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NETHERAVON BARROWS, FIGHELDEAN, WILTSHIRE
REPORT ON GEOPHYSICAL AND ANALYTICAL EARTHWORK SURVEYS, APRIL AND MAY 2014

Mark Bowden, Elaine Jamieson, Neil Linford, Paul Linford, Andrew Payne and Zoe Edwards

ENGLISH HERITAGE

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SUMMARY

During the installation of mitigation measures to reduce burrowing animal damage, a number of Early Bronze Age artefacts and a quantity of cremated human bone were found within spoil ejected from an active badger sett from the central mound of a group of three barrows at Netheravon, Figheldean, Wiltshire. Earth resistance, Earth Resistance Tomography (ERT) sections and Ground Penetrating Radar (GPR) surveys were conducted over the barrow producing the finds (~0.1ha), but were precluded from use over the other two monuments due to the prior installation of steel meshing. A subsequent analytical earthwork survey provided an immediate archaeological context of the whole group and, together, the surveys suggest a complex, phased development to the barrows which have suffered damage through a combination of quarrying, badger damage and the introduction of recent building waste. The badger sett producing the finds does not appear to penetrate deep into the mound, implying that the artefacts may not be from a primary deposit, perhaps suggesting the monument has an earlier origin.

CONTRIBUTORS

The field work was conducted by Neil Linford, Paul Linford, Andy Payne and Zoe Edwards from the English Heritage Geophysics Team, Mark Bowden and Elaine Jamieson of the English Heritage Assessment Team and Phil McMahon, English Heritage Inspector of Ancient Monuments, South West.

ACKNOWLEDGEMENTS

The authors are grateful to Richard Osgood of the Defence Infrastructure Organisation and Tom Theed of Landmarc Support Services Ltd for assistance on site and for their oversight of the work which allowed the team access to the Ministry of Defence land on which the barrows sit.

ARCHIVE LOCATION

Fort Cumberland and the archive at Swindon.

DATE OF FIELDWORK AND REPORT

Geophysical surveys over Figheldean 2, were undertaken on the 22nd and 23rd April 2014 and the Analytical earthwork survey of all three barrows was carried out between the 1st and 5th May 2014. The report was completed on 5th January 2015. The cover photograph shows a view south from the Fittleton 1 barrow to the ERT survey in progress over the vegetation cleared mound of Figheldean 2.

CONTACT DETAILS

Assessment Team, The Engine House, Fire Fly Avenue, Swindon, SN2 2EH
Elaine Jamieson: tel. 01793 414485; email elaine.jamieson@english-heritage.org.uk

Geophysics Team, English Heritage, Fort Cumberland, Fort Cumberland Road, Eastney, Portsmouth, PO4 9LD.
Dr Neil Linford; tel. 02392 856761; email neil.linford@english-heritage.org.uk

CONTENTS

INTRODUCTION

On the outskirts of the village of Netheravon three barrows, Fittleton 1 (SU 14 NE 151; AMIE 916317), Figheldean 2 (SU 14 NE 150; AMIE 916311) and Figheldean 3 (SU 14 NE 149; AMIE 916283), are situated on top of a river cliff at about 100m OD above the Avon and overlooking Netheravon to the north-west. These barrows, though noted by Grinsell (Grinsell 1957, 174, 176), have never been described or studied; this is possibly because, at least from the time of the OS 1st edition until the present, they have been under woodland. The parish boundary between Fittleton and Figheldean passes between the northernmost and the central mound.

Attention has now been drawn to the central mound of the three, Figheldean 2, because of extensive badger damage which has resulted in the recovery of a number of Bronze Age artefacts and a quantity of cremated human bone. All this material is being brought out of one hole near the top of the mound, which is being monitored. Concerns over the best way to mitigate further badger damage prompted the English Heritage Inspector of Ancient Monuments, Phil McMahon, and the Senior Historic Advisor for the Defence Infrastructure Organisation, Richard Osgood, to request geophysical and analytical earthwork survey of Figheldean 2 to better understand its structure and the extent of damage that has occurred. This work was undertaken as part of the National Heritage Protection Programme (NHPP) where it is categorised under Activity 8A5 Offsetting loss through knowledge dividend; Protection Result 8A5.2 Emergency investigation assistance for threatened heritage outside the planning process.

