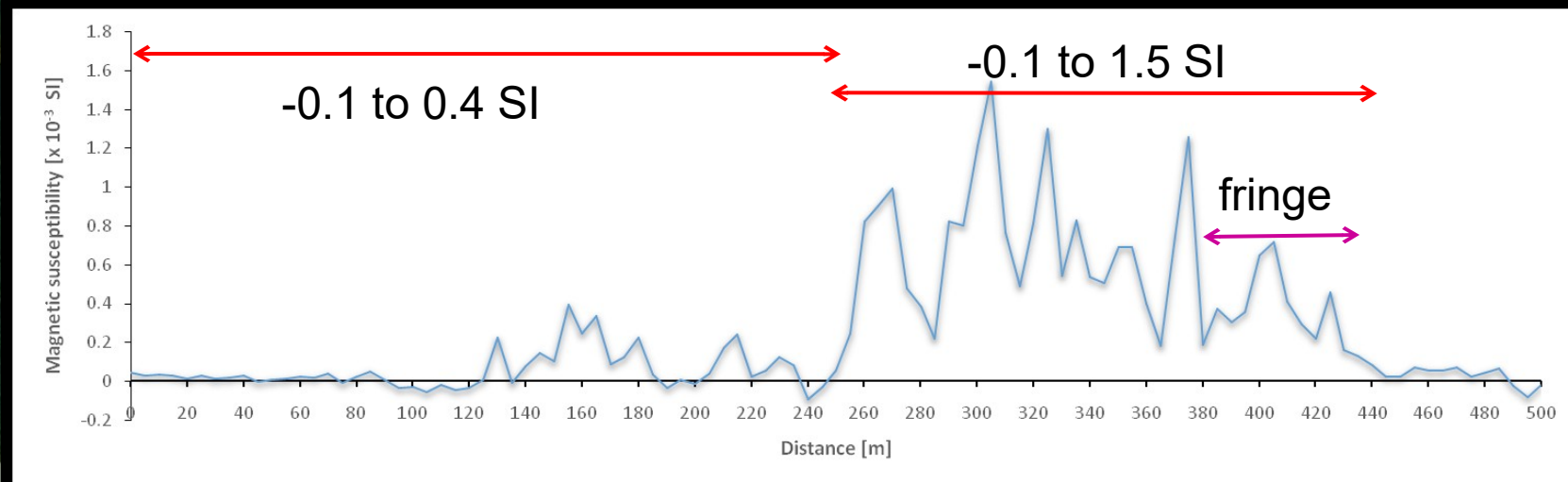
Results: Magnetic susceptibility over the site



- Divided into two segments:

From 130 to 250 m / From 250 to 435 m

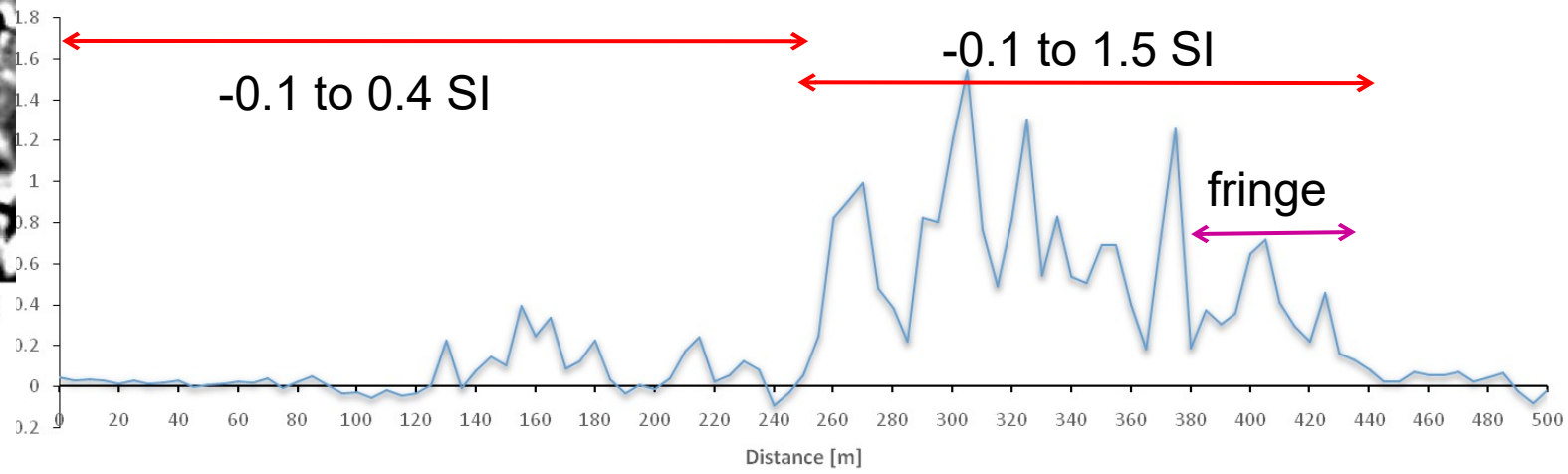
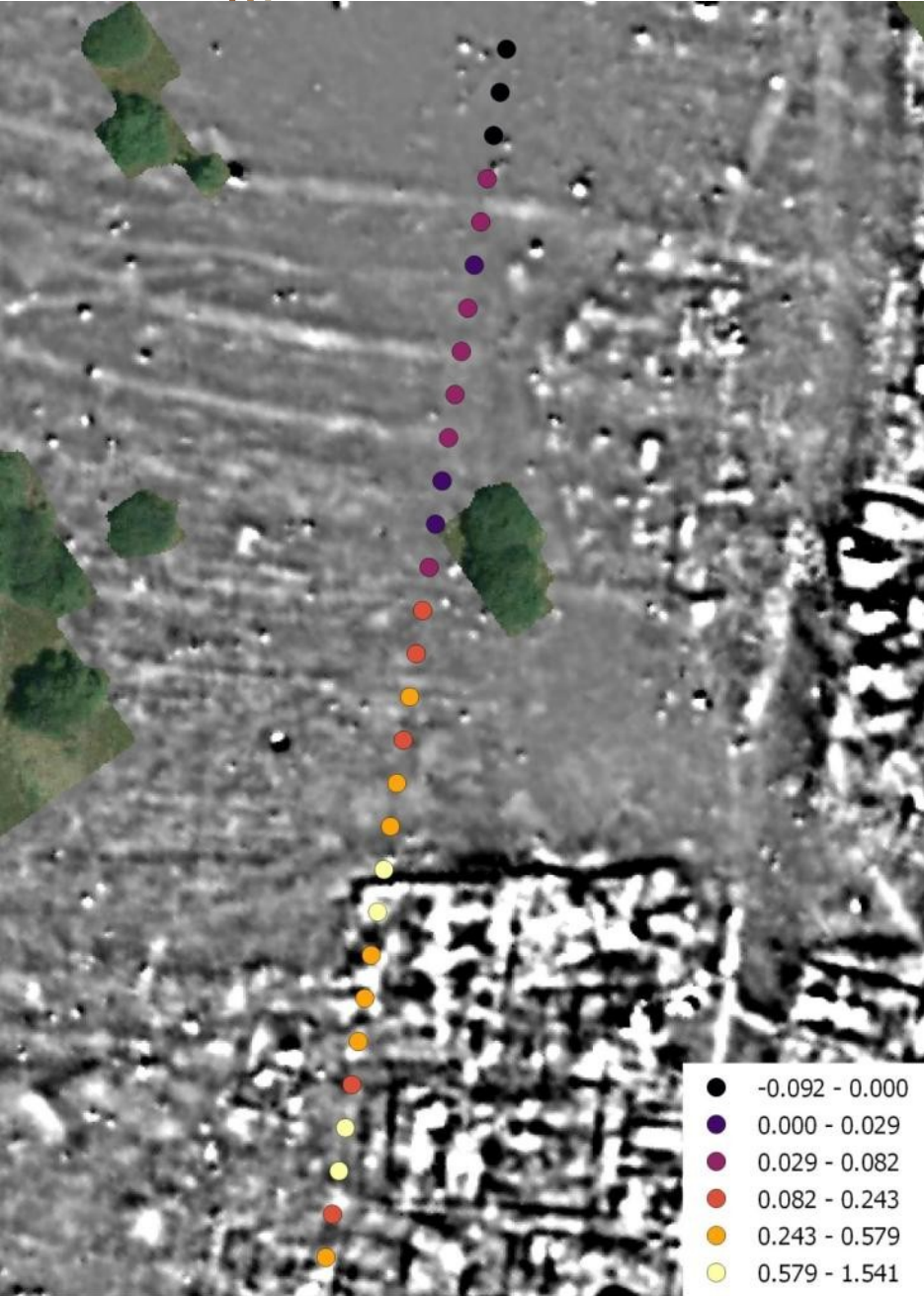
- Good correlation with gradiometer response map but: enhanced values in northern fringe





Magnetic susceptibility over the site

- Divided into two segments:
 - From 130 to 250 m / From 250 to 435 m
- Good correlation with gradiometer response map but: enhanced values in northern fringe

