Waun Mawn Standing Stones
Eglwyswrw, Pembrokeshire,
Wales

Geophysical Survey Report

BUARC
Protecting the past, supporting the future

Waun Mawn Standing Stones
Eglwyswrw, Pembrokeshire, Wales SA41 3TT

Geophysical Survey Report

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Documentation summary

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DIGITAL ARCHIVE

1. Animation of GPR data from *c*. 0-1.25m bgl

Project summary

Project Name:	Waun Mawn Standing Stones Geophysical Survey
Location:	Waun Mawn Standing Stones, Eglwyswrw, Pembrokeshire, Wales SA41 3TT
NGR:	SN 08357 33995
Project Type:	Geophysical Survey
Date of Fieldwork:	18 – 23 June 2018
Date of Issue:	30 July 2018
Project Code:	0203
Report Reference:	BUARC/2018/0203/1
Survey Size:	*c*. 0.7ha
Survey Type	Ground-penetrating Radar, Earth Resistance
Weather Conditions:	Mixed
Site Conditions:	Mixed with concentrated areas of high soil moisture content Open grassland with gorse
Survey Equipment:	MALÅ RAMAC X3M, Geoscan Reseach RM85 with MSP40
Location of Archive:	Bournemouth University

Summary

BUARC, Bournemouth University's Archaeological Consultancy, was commissioned by Mike Parker Pearson to carry out a programme of geophysical survey at the Waun Mawn Standing Stones.

The surveys delineated areas of archaeological potential, geological variation, and modern activity. Based on the results of this survey the archaeological potential of the site is deemed to be medium.

It is anticipated this report will be used to inform a future research strategy for the site and help determine the nature and extent of further investigations including, but not necessarily limited to, an archaeological trench evaluation and test pitting of the potential archaeological features represented by geophysical anomalies recorded during this project.

Abbreviations

aOD	Above Ordnance Datum
bgl	below ground level
CIfA	Chartered Institute for Archaeologists
DBA	Desk-Based Assessment
OS	Ordnance Survey
SD	Standard deviations
WSI	Written Scheme of Investigation

1 INTRODUCTION

1.1 Project Background

1.1.1 BUARC, Bournemouth University's Archaeological Consultancy, was commissioned by Mike Parker Pearson to carry out a programme of geophysical survey at the Waun Mawn Standing Stones.

1.1.2 Previous archaeological investigations on the site include preliminary geophysical survey in 2011 by Prof. Kate Welham for the Stones of Stonehenge Project, trial excavation in 2017 by the Stones of Stonehenge Project, and an electro-magnetic induction survey by Philippe de Smedt in March 2019.

1.1.3 The grey literature related to this project will be submitted in an OASIS database record, and a copy of the survey report will lodged with Royal Commission on the Ancient and Historical Monuments of Wales. The raw data will remain with Bournemouth University.

2 PROJECT DESCRIPTION

2.1 Site Location

2.1.1 The Waun Mawn Standing Stones (NPRN 300423) are located northwest of Tafarn-y-bwlch, Crymch, in Eglwyswrw, Pembrokshire, Wales (Figure 1).

2.1.2 The survey area is located 2.3km southwest of Brynberian, Crymych SA41 3TN (centred at SN 08357 33995) on open heathland with concentrated areas of overgrown gorse (see Figure 2). At the time of survey the land was in use as pasture.

2.2 Geology and Topography

2.2.1 The solid underlying geology is of the Aber Mawr Shale Formation, a sedimentary bedrock (mudstone) (BGS 2018). These rocks formed in areas dominated by open seas with pelagite deposits approximately 461 to 478 million years ago (BGS 2018). There are no superficial deposits recorded for the survey area.

2.2.2 The survey area lies approximately 322m above Ordnance Datum (aOD).

2.3 Archaeological and Historical Background

2.3.1 The Waun Mawn Standing Stones are a possible stone circle comprised of four stones – one standing and three recumbent stones (see Figure 4).

2.3.2 A brief assessment of the information available through the Historic Wales Database (2018) identified several indications of archaeological and/or anthropogenic activity within 1km of the survey area; these are detailed in Table 1 and Figure 1.

Table 1: Details of archaeological features within 1km of the survey area

Name	Description	NGR
Gernos-Fach	Pillow Mound	SN 0729 3443
Banc-Du	Unknown	SN 0750 3470
Trebwlch Farm	Inscribed Stone	SN 08621 35168
Waun Mawr	Common Land	SN 075 347
Bank Ddu	Unknown Earthwork	SN 077 347
Waun Maes	Sheep Fold	SN 0744 3334
Waun Maes	Long Hut	SN 0752 3333
Waun Maes	Long Hut	SN 0746 3336
Castell Y Cynhen	Unknown	SN 0856 3375
Tafarn-Y-Bwlch	Deserted Rural Settlement	SN 07952 33822
Tafarn-Y-Bwlch, Building	Settlement	SN 0798 3381
Tre-Bwlch Pillar Stones, Brynberian	Inscribed Stone	SN 0862 3507
Tafarn-Y-Bwlch, Enclosure	Field System	SN 0796 3388
Cnwc-Yr-Hydd, Waun-Mawn, Cilgwyn	Deer Park	SN 08287 34494
Talfarn-Y-Bwlch Stone Pair	Standing Stone Pair	SN 0813 3370
Tafarn-Y-Bwlch Trackways	Trackway	SN 0828 3347
Pen-Lan-Oleu, Farmstead	Farmstead	SN 0787 3481

Cnwc-Yr-Hydd, Circular Feature	Platform	SN 0807 3411
Disused Sheepfold, Waun Maes, South-East of Gellifawr	Sheep Fold	SN 0744 3333
Cnwc Yr Hydd Quarries, Wsw Of Brynberian	Quarry	SN 083 345
Tafarn-Y-Bwlch Common Standing Stone	Standing Stone	SN 081 332