Analytical earthwork survey was conducted over all three barrows, although the geophysical coverage was limited to Figheldean 2 as the other two barrows had already been covered in steel mesh to protect them from badger burrowing. A factor affecting both forms of survey is that although the barrows themselves have been cleared of trees the immediately surrounding area remains well wooded, so it has not been possible to set the mounds graphically into their landscape context. However, it is clear that the three mounds are in a very conspicuous position, set on the very lip of a steep river cliff, which drops about 15m to the floor of the Avon valley to the west (Figure 1).

The barrows are situated on Upper Chalk, a soft white chalk with many flints (Geological Survey of England and Wales 1959), over which have formed soils of the ANDOVER 1 association, shallow well drained calcareous silty soils over chalk on slopes and crests (Soil Survey of England and Wales 1983). The ground on which the mounds stand drops by about 5m from north-north-east to south-south-west. The weather at the time of the geophysical surveys was overcast throughout with occasional rain in the afternoons on both days.

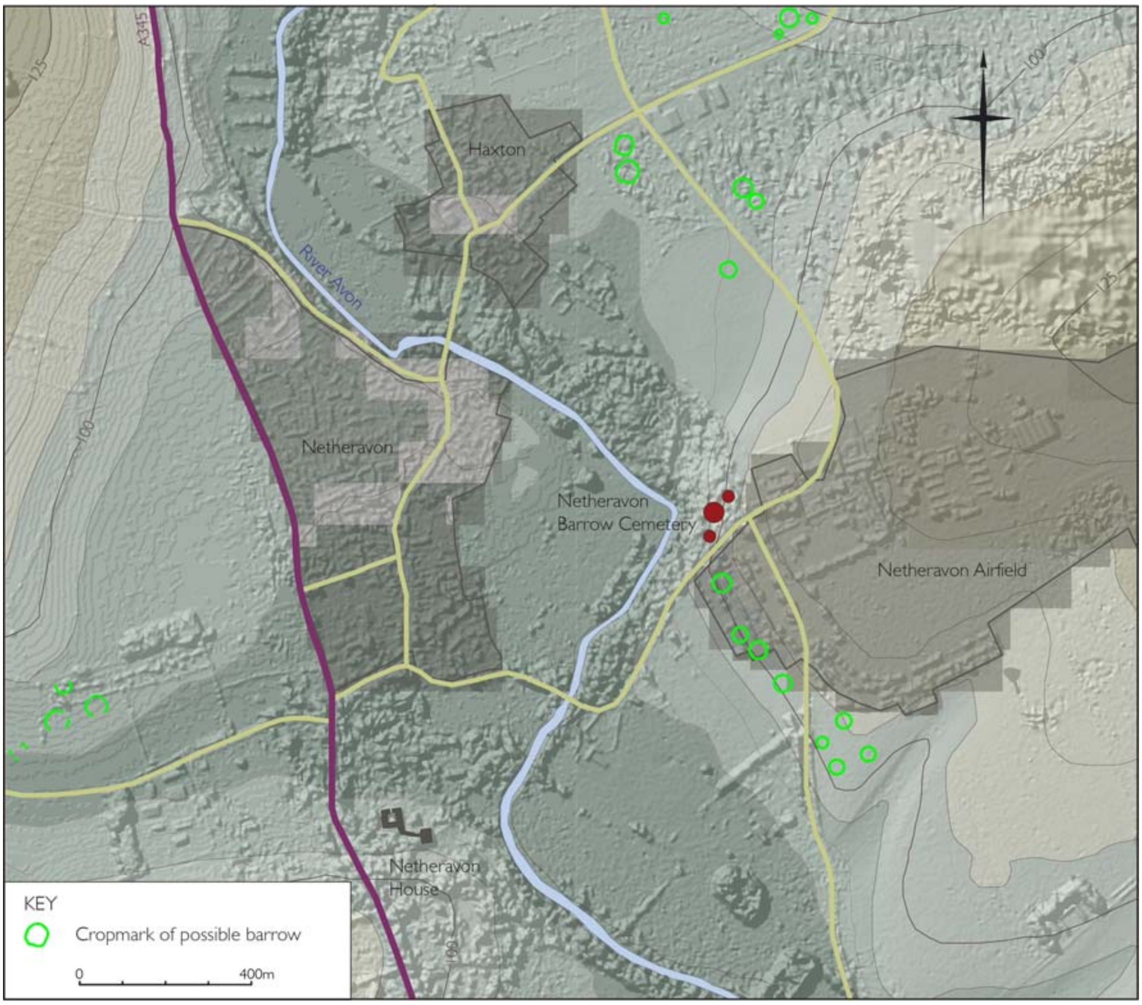

Figure 1 General location plan.

METHODS

Analytical earthwork survey

Earthwork survey was undertaken with Trimble R8 survey grade GNSS receivers working in Real Time Kinetic (RTK) mode, with points related to an R8 receiver configured as an on-site base station. The position of the base station had been adjusted to the National Grid Transformation OSTN02 via the Trimble VRS Now network (OSNet) and gives a stated accuracy of 0.01-0.015m per point. The data was downloaded and transferred into AutoCAD 2008 to print at a scale of 1:1000 (Figure 2). This was checked in the field and additional detail added using tape-and-offset.

Earth resistance survey

Measurements were recorded over a series of 20m grids established with a Trimble R8 series (Figure 3) using a Geoscan RM15 resistance meter, a PA5 electrode frame in the Twin-Electrode configuration and a MPX15 multiplexer, to allow two separate surveys, with electrode separations of 0.5m and 1.0m, to be collected simultaneously. The 0.5m electrode separation coverage was designed to detect near-surface anomalies in the upper 0.5m of the subsurface whilst the 1.0m separation survey allowed anomalies to a depth of about 1-1.25m to be detected. For the 0.5m electrode separation survey readings were taken at a density of 0.5m by 1.0 m whilst for the 1.0m separation survey they were taken at a density of 1.0m by 1.0m.