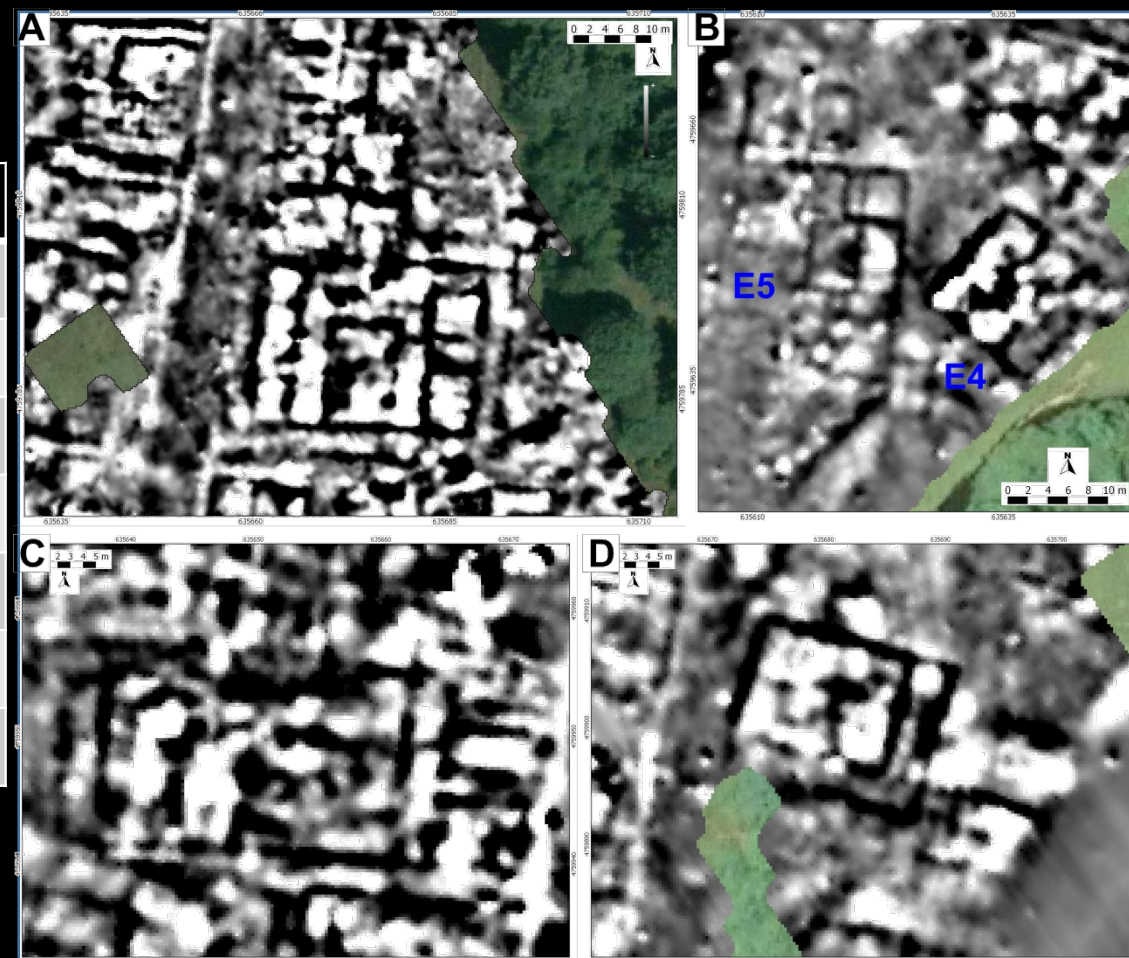




Results: Magnetic susceptibility over the site

Measures made in the rocks of the excavation area

Rock Material	Mag Susceptibility (x10 ⁻³ SI)
Mudstone	0.18-0.35
Sandstone red	0.00-0.1
Sandstone black	0.24
Shale	0.01-0.19
Brick light yellow	0.24-0.63
Brick light reddish	2.16-4.00
Brick red	6.41-7.39