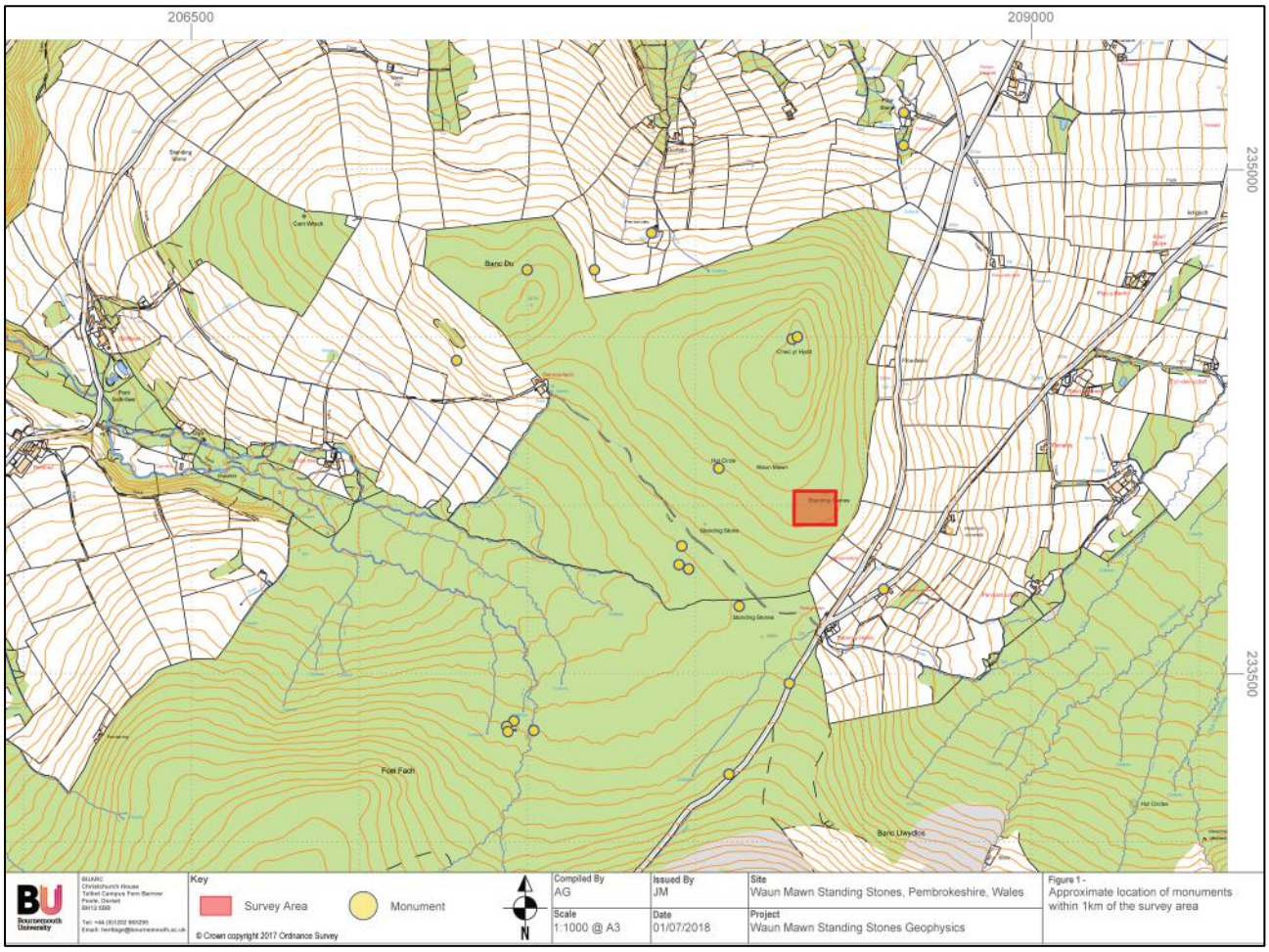

Figure 1: Location of archaeological features with 1km of the survey area

3 AIMS AND OBJECTIVES

3.1 Project Aims

1.1.1 The Waun Mawn survey aimed to provide information that will aid archaeologists and the land managers in understanding the monument and its setting within the landscape, while also informing future research and investigation, including an excavation strategy to investigate the nature and extent and archaeological significance of the site.

3.2 Project Objectives

3.2.1 The objective of archaeological investigations at Waun Mawn is to establish the presence or absence of archaeological deposits through non-invasive geophysical survey, such that the archaeological record can be improved and facilitate the better understanding of the archaeology of the site and region.

1.1.2 It is envisaged that the targeted GPR survey will help identify any additional stone sockets similar to those identified during previous excavations.

4 METHODOLOGY

4.1 General

4.1.1 The survey was undertaken by BUARC staff who are certified members of the Charted Institute for Archaeologists and abide by the Chartered Institute for Archaeologists Code of Conduct (2014) and follow standards and best practice set out in the Chartered Institute for Archaeologists.

4.1.2 Earth resistance survey data were processed using TerraSurveyor™ and Geoplot™ 4. Ground-penetrating radar data were processed using GPR-Slice™ v7.

4.2 Geophysical Survey Techniques

4.2.1 Ground-penetrating radar (GPR) detects slight variations in the subsurface conditions (e.g. geological variations, anthropogenic activity, services) by emitting electromagnetic pulses through the ground from a transmitting antenna. When the emitted signal interacts with changes in the subsurface material, it is reflected to the ground surface to the receiving antenna and converted to wavelets presented on a monitor held by the surveyor. As such GPR detects changes in the subsurface matrix, whether they are significant archaeological features or variations in geology. The amount of time passed from the emission of the electromagnetic signal to receiving is used to determine the approximate depth of any detected objects. Higher frequency antennas are suitable for detecting near surface objects, while lower frequency antennas have a greater potential penetration depth (up to 20m under certain conditions) but with lower resolution.

1.1.3 By passing an electrical current through the ground, earth resistance systems measure the subsurface material's resistance to the current. Resistance surveys can be conducted with a range of electrode arrays (e.g., twin, pole-pole, Wenner) dependent on the level of vertical and horizontal resolution required by the nature of the survey area and target. The Geoscan Research MSP40 is a resistance meter mounted on a cart platform which is used in a square array with four wheels spaced 0.75m apart. The electrode spacing allows for collecting alpha and beta data at sampling intervals as small as 0.25m. Plain-view surveys allow surveyors to detect horizontal variations in bulk resistance values, which may indicate structures, ditches, or waterlogged areas. Increased electrode separation will allow greater depths of investigation but will have decreased resolution as depth increases.

4.2.2 Soil velocity and chemistry, the condition of the target object, groundwater retention, ferrous objects, rubble, and the presence of subsurface obstacles such as tree roots, animal activity, and large stones, all affect data acquisition in geophysical surveys.

4.2.3 For an object to be detected, it must differ from the surrounding material. During survey the operator has control over the traverse spacing and sampling interval to acquire high-resolution data. The parameters for this survey follow or exceed Historic England's (formerly English Heritage) geophysical survey guidelines (David et al. 2008). Under optimal conditions, these techniques are likely to detect a large range of features including large voids, stratigraphic changes, interments (modern and archaeological), geomorphological changes, structures (or their foundations), large stones, pits and ditches.

4.3 Ground-penetrating Radar (GPR)

4.3.1 GPR survey of the monument was conducted with a MALÅ RAMAC X3M system using a 500 MHz central frequency antenna cart-pushed at a rate of 0.6 – 0.8m/s. The area was surveyed in parallel traverses. Test traverses were conducted to determine the appropriate time window parameters for the survey area. The traverse spacing was 0.5m and sampling interval 0.05m.

4.3.2 The approximate soil velocity was calculated utilizing the hyperbola migration function in GPR-Slice™ v7.

4.3.3 Data were migration filtered, sliced with 30% overlap, and plotted using a squared amplitude binning parameter in relative normalization.

4.4 Earth Resistance Survey

4.4.1 Earth resistance surveys were conducted with a Geoscan Research RM85 mounted on a MSP40 cart. The survey employed a 1m traverse interval and 0.5m sampling interval, measuring alpha and beta to obtain an overall 0.25m sampling interval, with data collected in a zig-zag traverse pattern.

4.4.2 The data were despiked using a 3x3 window with a threshold of 1, interpolated along the X and Y axes twice, and display clipped to ±3 standard deviations. The alpha and beta data were merged using Geoplot™ 4 with the default parameters.

4.5 Survey Constraints

4.5.1 The survey methodology was established to acquire the highest quality data possible while accounting for the following constraints:

- Heavy rainfall throughout the duration of the survey;
- Waterlogged ground conditions from flooding across many areas of the survey;
- Dense vegetation (gorse and bracken) impeding the electrode contact in the earth resistance survey which consequently reduced the quality of the data.

4.5.2 Due to the survey constraints large areas of the proposed survey area could not be adequately surveyed. The extent of these areas is shown in Figure 3.

5 RESULTS

5.1 Summary

5.1.1 Raw data plots, and an XY trace plot of the earth resistance data are available in Appendix A. The complete set of GPR time slices are available in Appendix B.

5.1.2 The combined interpretation for all techniques is presented in Figure 5. Comprehensive and detailed interpretation is shown in the figures for the individual techniques. The interpretation of the processed earth resistance data is presented in Figure 6 and the interpretation thereof in Figure 7. A selection of processed ground-penetrating radar time slices and interpretation thereof are presented in Figures 8-17.

5.1.3 The key terms used to classify responses in the earth resistance and GPR datasets are described in Table 2.

Table 2: Description of the terms used to classify responses in the geophysical dataset

Category	Description
Geology	Responses indicative of non-discrete geological variations, variations in topsoil thickness, or discrete geological formations.
Possible Archaeology	Responses similar to archaeological features but may not be morphologically discrete or definitive.
Topography	Responses caused by localised variations in the topography.
Modern	In the magnetic data these responses relate to paths, modern disturbance, or agricultural activity. In the GPR data these responses may result from modern disturbance or vegetation on the ground surface and/or tree roots noted during survey.
Signal Noise	Responses resulting from “ringing” of antenna noise in the GPR survey that could not be removed during processing.