Extreme values caused by high contact resistance (partially as a result of tree stumps and roots still in situ) were removed from both datasets using an adaptive thresholding median filter with radius 1m (Scollar *et al* 1990, 492). The results for the near-surface 0.5m electrode separation survey are depicted as a linear greyscale image in Figure 4 superimposed on the Ordnance Survey (OS) map. Figure 6 shows the minimally processed raw data, presented as , X-Y traceplots, linear and equal area greyscales (Figure 6(A) to 6(F)), and following the application of a contrast enhancing Wallis filters with radius 25m (Figure 6(G) and 6(H)).

To better visualise the vertical separation of the anomalies an Hotelling transform was applied to the 0.5m and 1.0m mobile probe separation data sets to indicate both the difference and similarity between the two sets of results (González and Woods 2002). In this case, the two resulting images may be due to near surface anomalies and more deeply lying regional trends within the data (cf Figure 6(I) and 6(J) Linford 2003; Linford *et al* 2013).

Earth Resistance Tomography

Two Earth Resistance Tomography (ERT) sections were measured over barrow Figheldean 2. The first, ERT01, across its SE flank was 40m long using 81 electrodes spaced 0.5m apart and was deliberately positioned to cross the opening of the badger burrow from which Bronze Age artefacts have recently been unearthed. The second, ERT02, ran across the centre of the barrow and was 47.5m long using 96 electrodes spaced 0.5m apart. The two sections were parallel to each other, separated by 4.5m. A GPS was used to accurately map the position and height of each electrode and the locations of the two sections are plotted in Figure 3.

Measurements were made with a Campus Tigre multiplexed earth resistance meter controlled by ImagerPro2006 software running on a field laptop computer. The expanding Wenner electrode configuration was employed owing to its high signal to noise ratio which was considered important due to the degree of disturbance caused by badger activity evident on the surface of the barrow. This made it difficult in places to insert the electrodes such that good electrical contact was achieved, so increased measurement error was anticipated. For ERT01 measurements were collected using all electrode separations (the Wenner 'a' value) from 0.5m up to 12.5m. For ERT02 the maximum separation was reduced to 10 m after inspection of the earlier results suggested little additional variation was being detected by the wider measurements.