Results. Area 1



Results. Area 1

GPR
RES



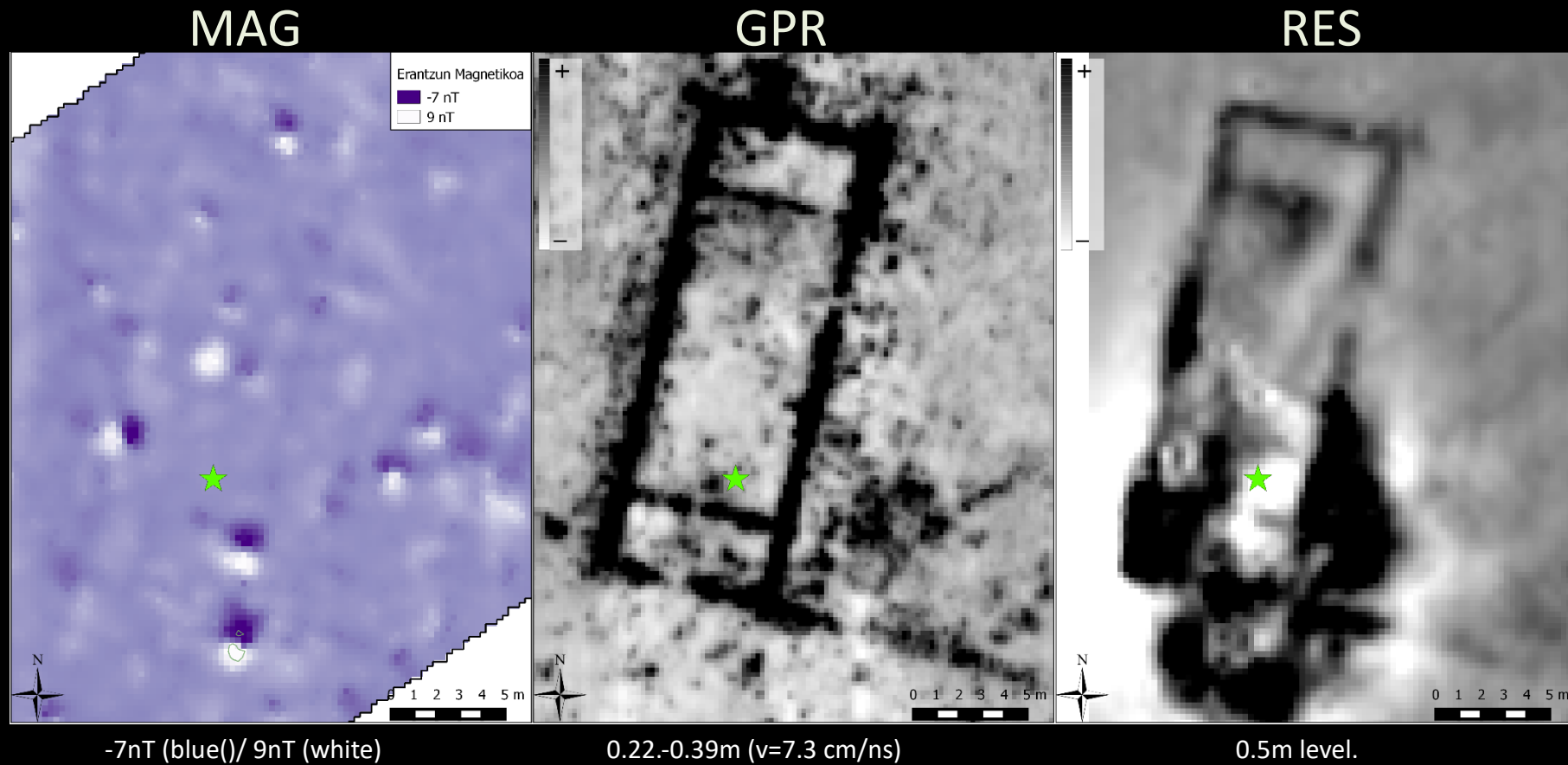
IDS Hi-mod
600MHz and 200MHz



RM15-Mpx15
0.5m & 1m



Results. Area 1



IDS Hi-mod
600MHz and 200MHz

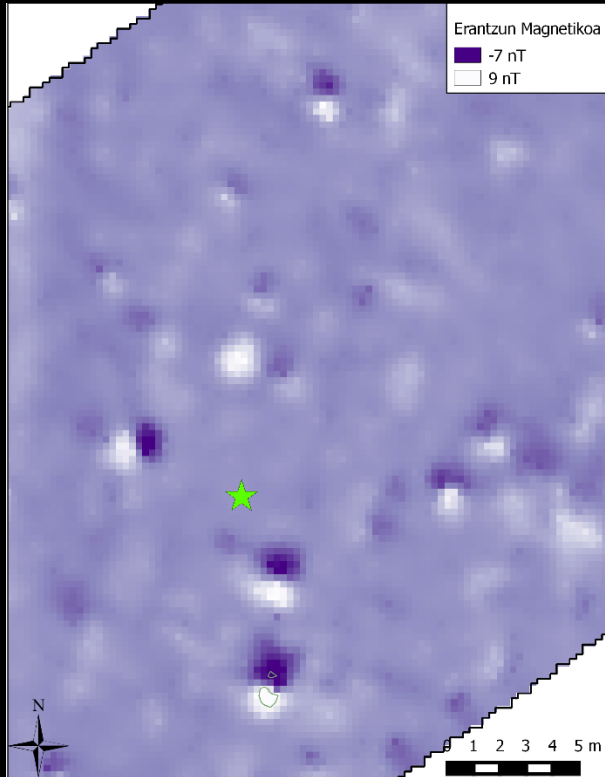


RM15-Mpx15
0.5m & 1m



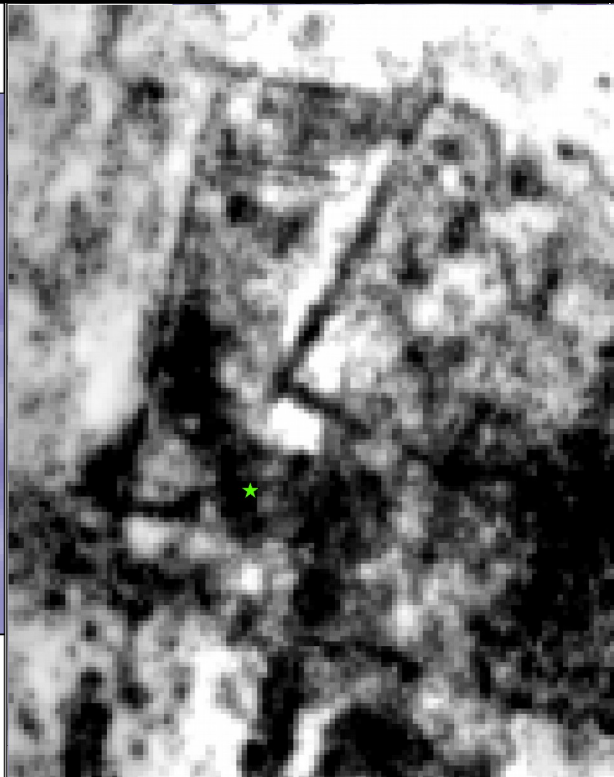
Results. Area 1

MAG



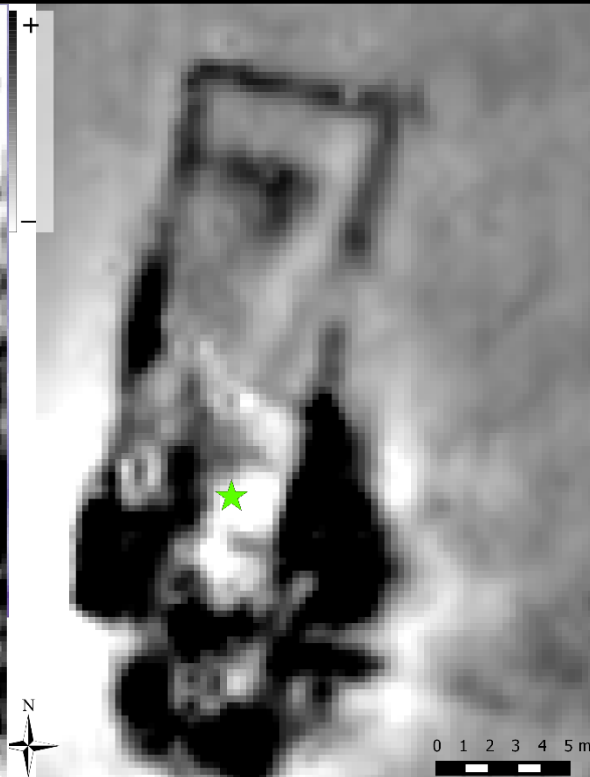
-7nT (blue)/ 9nT (white)

GPR



0.55-0.72m (v=7.3 cm/ns)

RES



0.5m level.