5.1.4 The results of the surveys have been interpreted alongside analysis of aerial photographs available for the area. These together reveal that many of the geophysical anomalies align with geological and potential archaeological features.

5.2 Description

5.2.1 Earth Resistance Survey (see Figures 6-7)

5.2.1.1 **A** is a rectangular high resistance response surrounding the westernmost excavation trench. Based on its morphology, **A** is considered to be of medium archaeological potential.

5.2.1.2 **B** is a curvilinear high resistance response which corresponds to **L** in the GPR data. **B** may form part of the stone circle as it is in alignment with the known stones.

5.2.1.3 **C** are rectangular low resistance responses which correlate to the backfilled trenches (see Figure 4).

5.2.2 GPR Survey (see Figures 8-17)

5.2.2.1 **C** are rectangular low and high amplitude responses which correlate to the backfilled trenches (see Figure 4).

5.2.2.2 **D** is a group of subrectangular and oval high amplitude which form a linear trend. **D** is of low-medium archaeological potential due to its morphology.

5.2.2.3 **E** is a group of isolated subrectangular high amplitude responses. As **E** fits within the potential extent of the stone circle it is considered to be of archaeological potential.

5.2.2.4 **F** is a discrete high amplitude response of low archaeological potential due to its morphology.

5.2.2.5 **G** is a linear high amplitude response which aligns with a sheep track on aerial photos.

5.2.2.6 **H** is a curvilinear high amplitude response of low archaeological potential based on its morphology.

5.2.2.7 **I** is a subrectangular spread of high amplitude reflections which are likely a result of localised variation in vegetation or geology.

5.2.2.8 **J** is a morphologically ambiguous curvilinear low amplitude response which may correspond to a localised variation in geology, vegetation, or topography.

5.2.2.9 **K** is a linear low amplitude response which is morphologically indicative of anthropogenic activity; however, a geological origin cannot be excluded.

5.2.2.10 **L** is a circular low amplitude response of medium archaeological potential as it is in alignment with the known stones in the circle.

5.2.2.11 **M** is a semi-circular low amplitude response located centrally within the westernmost trench; however, it is morphologically similar to a response of anthropogenic origin.

6 DISCUSSION AND CONCLUSION

6.1.1 In comparing the results of the two techniques, discrete responses have been identified across the survey area. Analysis of aerial photographs, however, reveals that many of these anomalies align with geological and potential archaeological features.

6.1.2 Based on the results of the geophysical survey and the proximity of the site to several known archaeological features, the archaeological potential of the site is deemed to be medium.

6.1.3 It is recommended that further research and investigation of the site is considered in line with those

proposed by the client. Targeted investigation of some of the anomalies through a trial trench evaluation and test pits may be successful in identifying their archaeological potential and association with the possible stone circle.

7 COPYRIGHT

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8 ACKNOWLEDGEMENTS

8.1.1 The project was managed by BUARC Project Manager Jonathan Monteith, while the survey was carried out by Jon Milward and Ashely Green.

8.1.2 This report was authored by Jonathan Monteith and Ashely Green. The authors would like to thank Mike Parker Pearson for commissioning the project and for providing assistance throughout the project.

9 REFERENCES

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10 PLATES

Plate 1: View of the survey area facing east.

Plate 2: View of the survey area facing west.

Plate 3: View of the survey area facing east.

Plate 4: View of the survey area facing northwest.

Plate 5: View of the survey area facing north.

Plate 6: View of the survey area facing south.

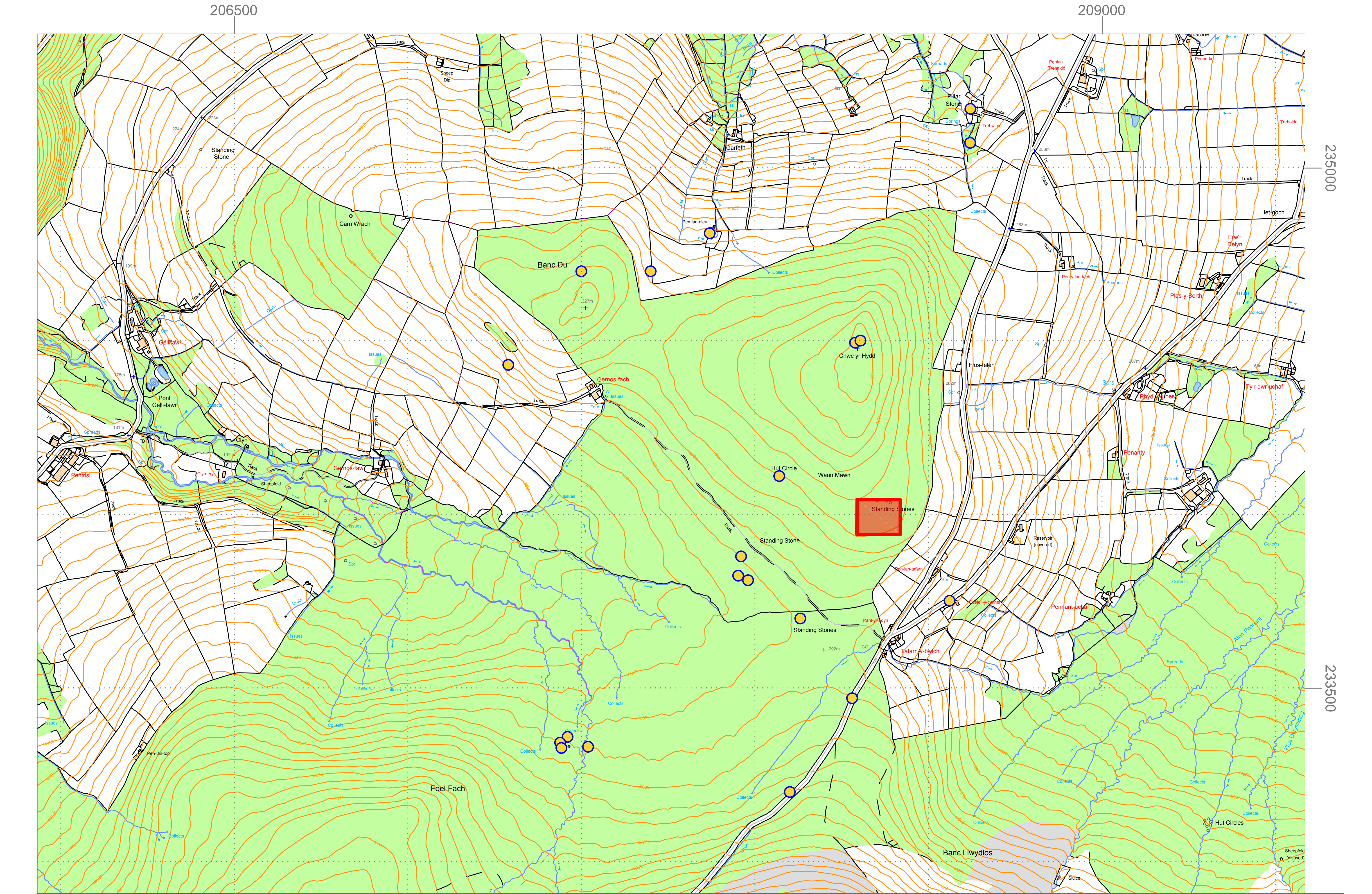
Plate 7: View of the survey area facing southeast.

Plate 8: View of the survey area facing southwest.

Plate 9: View of the survey area facing northeast.

Plate 10: View of the survey area facing east.