Data from each section were inverted to infer a subsurface resistivity models using Geotomo Software's Res2dinv software (version 3.59.116) with the GPS electrode positions incorporated to allow topographic correction. For error estimation during the inversion the robust inversion method was selected (absolute errors or the L1 norm) as this method is more tolerant of discontinuities between adjacent cells and thus tends to resolve boundaries between layers more sharply than the standard least mean squares inversion. The model space was discretised using 0.25m cells (half the base electrode separation) to provide finer resolution of any near-surface anomalies.

False colour images of the output models are shown in Figures 7(A) and 7(B) with annotations to indicate anomalies of interest.

Ground Penetrating Radar (GPR)

The Ground Penetrating Radar (GPR) data was collected over a 40m x 30m grid (Figures 3 and 5) using a Sensors and Software Pulse Ekko PE1000 console with a 225MHz centre frequency ground coupled antenna, to record reflections through a 90ns window. The antenna was mounted in a small sledge and individual GPR traces were collected at 0.05m intervals along profiles separated by 0.5m, guided by survey lines established over the grid.

Post acquisition processing involved the adjustment of time-zero to coincide with the true ground surface, background and noise removal, and the application of a suitable gain function to enhance late arrivals. Where appropriate, a tilt correction algorithm was applied to the data to compensate for the translation of the anomalies due to variations in topography along each profile (Goodman *et al* 2006). An average sub-surface velocity of 0.067m/ns was assumed following constant velocity tests on the data, and was used for the time to estimated depth conversion and the static topographic correction applied to the representative profiles shown on Figures 8. In addition, owing to antenna coupling between the GPR transmitter and the ground to an approximate depth of $^{\lambda}/_{2}$, very near-surface reflection events should only be detectable below a depth of 0.148m if a centre frequency of 225MHz and a velocity of 0.067m/ns are assumed. However, the broad bandwidth of an impulse GPR signal results in a range of frequencies to either side of the centre frequency which, in practice, will record significant near-surface reflections closer to the ground surface. Such reflections are often emphasised by presenting the data as amplitude time slices. In this case, the time slices were created from the entire data set by averaging data within successive 6ns (two-way travel time) windows (Linford 2004). Each resulting time slice, illustrated as a greyscale image in Figure 9 represents the variation of reflection strength through successive 0.2m intervals from the ground surface.

RESULTS

Earthwork description

A hachured plan of the earthworks discussed in the following text, superimposed on the base OS map data, is provided in Figure 2 and together with the significant geophysical anomalies in Figure 12.

Fittleton 1

This mound survives to a maximum height of 2.7m. It is round but its northern flank has been flattened, probably by the chalk pit that is noted on early OS maps; a slight earthwork, perhaps demarcating the edge of this chalk pit, can be seen curving away to the north. The parish boundary of Fittleton used this mound as a marker; the earthworks to the south of the mound suggest the possibility of a surrounding ditch, surviving only 0.2m deep, but also may owe something to the existence of this boundary, which curves around the southern side of the barrow and may be marked by the slight scarp, up to 0.2m high, beyond the ditch earthwork and approximately parallel to it. Alternatively this scarp might indicate that the barrow had an external bank. A ledge can be seen on the flank of the mound on both south and north sides at the same height; this probably indicates that the mound has been raised. Though, as noted above, there is no record of any antiquarian or archaeological interest in this barrow, there is a slight hollow in the top of the mound which might indicate unrecorded excavation or a tree throw. There is no sign of burrowing activity on this mound but there is some superficial damage from tree roots.

Figheldean 2

This large mound, up to 4.4m high, is oval rather than round, with its longer axis running from south-south-west to north-north-east. It has been extensively damaged by badgers, which have seriously distorted the lower flank of the barrow on the north-west side. Elsewhere the damage is relatively superficial on the surface but must be considerable within the interior (though the geophysical survey indicates that it may be restricted to the upper levels). As with its neighbour to the north, there are ledges and breaks of slope around the flanks of the mound; these are less regular and though they probably represent building phases they could, at least in part, also be the result of later damage, disturbance and slumping. The earthwork evidence suggests that the mound could have been raised by as much as 1.4m. There is a slight indication of a surrounding ditch on the north-east side, up to 0.3m deep; though there is no corresponding earthwork to the south, two badger holes beyond the foot of the mound here indicate that there may be relatively soft ditch fills that are being exploited. As with Fittleton 1, there is a slight hollow in the broad, flat top of the mound which may indicate unrecorded antiquarian digging though it is perhaps more likely to be the result of a tree throw.