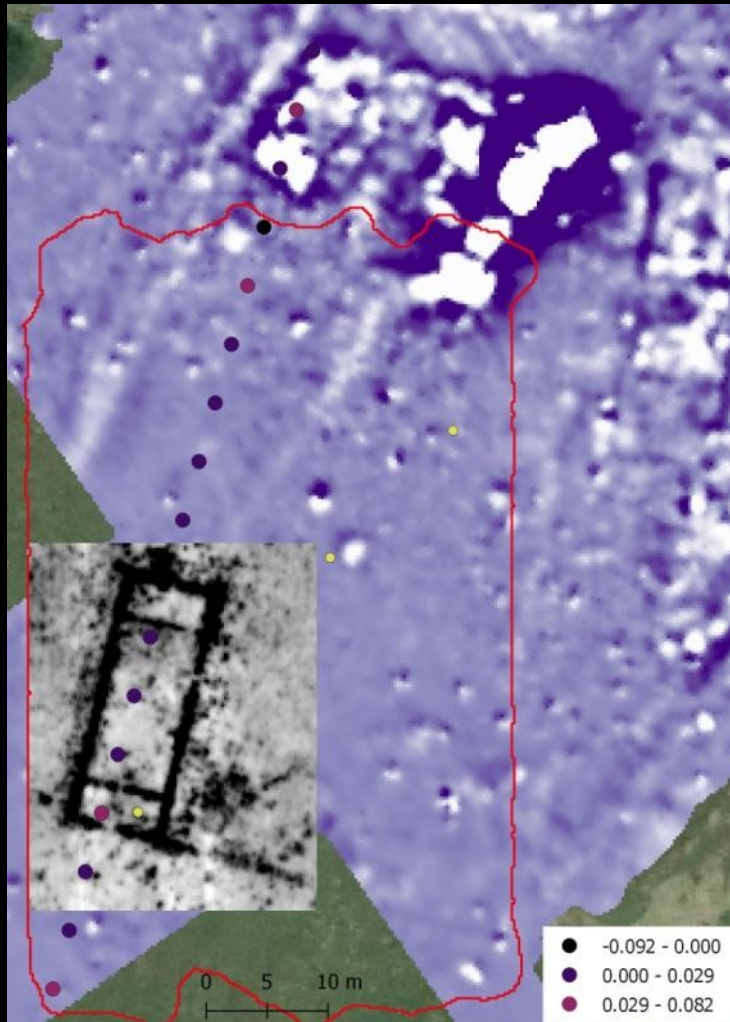
IDS Hi-mod
600MHz and 200MHz



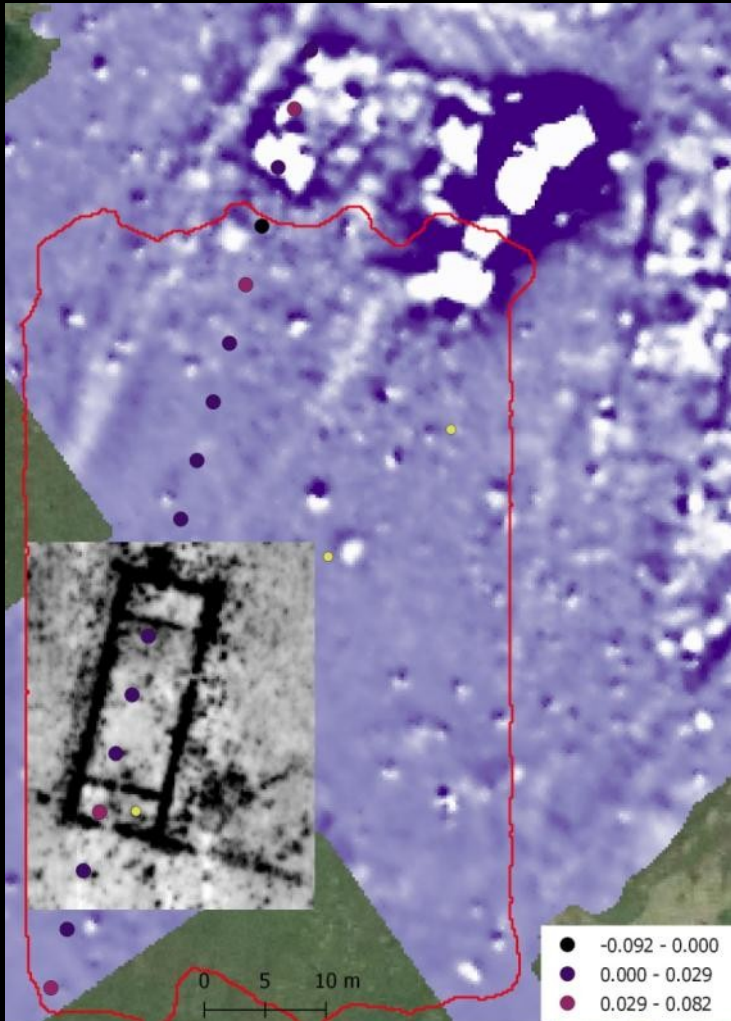
RM15-Mpx15
0.5m & 1m



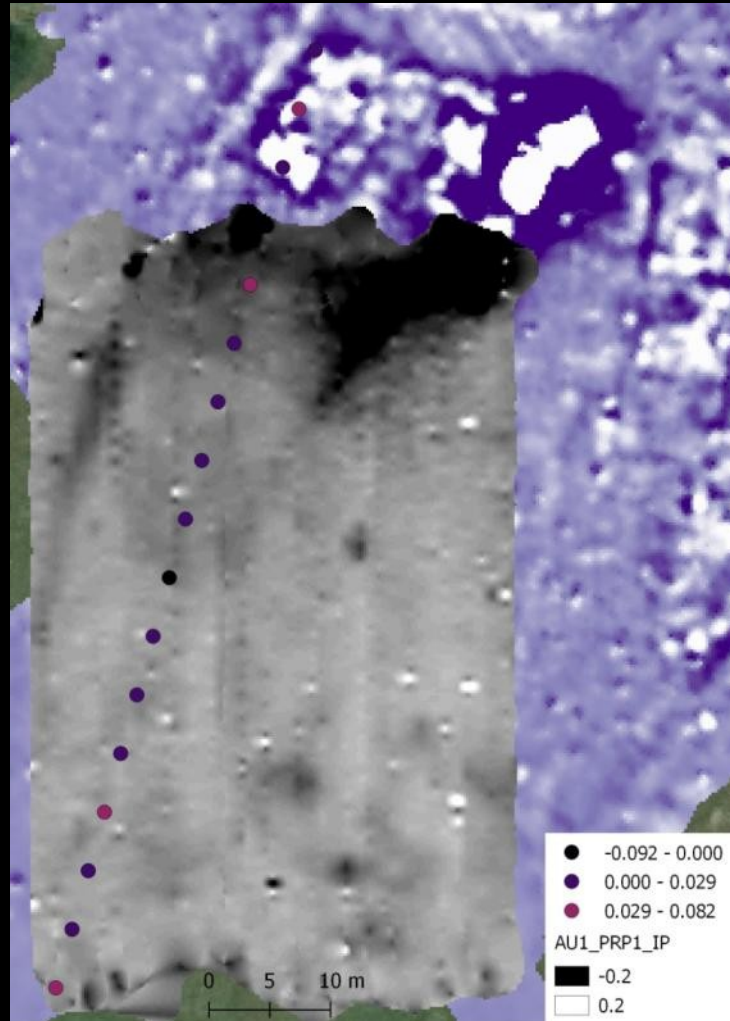
Results. Area 1



Results. Area 1

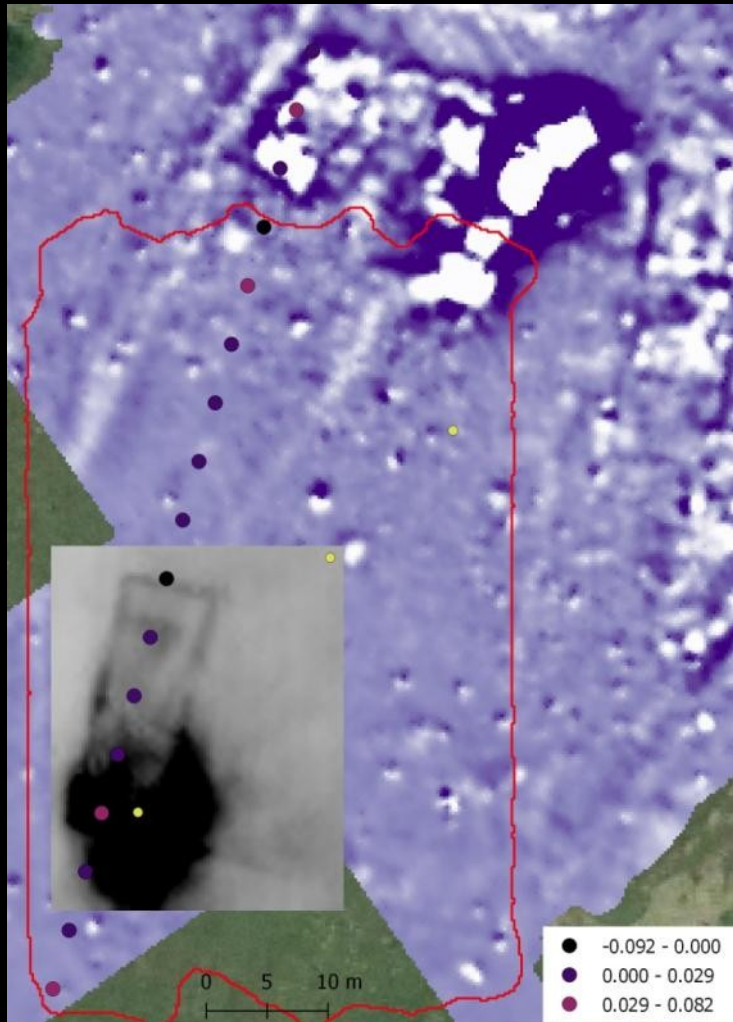


Magnetic response map. + GPR

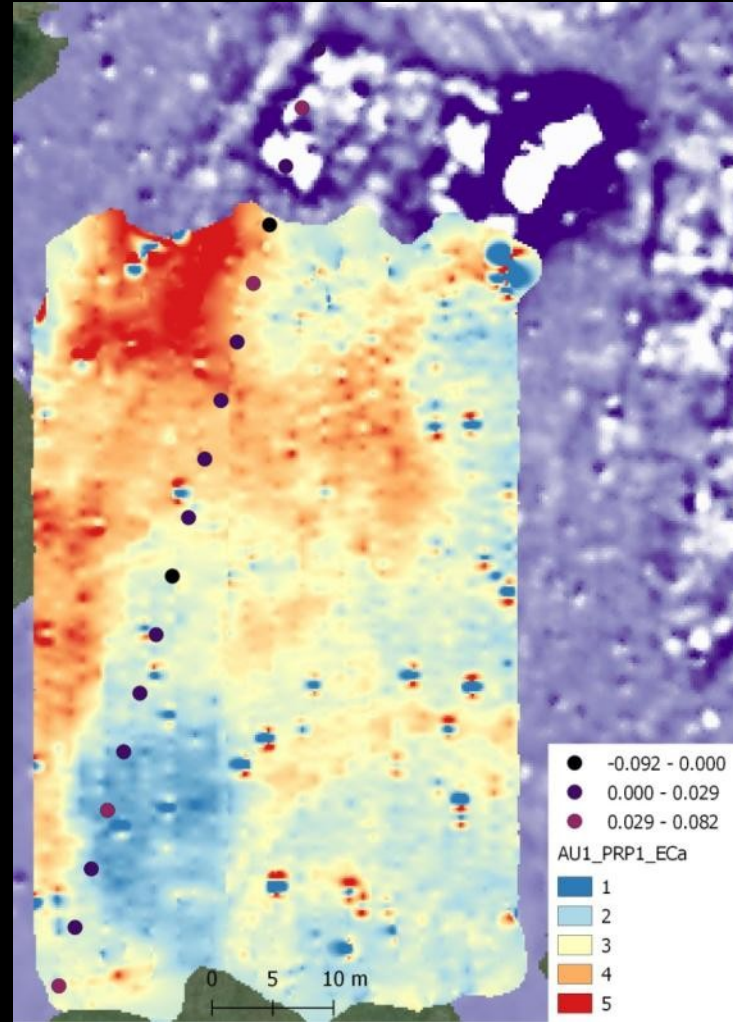


In Phase MAG susceptibility – PRP (0.5m depth)

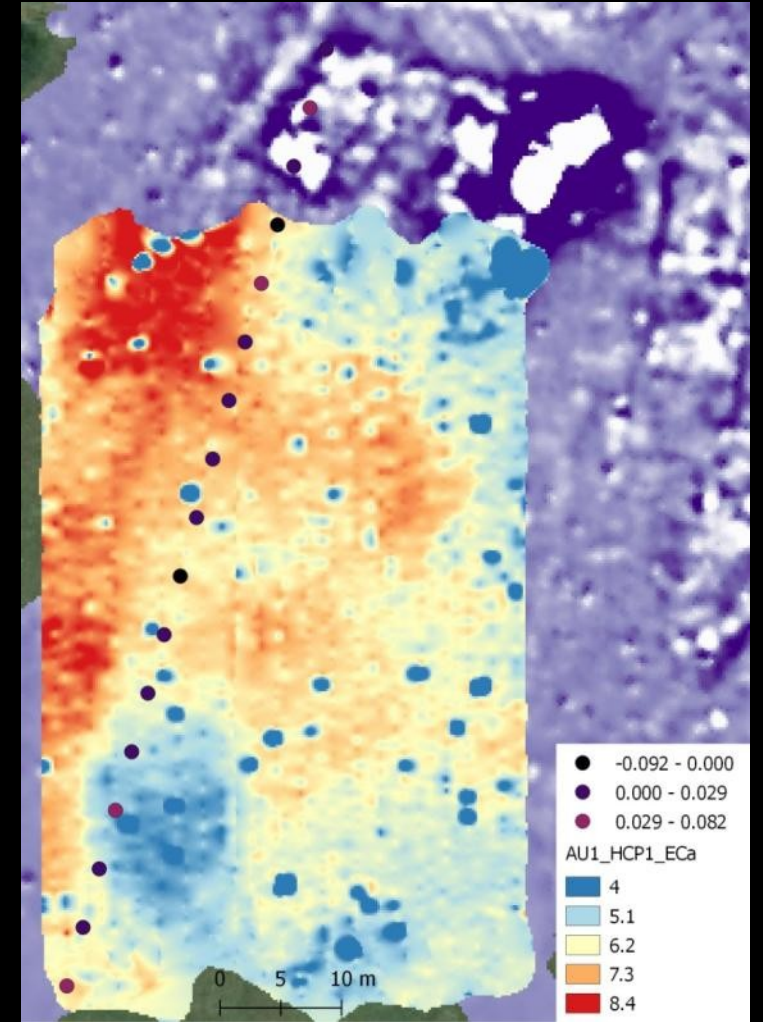
Results. Area 1



Magnetic response map. + RES survey (twin, 0.5m)

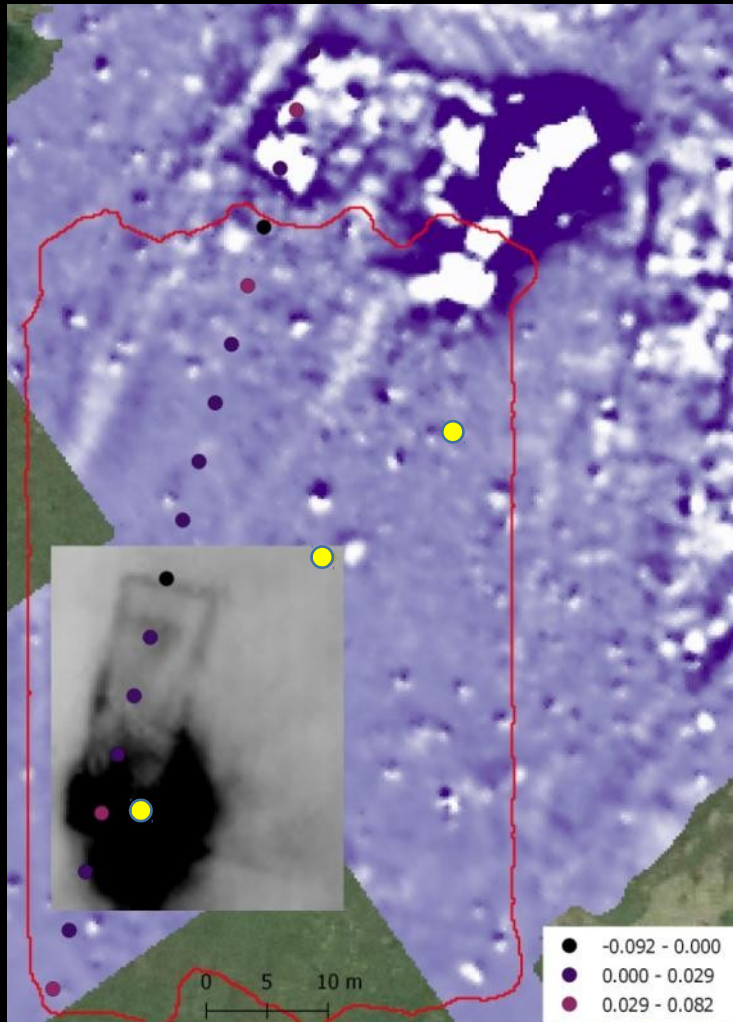


Electrical conductivity - PRP (0.5m depth)