11 FIGURES



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Key

Survey Area

Monument

N

Compiled By	Issued By	Site	Figure 1 -
AG	JM	Waun Mawn Standing Stones, Pembrokeshire, Wales	Approximate location of monuments within 1km of the survey area
Scale	**Date**	**Project**	
1:10000 @ A3	01/07/2018	Waun Mawn Standing Stones Geophysics	

204500

210000

236000

232500

Mynydd Caregog

Waun Mawn Standing Stones

Brynberian

Banc Du

Foel Fach

Waun Mawn

Banc Llwydos

Rhos y Bryn

Rhiwngyddwyfforlod

Banc Ty-Canol

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Survey Area

N

Compiled By	Issued By	Site	Figure 2 -
AG	JM	Waun Mawn Standing Stones, Pembrokeshire, Wales	Site location
Scale	**Date**	**Project**	
1:20000 @ A3	01/07/2018	Waun Mawn Standing Stones Geophysics	

208300

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Standing Stone

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Key

Survey Area

Unsuitable Ground Conditions

N

Compiled By	Issued By	Site	Figure 3 -
AG	JM	Waun Mawn Standing Stones, Pembrokeshire, Wales	Location of ground conditions unsuitable for survey
Scale	Date	Project	
1:500 @ A3	01/07/2018	Waun Mawn Standing Stones Geophysics	

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Key

Backfilled Excavation Trench

Extant Stone

N

Compiled By	Issued By	Site	Figure 4 -
AG	JM	Waun Mawn Standing Stones, Pembrokeshire, Wales	Plan of the stones at Waun Mawn
Scale	**Date**	**Project**	
1:500 @ A3	01/07/2018	Waun Mawn Standing Stones Geophysics	

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Key

Modern | Geology | ?Archaeology | Potential Extent of Stone Circle

N

Compiled By	Issued By	Site
AG	JM	Waun Mawn Standing Stones, Pembrokeshire, Wales
Scale	**Date**	**Project**
1:500 @ A3	01/07/2018	Waun Mawn Standing Stones Geophysics

Figure 5 -
Combined interpretation from both techniques with location of potential stone circle (*c.* 100m diameter)

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Key

-3SD 3SD

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Compiled By	Issued By	Site	Figure 6 -
AG	JM	Waun Mawn Standing Stones, Pembrokeshire, Wales	Greyscale plot of processed earth resistance data
Scale	Date	Project	
1:500 @ A3	01/07/2018	Waun Mawn Standing Stones Geophysics	

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A

C

D

C

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Key

Modern Geology ?Archaeology Survey Extent

N

Compiled By	Issued By	Site	Figure 7 -
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Scale	Date	Project	
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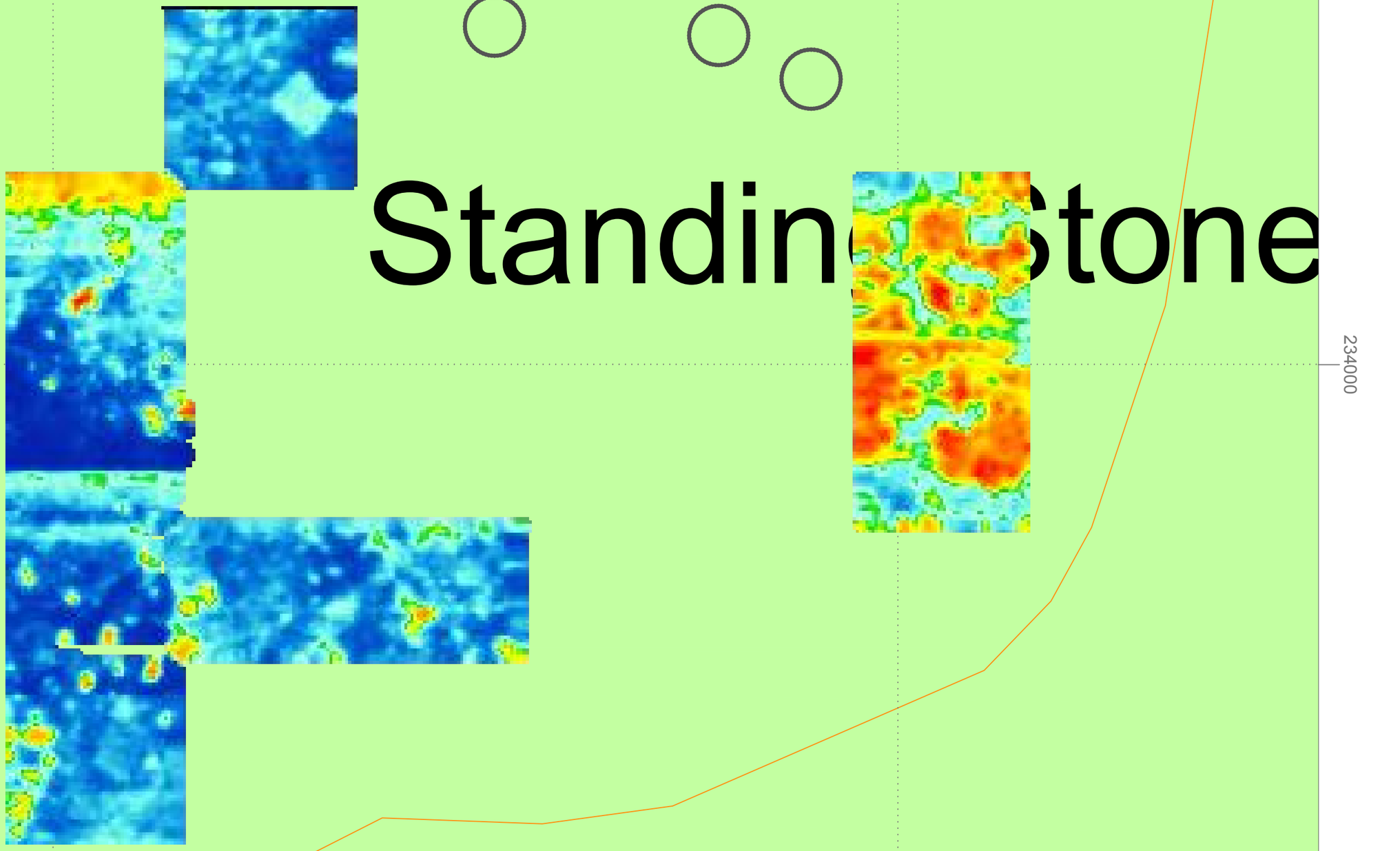

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Key

Low Amplitude — High Amplitude

N

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Scale	**Date**	**Project**
1:500 @ A3	01/07/2018	Waun Mawn Standing Stones Geophysics

Figure 8 -
Colour plot of processed GPR data at *c.* 0.03m bgl

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Standing Stone

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Key

Modern

Geology

?Archaeology

Survey Extent

N

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Scale	**Date**	**Project**
1:500 @ A3	01/07/2018	Waun Mawn Standing Stones Geophysics