A slight earthwork to the south-west of the barrow has been distorted by badger activity; its significance is uncertain but it may be the result of relatively recent chalk extraction.

Figheldean 3

The southernmost barrow is a relatively small oval mound, only 1.2m high to the east but nearly 3m high to the west. Like its neighbour, its long axis is south-south-west to north-north-east. It has been disturbed by badgers and by trees, including one recent tree-throw at its northernmost point. There is no sign of a surrounding ditch. The flanks of the mound have been distorted; it has possibly been truncated by the modern road, which passes very close to the east, and the western flank now has two terraces, which almost look like the result of paths or tracks crossing this lower side of the mound. If it were not for this damage the overall shape of the mound would be more nearly round; it is perhaps worthy of note that this mound, like Fittleton 1, has a diameter of approximately 20m. There is no sign of antiquarian excavation into this mound though there is considerable recent disturbance.

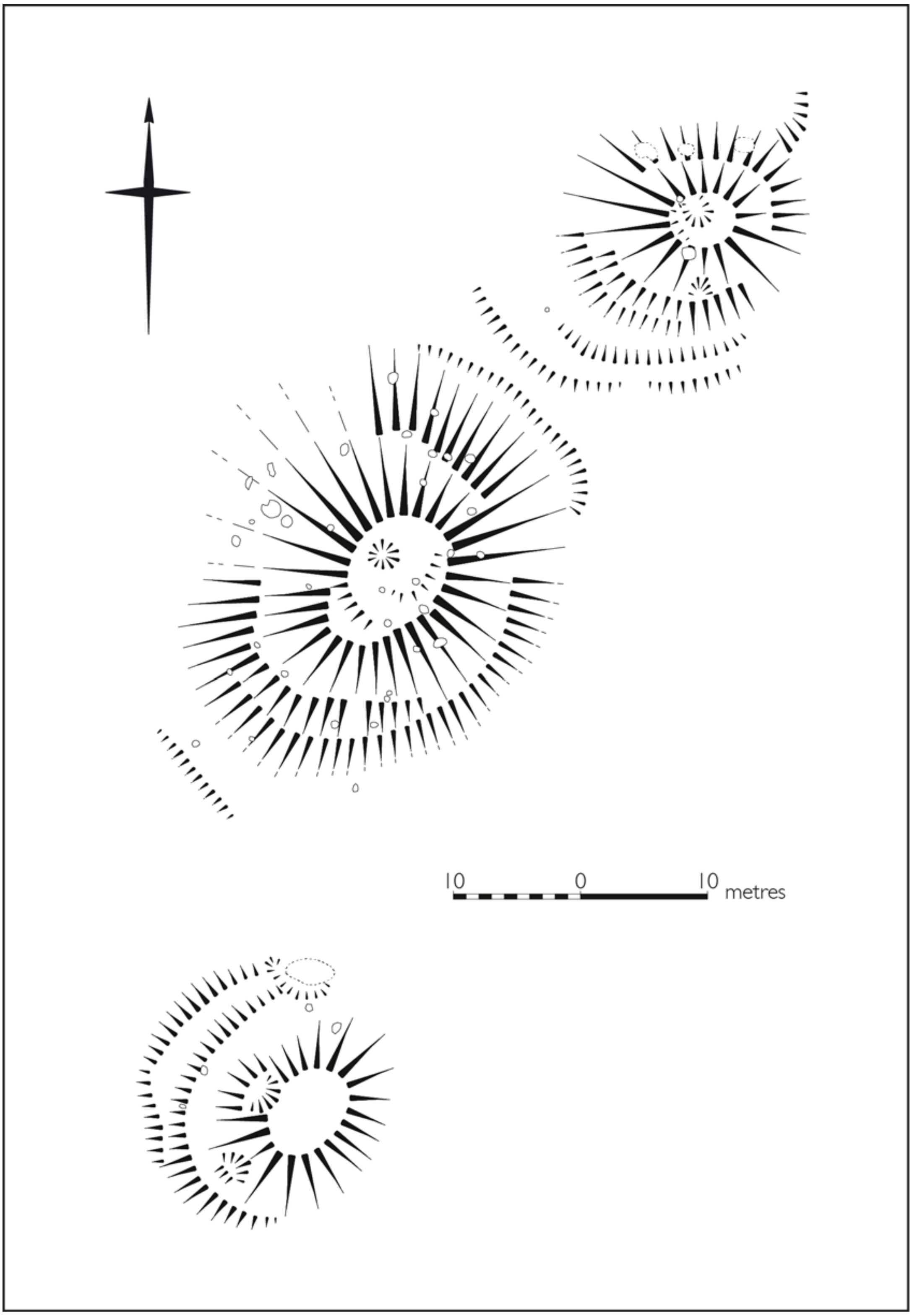

Figure 2 Analytical earthwork hachured plan (1:1000).

Earth resistance survey

Figheldean 2

A graphical summary of the significant earth resistance anomalies [r1-7] discussed in the following text, superimposed on the base OS map data, are provided in Figure 10.

An area of higher resistance [r1] on the summit of the barrow mound, may represent an inner core of flint with chalk or, perhaps, presence of extensive voiding related to the badger setts, is surrounded by a sub-circular ring of lower readings [r2]. Although inconclusive, the results may indicate the enlargement of an original barrow mound, sealing the earlier inner ring-ditch [r2], which appears better defined in the deeper penetrating 1.0m probe spacing readings (Figure 6).

A ring of higher resistance [r3] around the perimeter of the barrow mound is suggestive of an outer retaining bank or revetment feature. However, beyond [r3] there is little evidence for an outer ditch described within the survey area other than the tentative low resistance anomalies [r4] and [r5].