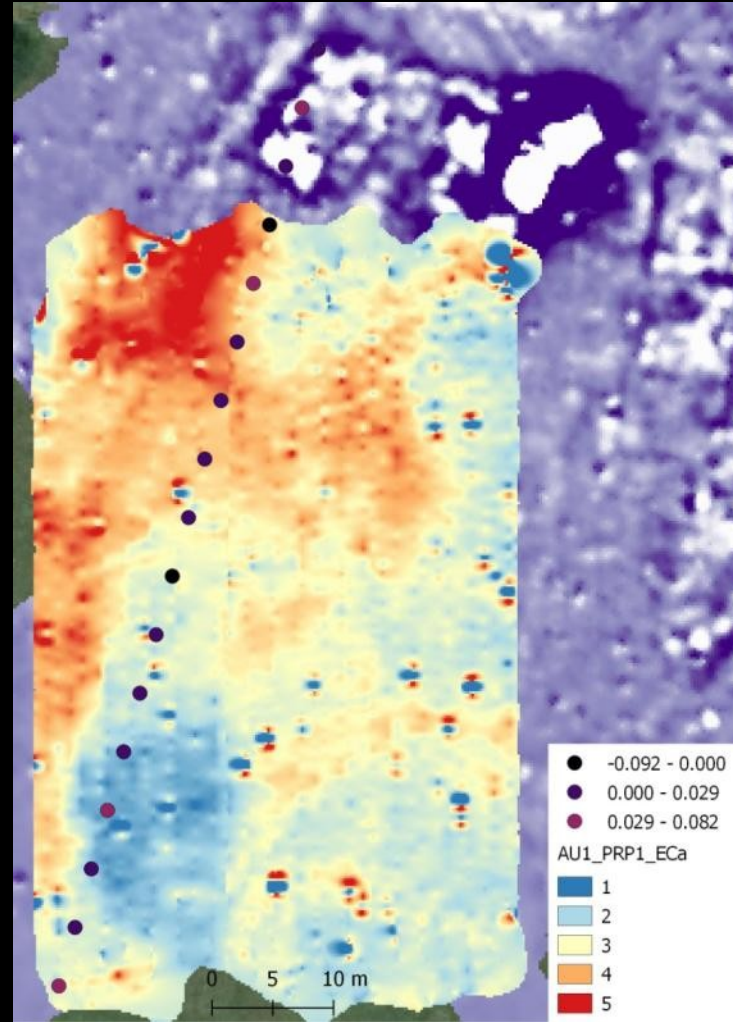


Electrical conductivity - HCP (1.5m depth)

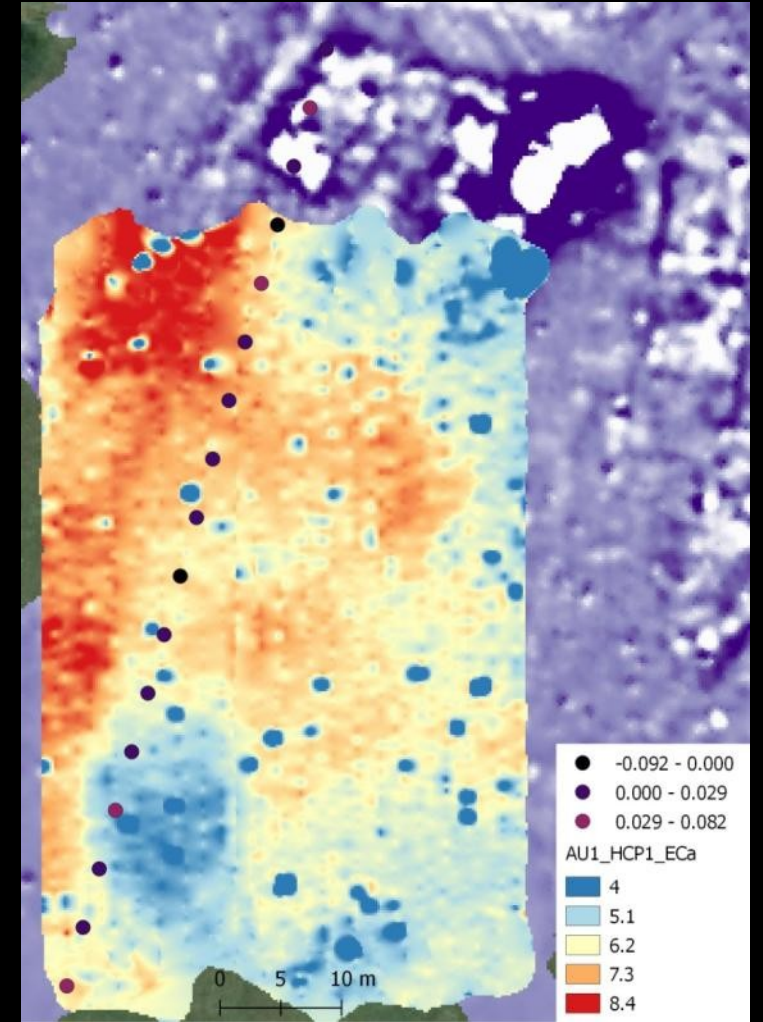
Results. Area 1



Magnetic response map. + RES survey (twin, 0.5m)



Electrical conductivity – PRP (0.5m depth)



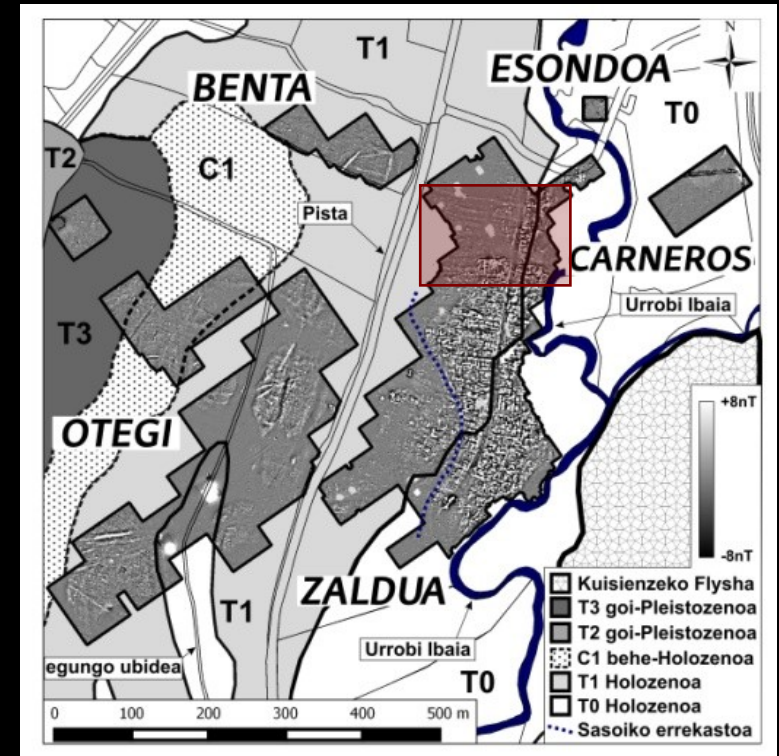
Electrical conductivity – HCP (1.5m depth)