Figure 9 -
Interpretation of GPR data at *c.* 0.03m bgl

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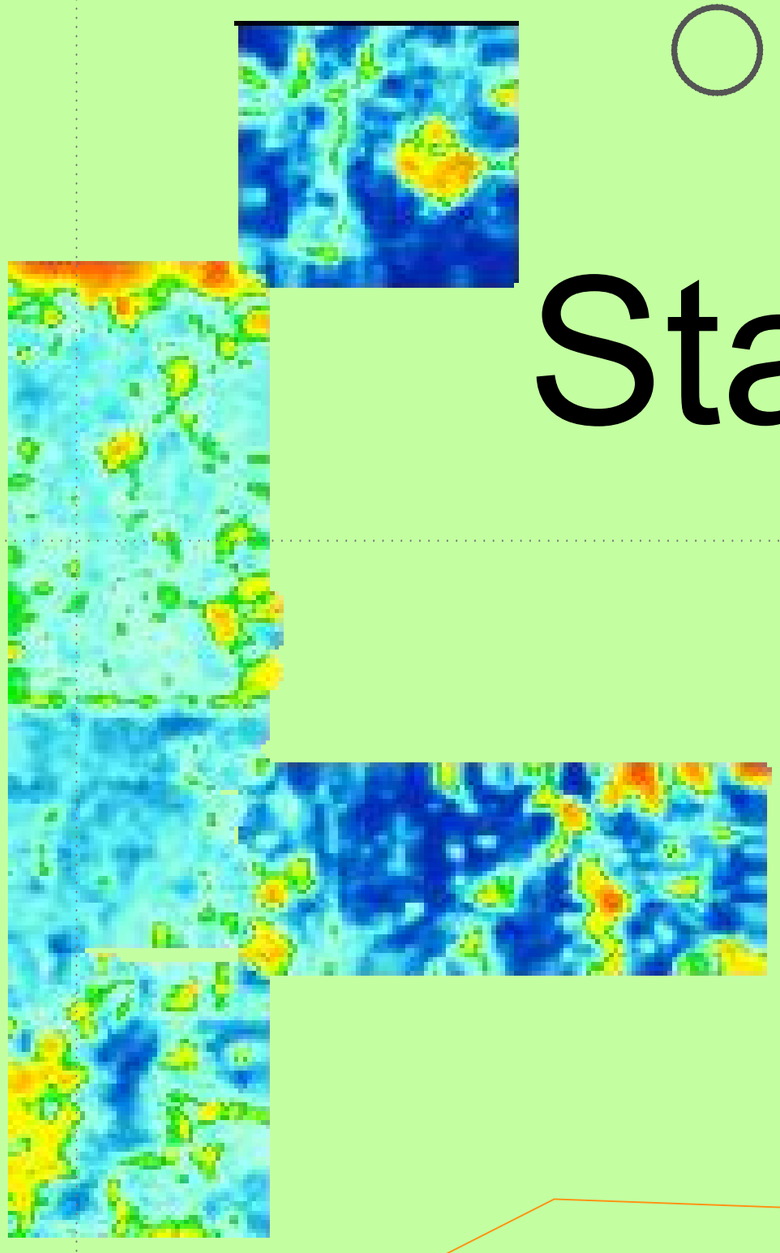

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Key

Low Amplitude — High Amplitude

N

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Scale	**Date**	**Project**
1:500 @ A3	01/07/2018	Waun Mawn Standing Stones Geophysics

Figure 10 -
Colour plot of processed GPR data at *c.* 0.11m bgl

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Standing Stone

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Key

Modern

Geology

?Archaeology

Survey Extent

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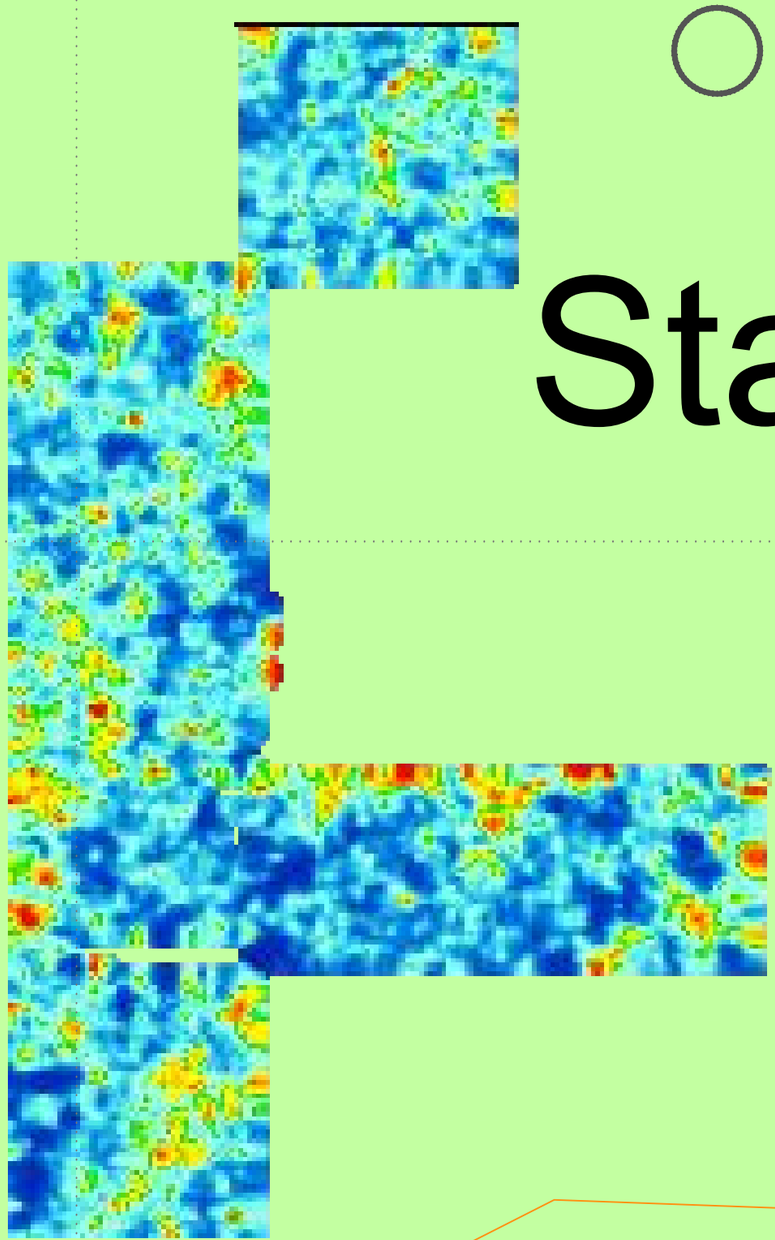

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Low Amplitude — High Amplitude

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1:500 @ A3	01/07/2018	Waun Mawn Standing Stones Geophysics

Figure 12 -
Colour plot of processed GPR data at *c.* 0.31m bgl

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Key

Modern | Geology | ?Archaeology | Survey Extent

N

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Scale	**Date**	**Project**
1:500 @ A3	01/07/2018	Waun Mawn Standing Stones Geophysics