Extremely high resistance readings [r6-8] to the north east of the barrow may represent re-deposited material from the badger setts, chalk quarrying, fly-tipping of building material or some other recent artificial landscaping activity. However, [r7] corresponds in part with slight scarp recorded around Fittleton 1 (Figure 12). A particularly pronounced near-surface response [r9] on the western edge of the central platform seems likely to be associated with either badger disturbance or a tree-root remaining from the vegetation clearance over the barrow mound.

Earth Resistance Tomography

Figheldean 2

The ERT sections through the barrow (Figure 7) suggest two distinct layers are apparent: a conductive near-surface layer with a thickness varying between 0.5 to 1.0 m and apparent resistivity values less than 100 Ωm; overlying a more resistive layer with apparent resistivity values consistently greater than 100 Ωm which appears to form the core of the mound. The profile of the interface between these two layers is indicated as a dashed line in the plots.

Evidence for internal structure

Examining the deeper core layer there is evidence for a possible revetment or some form of reinforcement containing the bulk of the barrow mound. This is suggested by concentrations of higher resistance measurements suggesting more closely packed material at positions ~11.5m and ~34.5m on ERT01 and ~11.5m and ~37m on ERT02. Comparison with the topographic survey (Figure 2) shows that all four positions correspond to the top of the outermost slope and with associated anomalies in the earth resistance and GPR data sets, lending weight to this inference (*cf* Figure 10, [r3] and Figure 8, [gpr5] and [gpr10-11]).

Towards the centre of the mound the profile of the core layer steps up quite sharply by about 1m suggesting a central raised platform ~12m in diameter. The sharp step is most apparent in ERT01 at 20m and 28m, these positions being only 8m apart as ERT01 is across the flank of the barrow just clipping the central raised section. The corresponding anomalies in ERT02 are at ~18.5m and ~29m although the latter is far less pronounced. On the north flank of the barrow this step appears to correspond with the top of the innermost slope in the hachure plan but any such correspondence is not clear on the southern flank where the hachure plan indicates a more complex sequence of slopes. However, the landscape slopes steeply towards the south so it is possible that slippage of material down-slope over time has slighted or masked both the subsurface anomaly detected by the ERT and the surface topography.