Results. Area 2

Results. Area 2

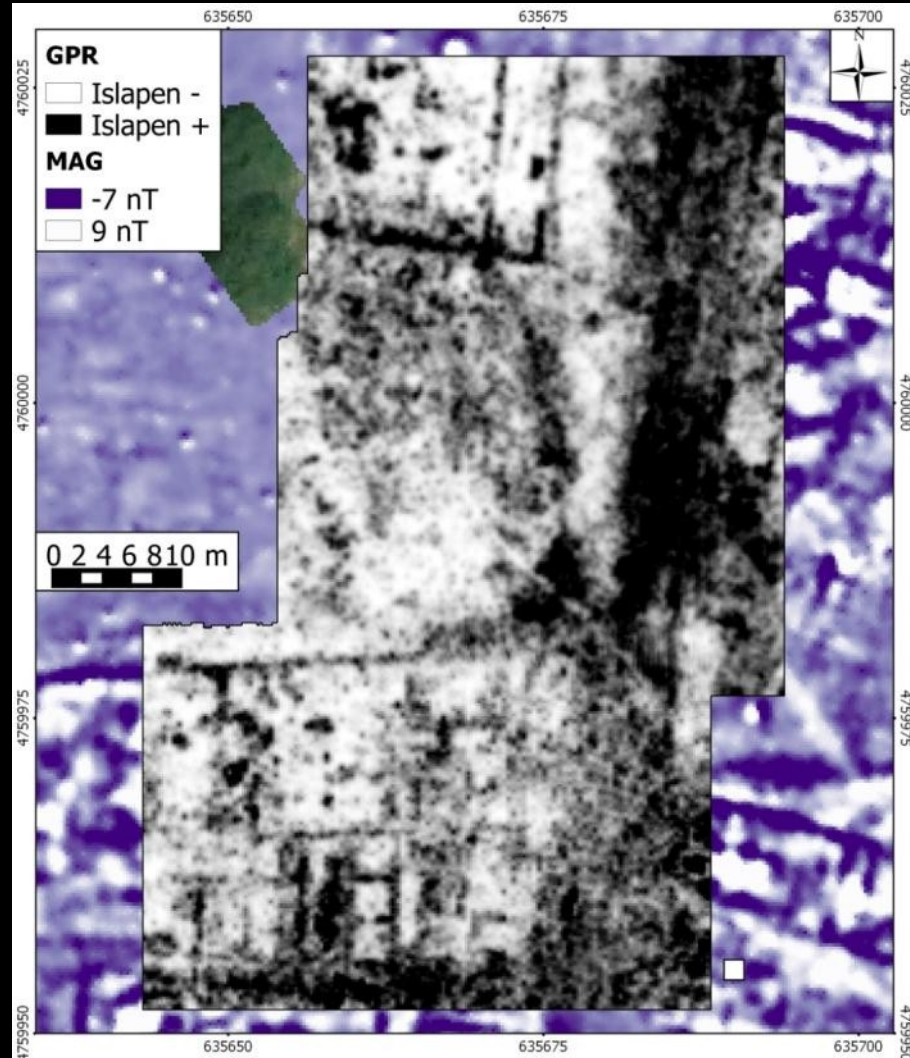
A possible limit in the north



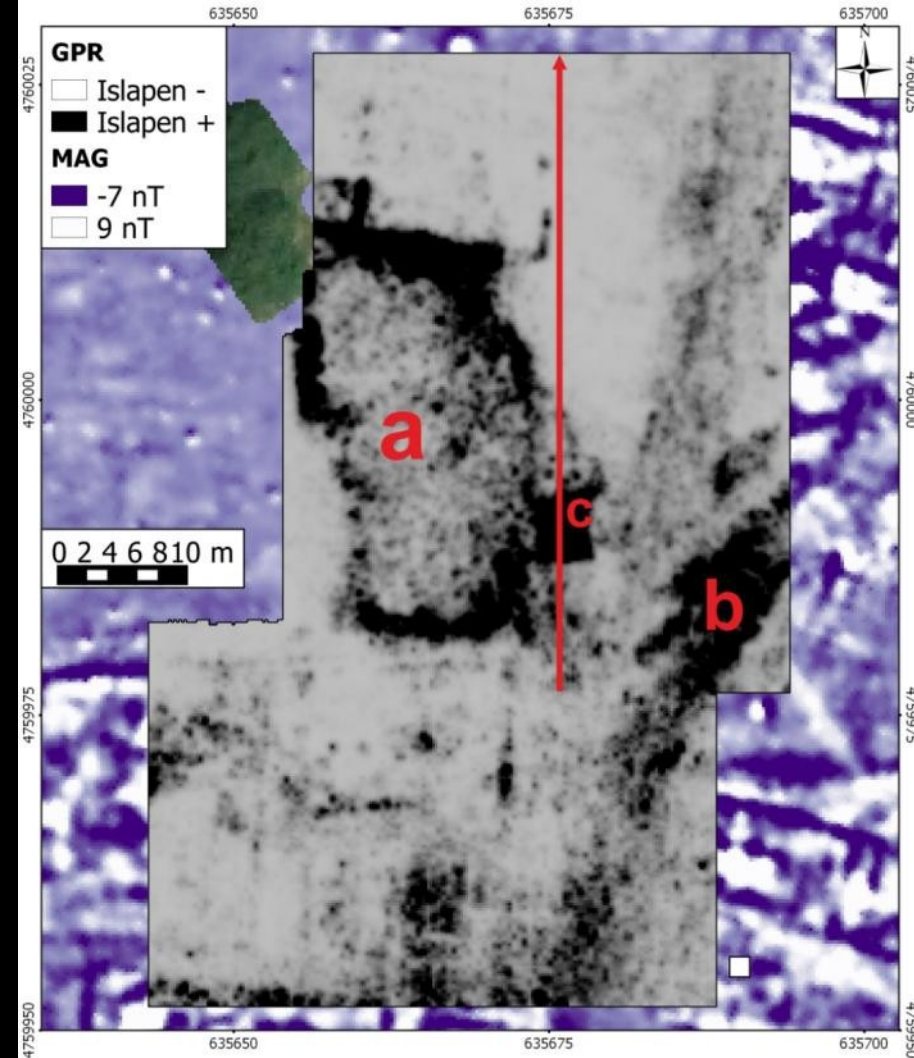
Bartington Grad 601-dual fluxgate gradiometer. Processed data. -7n (black) /+7nT (white)

Results. Area 2

A possible limit in the north



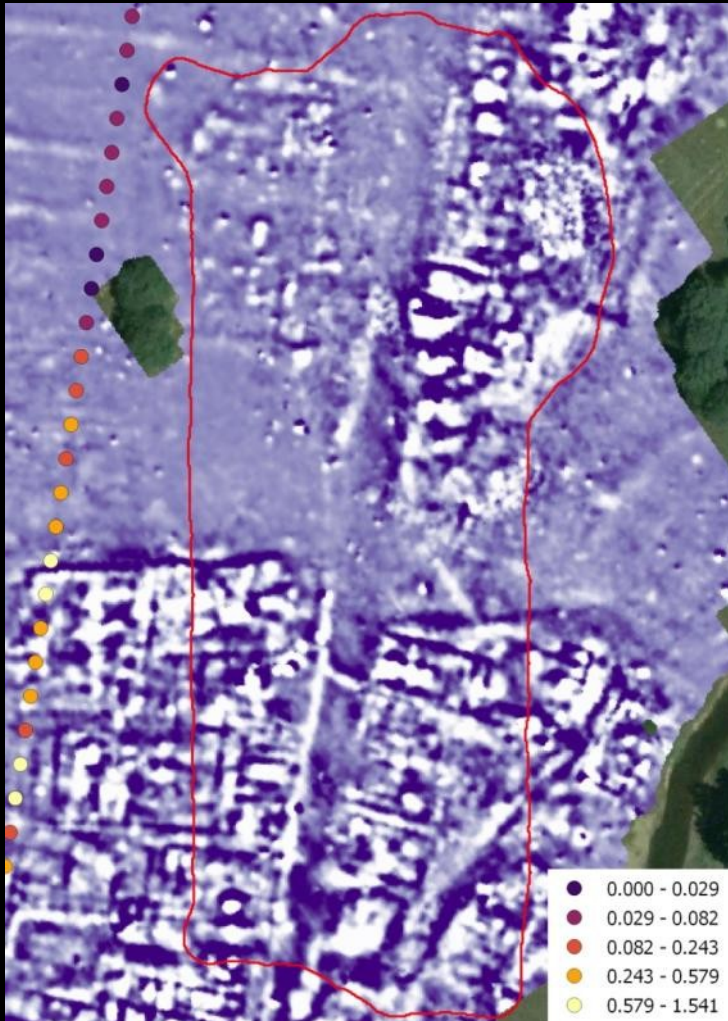
.GPR results. 0.50-0.64m (600MHz; v=7.3 cm/ns)



.GPR results. 1.07m-1.21m (600MHz; v=7.3 cm/ns)

Results. Area 2

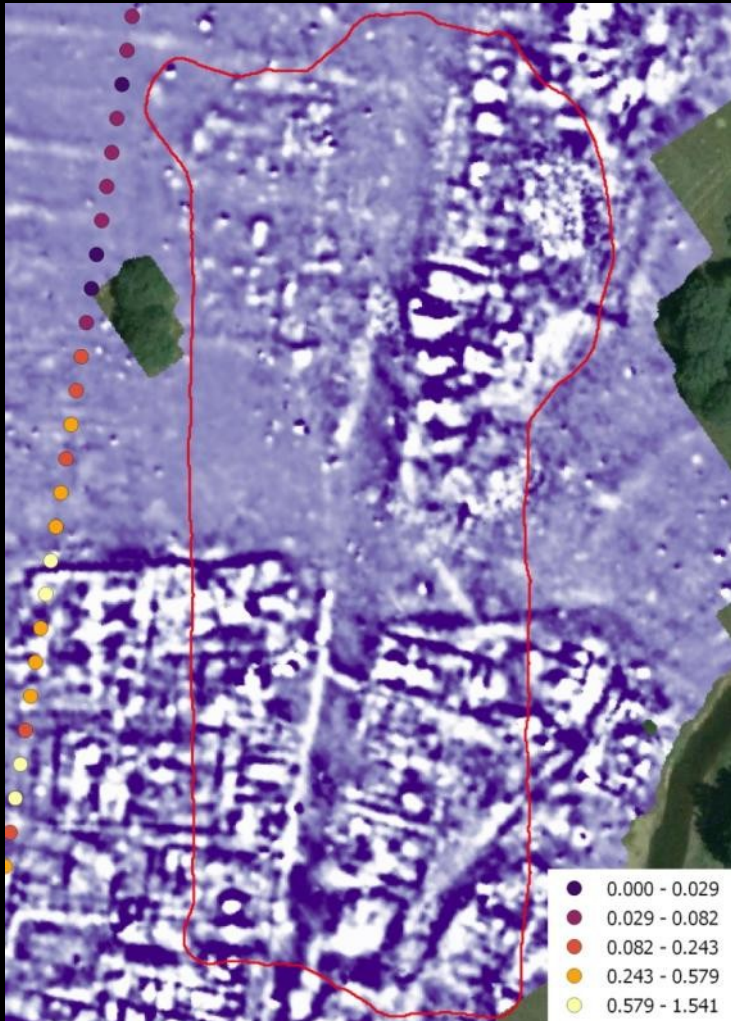
A possible limit in the north



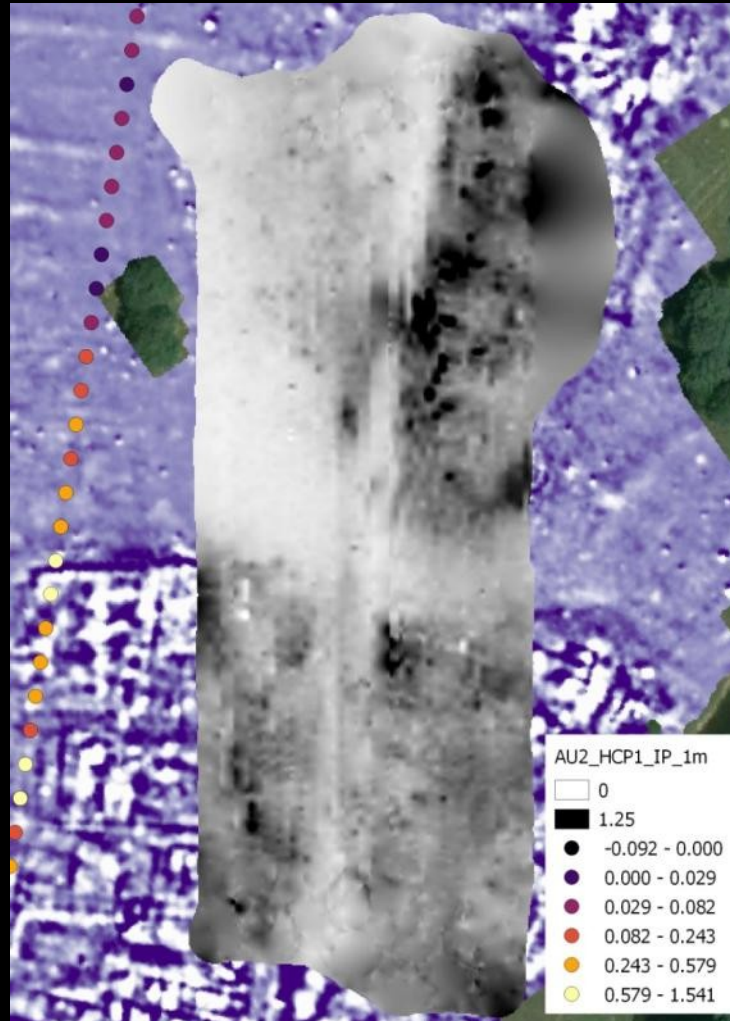
Magnetic response map. -7nT (dark) / 9nt (white)