Figure 13 -
Interpretation of GPR data at *c.* 0.31m bgl

208300

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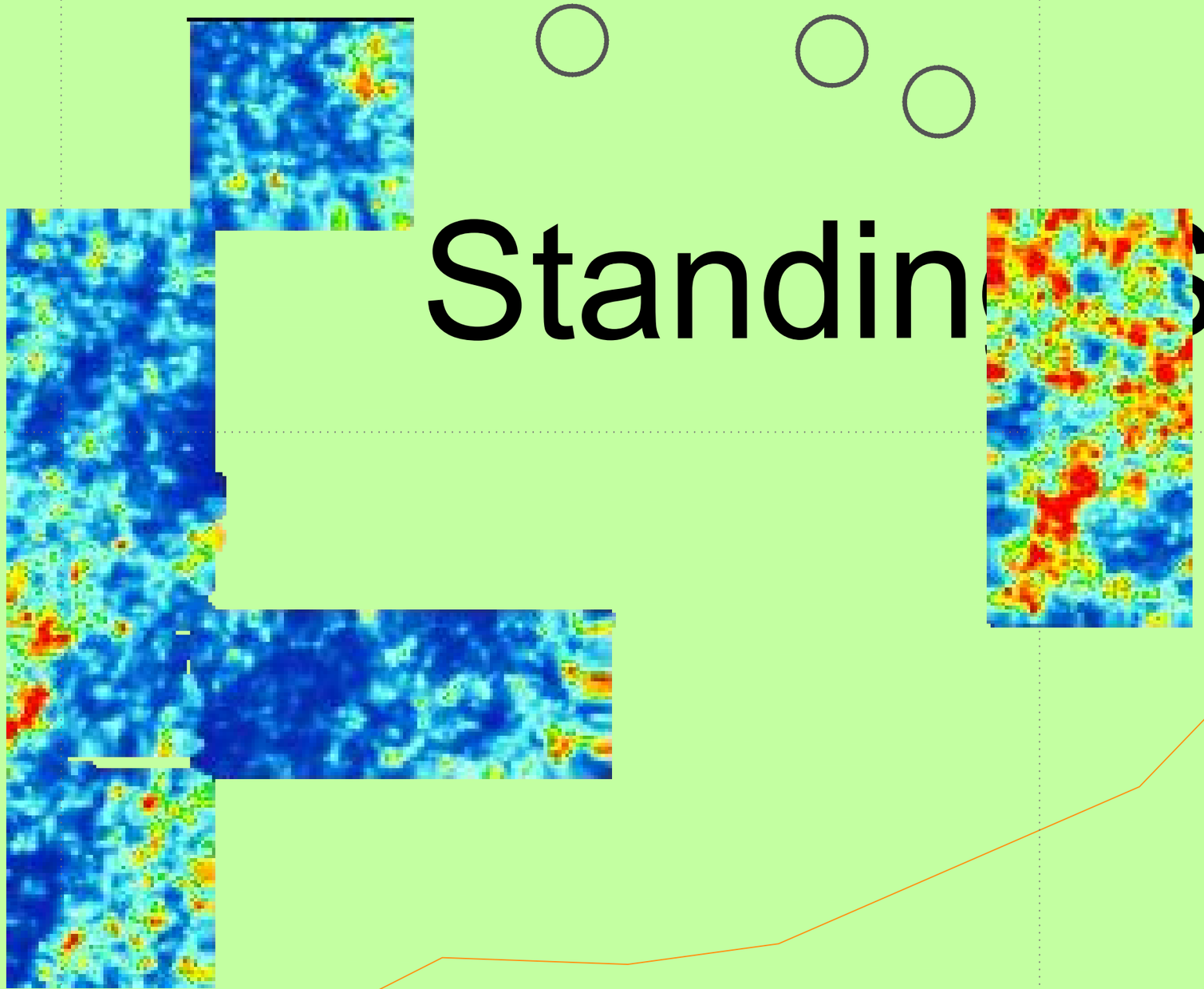
234000

Standing Stone



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Key

Low Amplitude — High Amplitude

N

Compiled By	Issued By	Site
AG	JM	Waun Mawn Standing Stones, Pembrokeshire, Wales
Scale	**Date**	**Project**
1:500 @ A3	01/07/2018	Waun Mawn Standing Stones Geophysics

Figure 14 -
Colour plot of processed GPR data at *c.* 0.62m bgl

208300

208400

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Standing Stone

K

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Key

Modern | Geology | ?Archaeology | Survey Extent

N

Compiled By: AG	Issued By: JM	Site: Waun Mawn Standing Stones, Pembrokeshire, Wales	Figure 15 - Interpretation of GPR data at *c*. 0.62m bgl
Scale: 1:500 @ A3	Date: 01/07/2018	Project: Waun Mawn Standing Stones Geophysics	

208300

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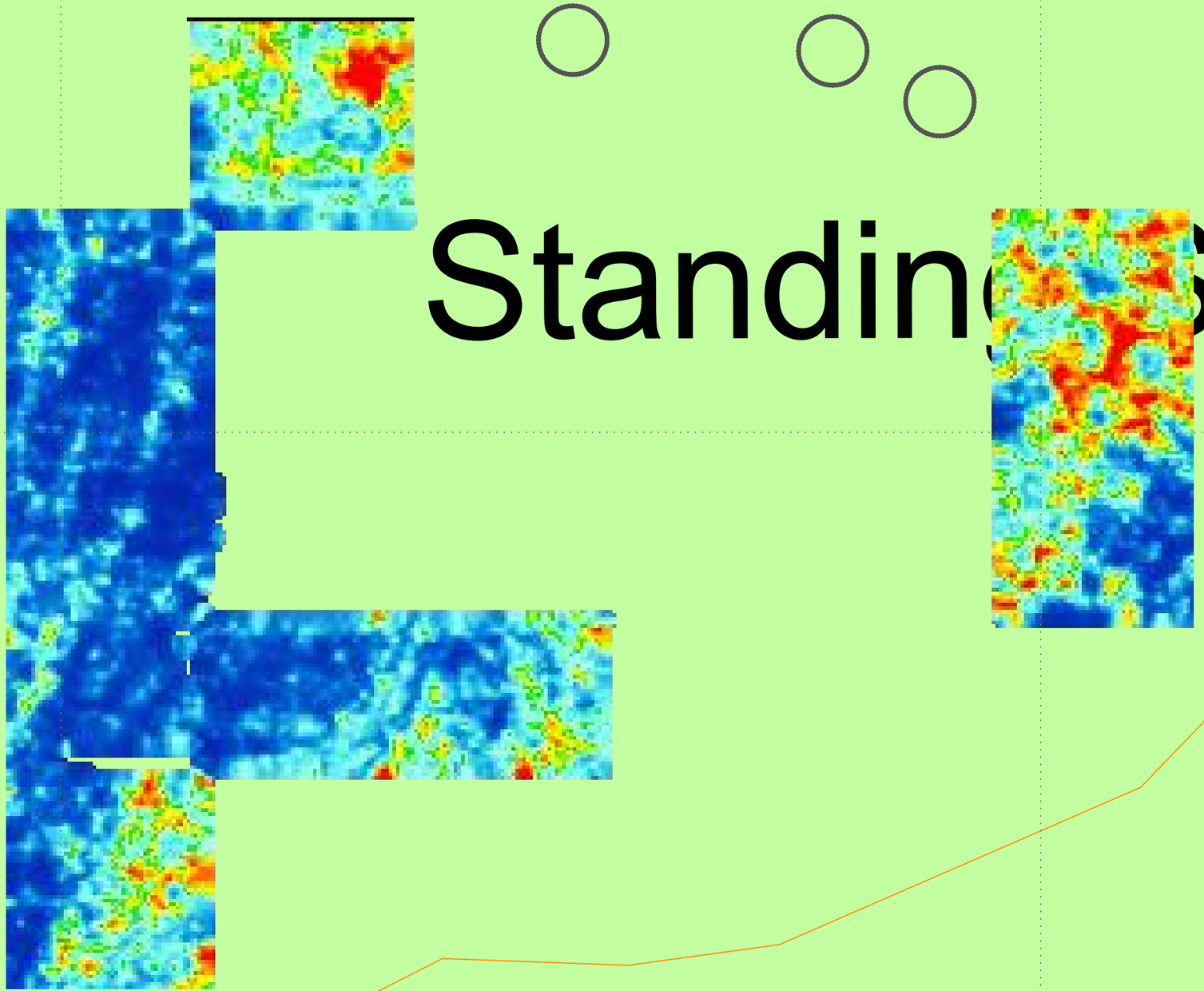
Standing Stone



Key

Low Amplitude — High Amplitude

N

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Compiled By AG	**Issued By** JM	**Site** Waun Mawn Standing Stones, Pembrokeshire, Wales	**Figure 16 -** Colour plot of processed GPR data at *c.* 0.90m bgl
Scale 1:500 @ A3	**Date** 01/07/2018	**Project** Waun Mawn Standing Stones Geophysics	

208300

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Standing Stone

M

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K

BU Bournemouth University	BUARC Christchurch House Talbot Campus Fern Barrow Poole, Dorset BH12 5BB Tel: +44 (0)1202 965295 Email: heritage@bournemouth.ac.uk	**Key** Modern Geology ?Archaeology Survey Extent N 	**Compiled By** AG **Scale** 1:500 @ A3	**Issued By** JM **Date** 01/07/2018	**Site** Waun Mawn Standing Stones, Pembrokeshire, Wales **Project** Waun Mawn Standing Stones Geophysics	**Figure 17 -** Interpretation of GPR data at *c.* 0.90m bgl

208300

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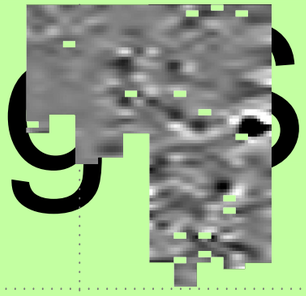

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Key

-3SD 3SD

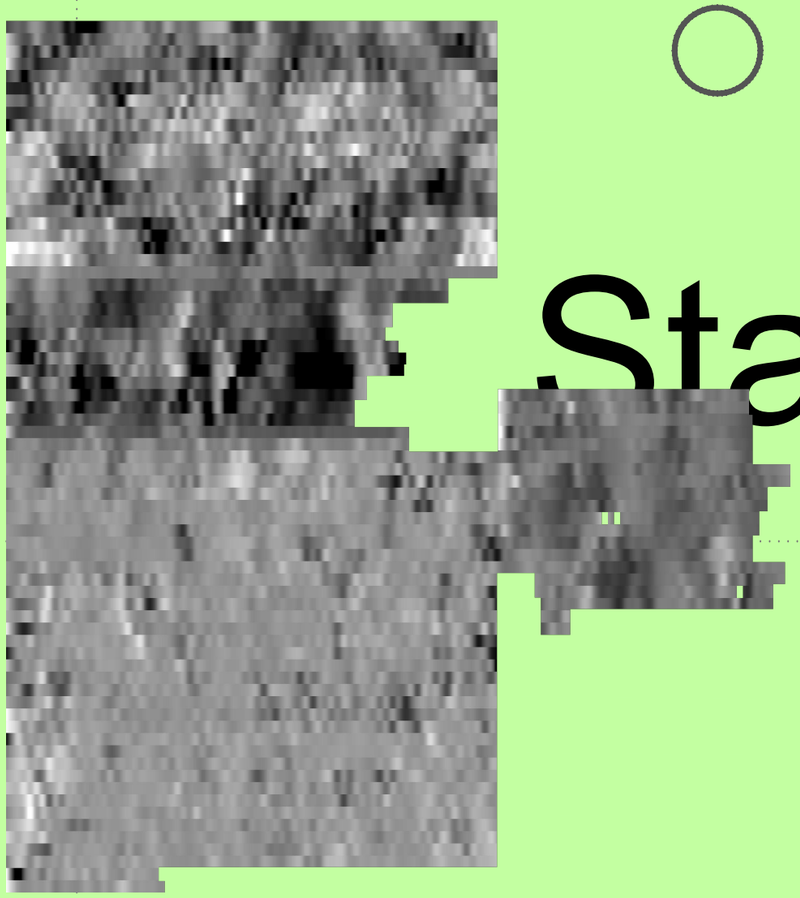
N

Compiled By	Issued By	Site	Appendix A1 -
AG	JM	Waun Mawn Standing Stones, Pembrokeshire, Wales	Raw greyscale earth resistance data (alpha)
Scale	Date	Project	
1:500 @ A3	01/07/2018	Waun Mawn Standing Stones Geophysics	

208300

208400

234000



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-3SD 3SD

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Compiled By	Issued By	Site	Appendix A2 -
AG	JM	Waun Mawn Standing Stones, Pembrokeshire, Wales	Raw greyscale earth resistance data (beta)
Scale	Date	Project	
1:500 @ A3	01/07/2018	Waun Mawn Standing Stones Geophysics	

208300

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Standing Stone

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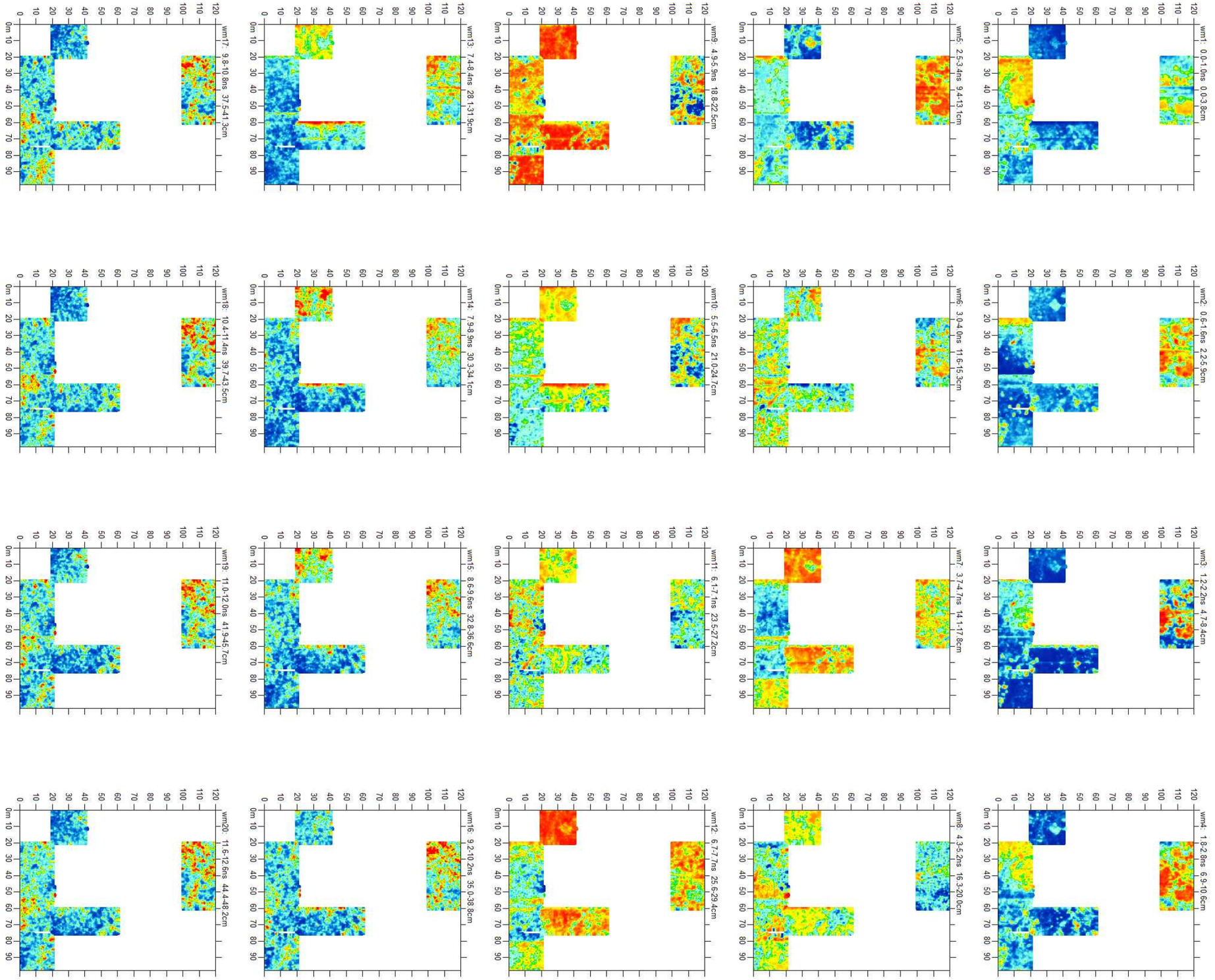
Key

50 Ohms

N

Compiled By	Issued By	Site	Appendix A3 -
AG	JM	Waun Mawn Standing Stones, Pembrokeshire, Wales	XY trace plot of earth resistance data
Scale	**Date**	**Project**	
1:50 @ A3	01/07/2018	Waun Mawn Standing Stones Geophysics	