Results. Area 2

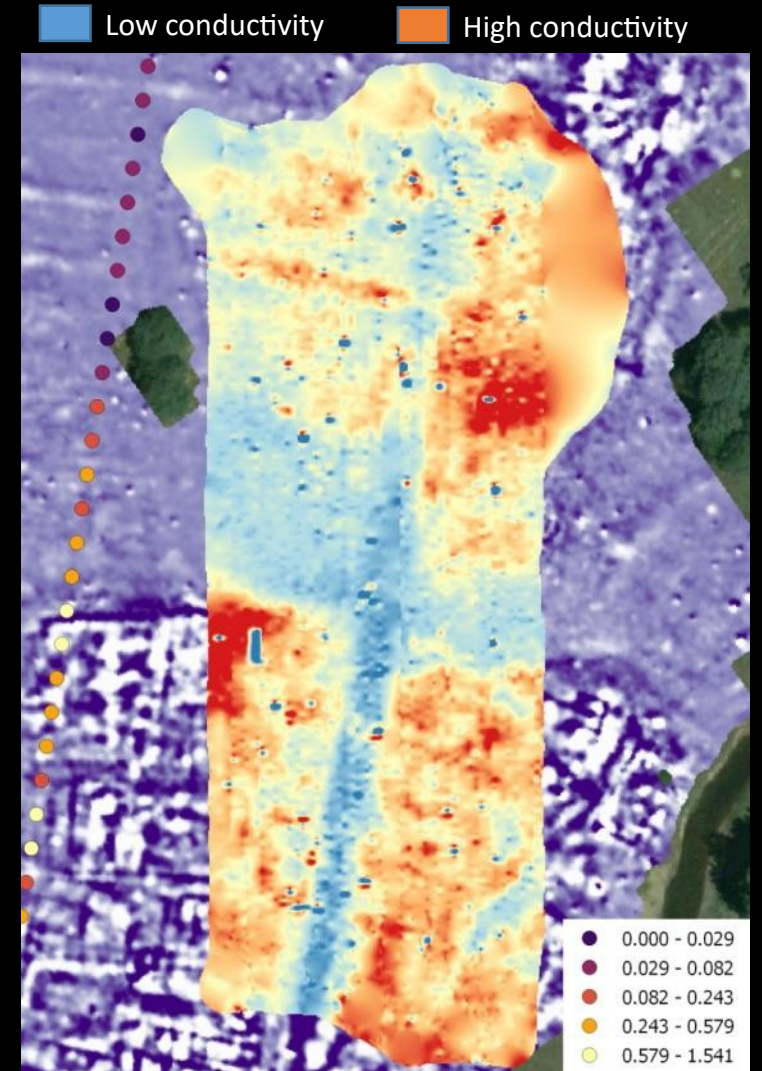
A possible limit in the north



Magnetic response map. -7nT (dark) / 9nt (white)



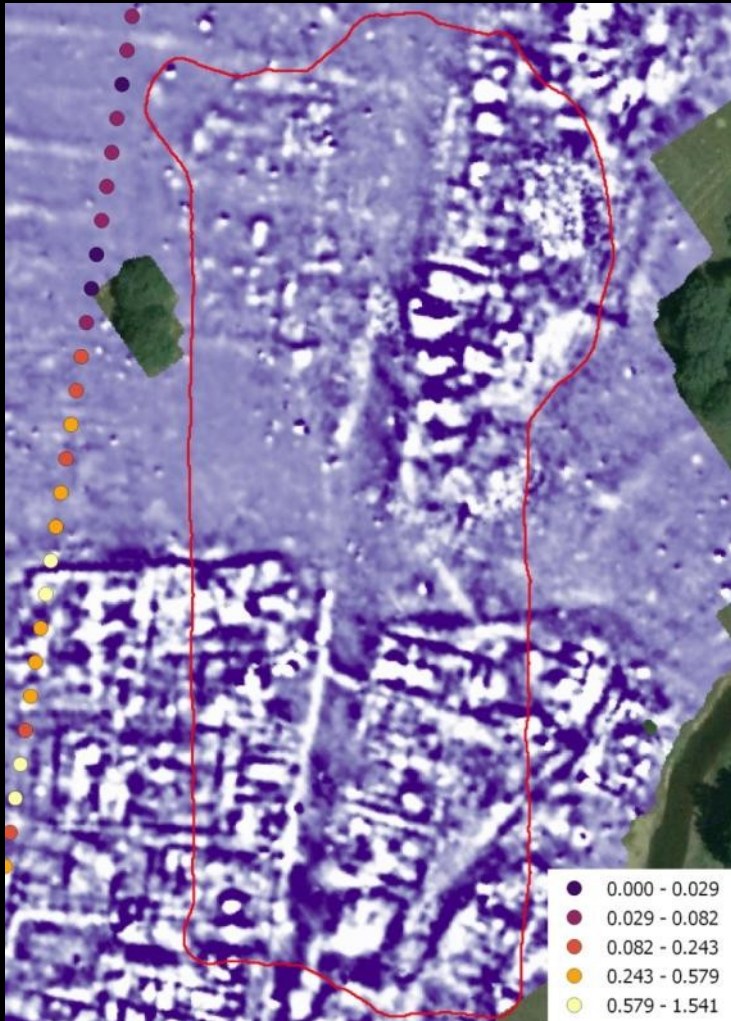
In Phase MAG susceptibility – HCP (1m depth)



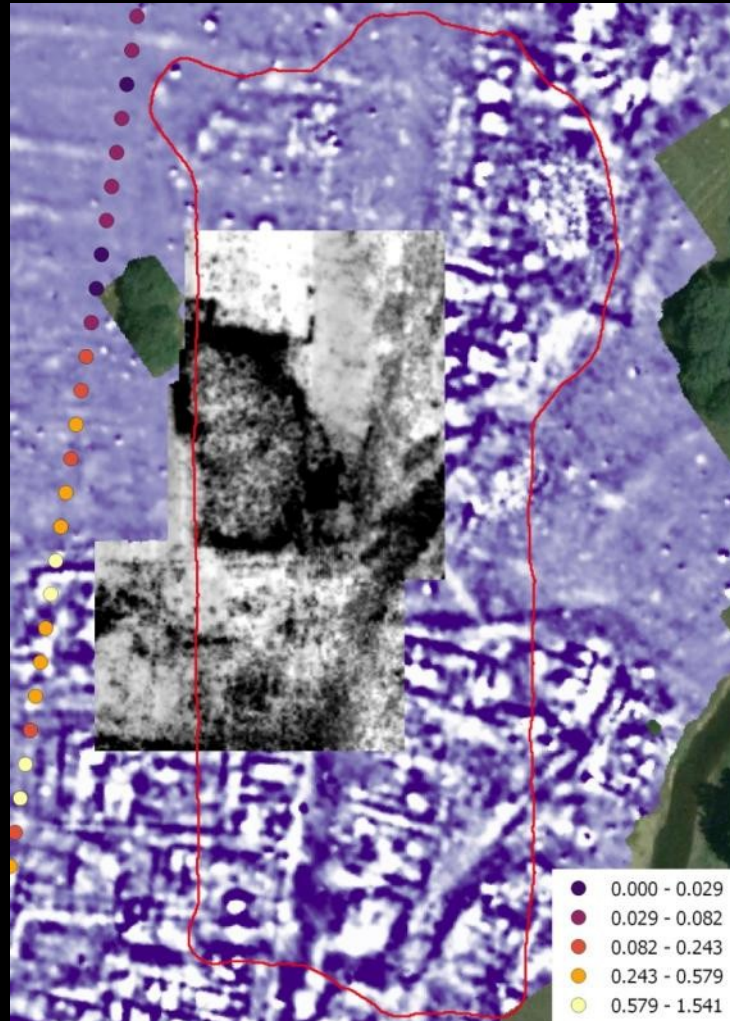
Electrical conductivity – PRP (0.5m depth)

Results. Area 2

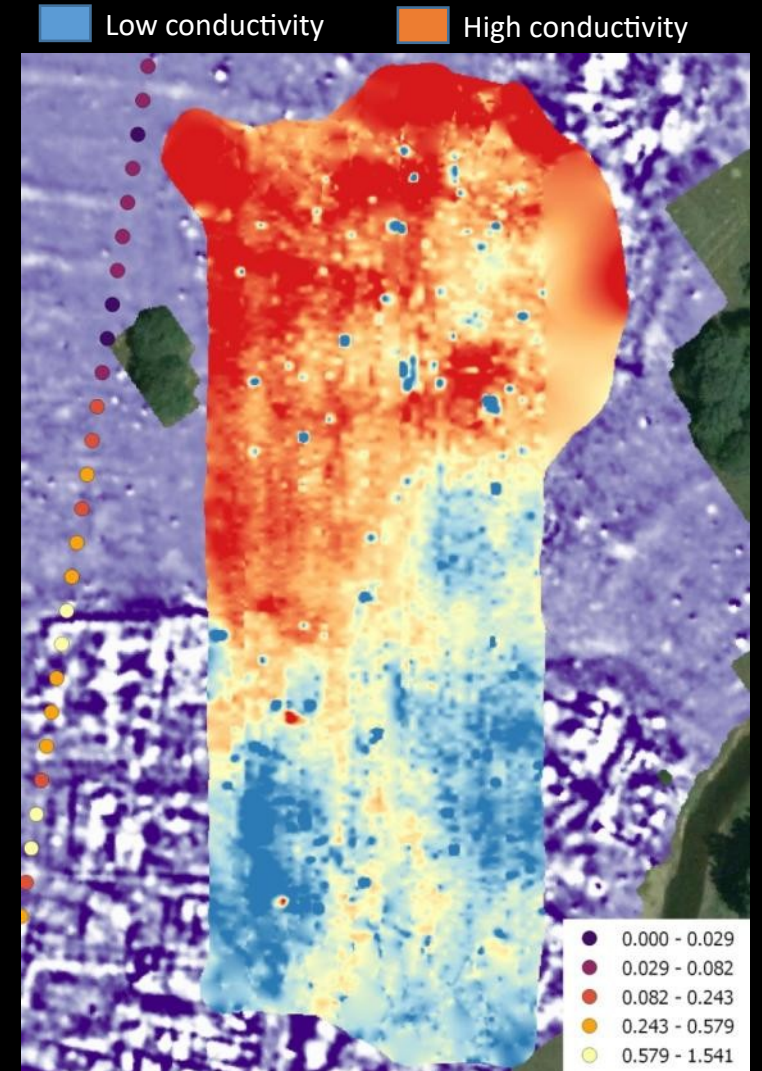
A possible limit in the north



Magnetic response map. -7nT (dark) / 9nt (white)