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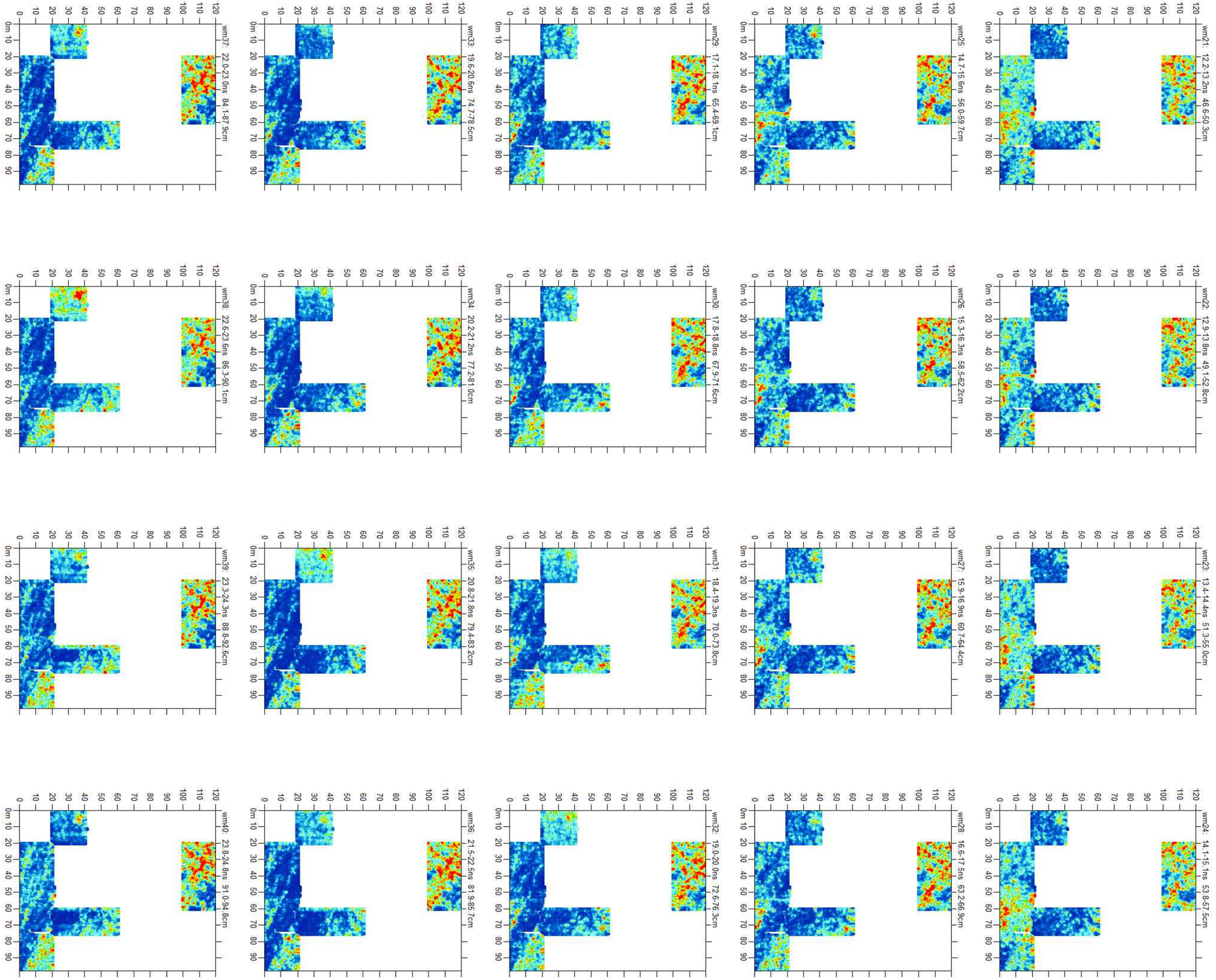
Key

Low Amplitude — High Amplitude

N

Compiled By	Issued By	Site	Appendix B1 -
AG	JM	Waun Mawn Standing Stones, Pembrokeshire, Wales	Time slices of corrected GPR data from *c*. 0-0.48m bgl
Scale	**Date**	**Project**	
1:2500 @ A3	01/07/2018	Waun Mawn Standing Stones Geophysics	



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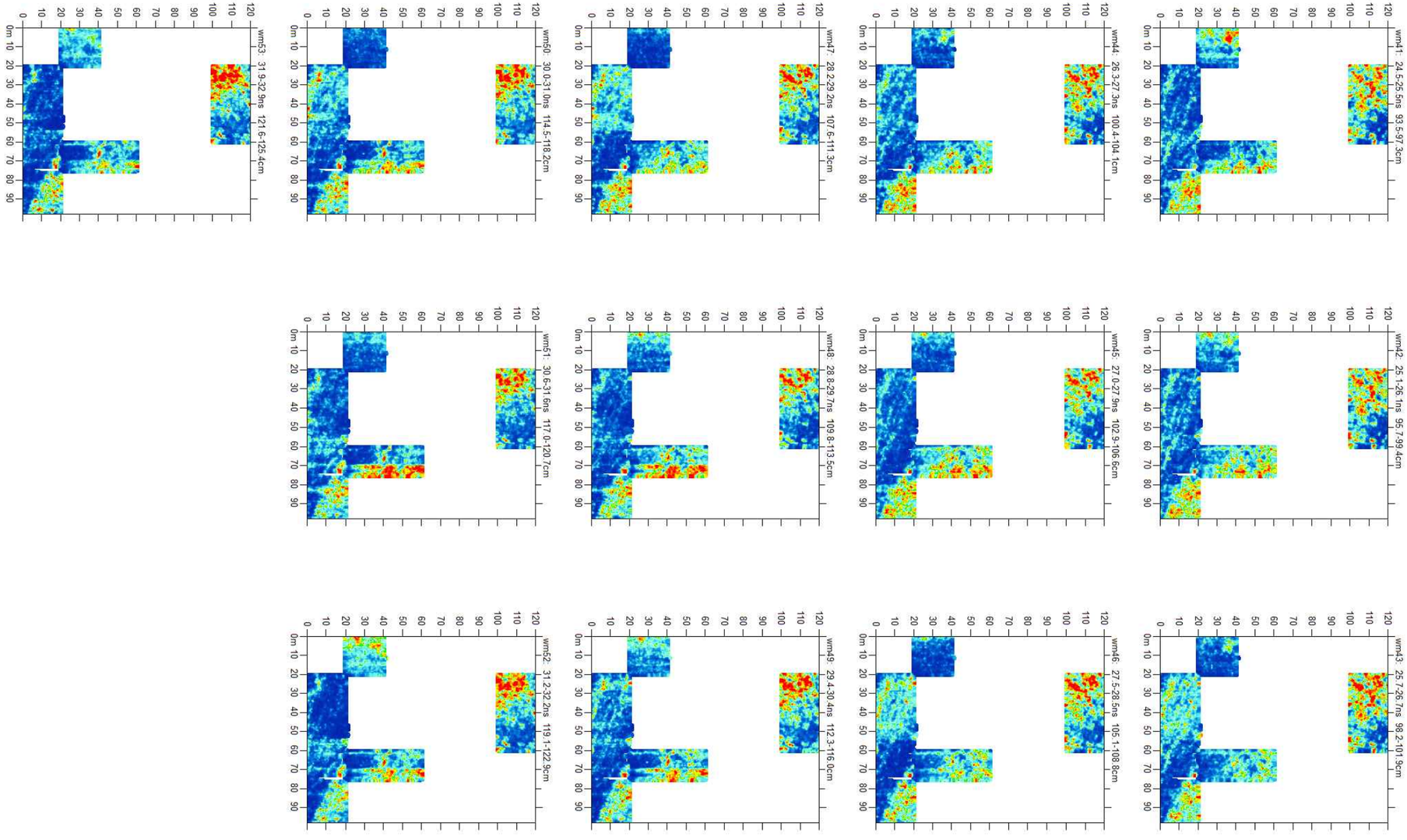

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		Scale 1:2500 @ A3	**Date** 01/07/2018	**Project** Waun Mawn Standing Stones Geophysics	