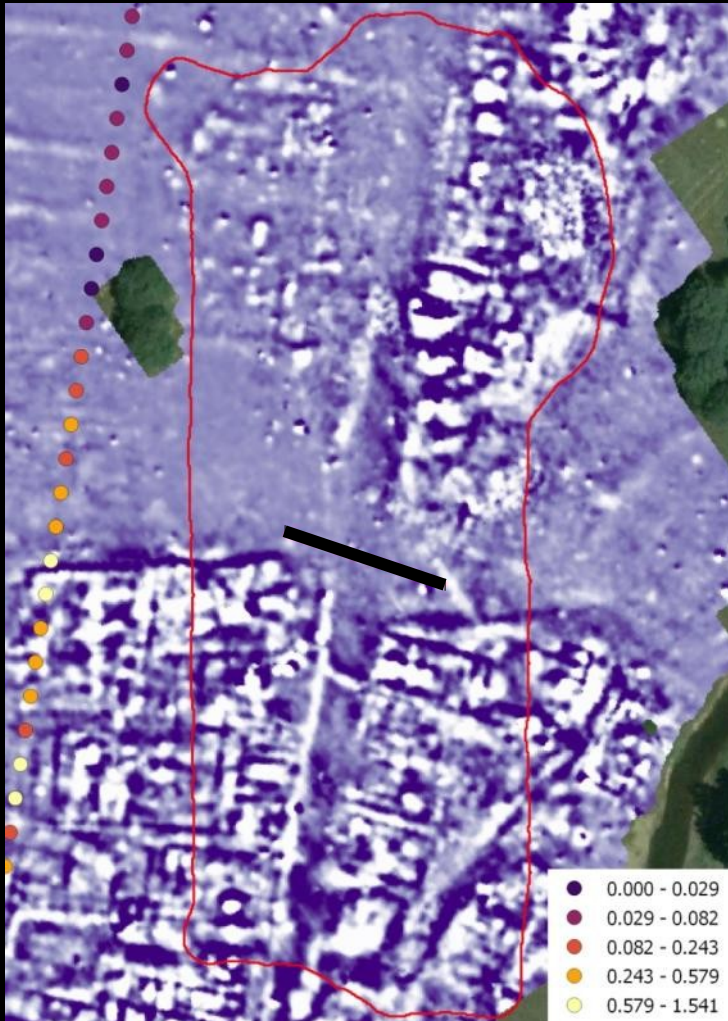
GPR results. 1.07m-1.21m (600MHz; $v=7.3$ cm/ns)



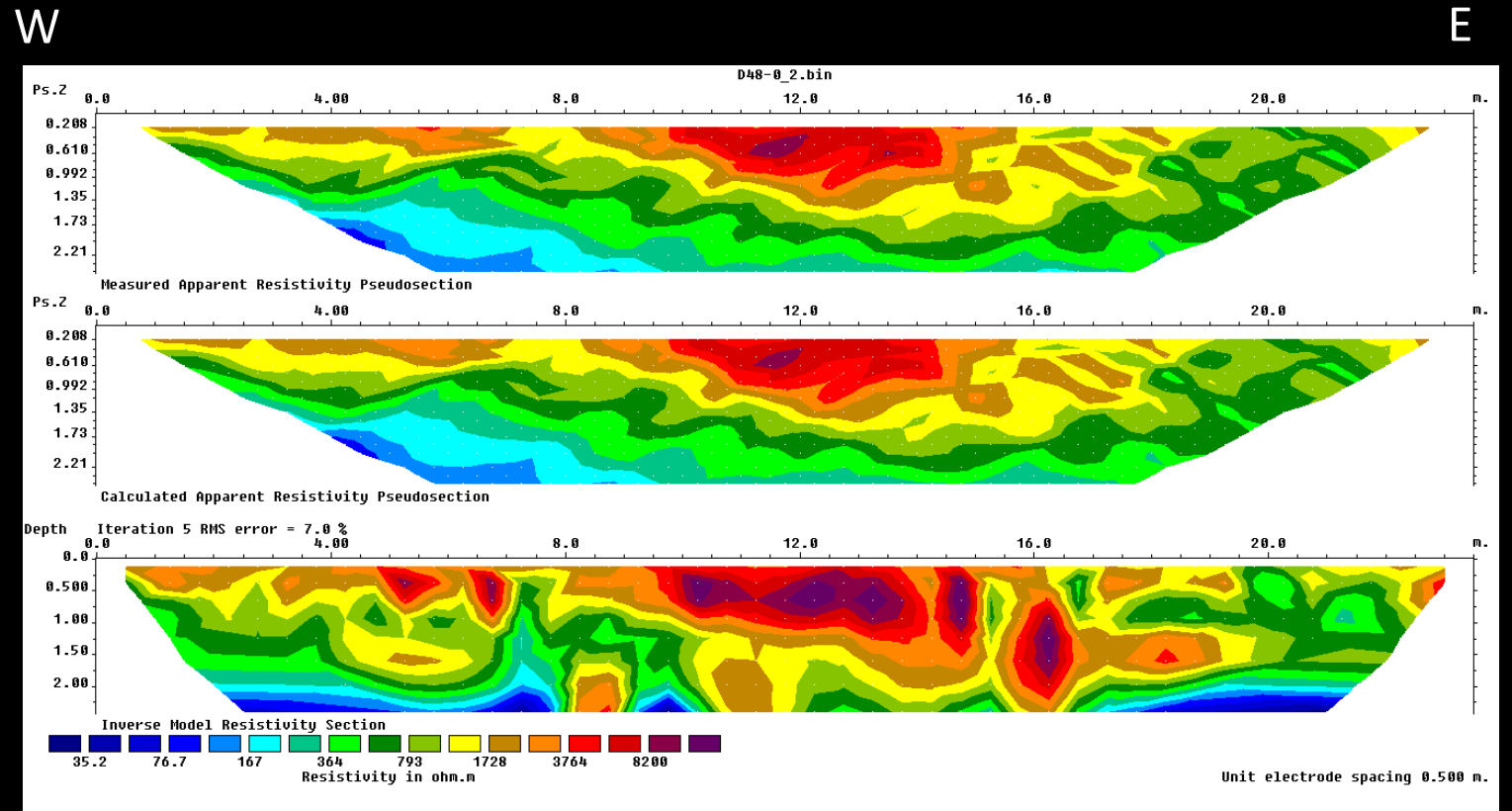
Electrical conductivity – HCP (1.5m depth)

Results. Area 2

A possible limit in the north



Magnetic response map. -7nT (dark) / 9nt (white)



Results. The excavation area



1. Top layer
11-12-16-17
2. Mixed layer with several inclusions
5-9-14
3. Black thin ashy layer
4-15
4. White mortar floor layer
3-8-13
5. Black thin ashy layer
1-2
6. Brown silty layer

Results. Open trench



1. Top layer
2. Mixed layer with several inclusions
11-12-16-17
3. Black thin ashy layer
5-9-14
4. White mortar floor layer
4-15
5. Black thin ashy layer
3-8-13
6. Brown silty layer
1-2



Results. The excavation area

SAMPLE	Context	Sn	Nb	Zr	Sr	Rb	As	Pb	Zn	Cu	Fe	Mn	Cr	V	Ti	Ba	Ca	K	Al	P	Si	Cl	S
saga9	3	< LOD	6.8	134.8	59.1	55.7	< LOD	392.6	88.9	61.2	20332.0	1708.6	82.6	< LOD	2167.2	372.4	29933.2	10976.4	29659.4	3252.9	126846.2	< LOD	470.9
saga14	3	42.3	6.8	143.7	60.7	61.8	< LOD	768.0	80.0	118.5	20463.6	1567.8	54.0	< LOD	1713.7	469.3	16068.3	9274.1	27738.6	5768.1	124473.6	< LOD	785.8
saga5	3	285.9	8.4	147.9	65.7	54.6	< LOD	578.8	103.4	173.9	19734.7	2077.6	62.6	145.6	2273.3	451.3	21887.2	10205.8	36058.5	5957.3	141886.7	< LOD	1436.4
saga8	5	< LOD	3.9	87.0	52.8	44.6	< LOD	177.3	47.0	70.5	21055.3	4082.3	67.9	68.1	1447.5	433.8	19047.0	8159.0	26680.5	3282.8	108075.2	< LOD	247.4
saga13	5	< LOD	5.9	95.4	56.3	69.0	< LOD	229.3	60.1	75.1	23663.8	3515.6	< LOD	113.2	1772.4	723.2	17581.1	10955.0	42788.9	3687.0	160453.1	< LOD	331.2
saga3	5	< LOD	7.9	66.2	63.7	33.5	< LOD	178.7	< LOD	162.9	18421.8	4964.9	< LOD	< LOD	619.7	577.6	39585.6	2890.3	5731.7	1213.0	31051.8	< LOD	247.6



Conclusion

- ❑ The application of new geophysical methods add additional information in some archaeological questions
 - ❑ Area 1: Confirmation of previous results
 - ❑ Area 2: Differences between the two occupied areas
- ❑ The geochemical data of the open trench revealed strong differences in archaeological deposits not discernible by eye.