A central depression was observed on the top of the mound (Figure 2) and is observed in the surface topographic profile between 21m and 23m along ERT02 in Figure 8(B). However, the earth resistance measurements indicate little disturbance to the immediate subsurface at this points, suggesting it is more likely to be a relatively superficial response to perhaps a tree throw hollow rather than evidence for antiquarian excavation.

At the northern end of both ERT sections measurements indicate the presence of material with high electrical resistivity (>130 Ωm) in the immediate subsurface. This is most pronounced in ERT02 between 0.5m and 4.5m where it corresponds with the edges of a possible boundary scarp detected by the earthwork survey encircling Fittleton 1. It is also possible that these high resistance anomalies are due to the introduction of compacted rubble or similar material in this area at some unspecified time in the past (*cf* earth resistance anomalies [r7] and [r8]).

Evidence for badger activity

Anomalies indicative of disturbance and therefore likely to be caused by badger activity have been indicated on Figure 7. In almost all cases these anomalies coincide with burrow entrances observed during the ERT survey or subsequently plotted by the topographic survey. However, at two positions these interpretations are more tentative as no burrows have been noted: these are at a position 11m along ERT01 and at 29m along ERT02. Such disturbance appears to be concentrated in the less compact upper layer (above the dashed line in Figure 7 denoting the interface with the denser core material) suggesting that the badgers have confined their activity to a depth within ~1m of the surface. Nevertheless, it should be borne in mind that the resolution of ERT falls off rapidly with increasing depth and it is possible that individual burrows have not been resolved by the method at greater depths.

One possible exception might be the burrow entrance from which finds have recently been unearthed at 24m along ERT01. Here there is an increase in electrical resistivity in the deeper core layer immediately below which might possibly be caused by a cavity caused by badger activity.

Ground Penetrating Radar

Figheldean 2

A graphical summary of the significant GPR anomalies discussed in the following text, are shown as annotations to the selected profiles on Figure 8, [gpr1-12], and superimposed on the base OS map data in Figure 11, [gpr13-23].

Despite the vegetation clearance over the majority of the barrow the surface was comparatively uneven which hampered data acquisition and resulted in the occasional loss of antenna coupling. Significant reflections appear to have been recorded to approximately 60ns (2m) and can be compared directly to the corresponding ERT sections, including a number of anomalies [gpr1–9] possibly indicating the location of extant badger setts (Figures 8). More complex, partially dipping reflectors at [gpr5] and [gpr10-11] appear on the lower edge of the central mound and correlate with both the break of slope observed over the topographic profile of the barrow and the high resistance possible revetment anomalies identified by both the earth resistance survey and ERT profiles. A short, group of horizontal reflections in the vicinity of [gpr12], resolved after the topographic correction of the data could, potentially, represent the upper surface of the chalk to the south at a depth of approximately 1.9m from the surface over which the barrow mound has been constructed.

The GPR amplitude time slices demonstrate a similar response to the earth resistance data with the central mound of the barrow characterised by a high amplitude reflector [gpr13] in the near-surface, between 0 and 12ns (0 to 0.4m) surrounded by a low amplitude anomaly [gpr14] perhaps most evident in the deeper data between 18 and 48ns (0.6 to 1.6m). This correlates well with the areas of high [r1] and low [r2] resistance and, perhaps, corroborates the suggestion of a central mound and surrounding, sealed ditch like deposits. The bounding areas of high resistance to the north [r4] and south [r5] are also partially replicated by [gpr15] and [gpr16] between 18 and 48ns (0.6 to 1.6m), with [gpr16] demonstrating a strong correlation with the break if slope to the south of the barrow. A series of tentative linear anomalies [gpr17 – 23] may, perhaps, indicate extant animal burrows within the barrow.

CONCLUSION

These three barrows occupy what was clearly a very visible location when viewed from the north and west, on the lip of a substantial river cliff above a meander on the Avon, not very far north of the major prehistoric ceremonial complexes surrounding Stonehenge (and also not far from the complex near the source of the Avon at Marden). A number of circular features to the north and south have been seen on aerial photographs but although some of them were identified as barrows by Grinsell (1957, 174) it has subsequently been suggested that they are features of military origin connected with Netheravon Airfield. There are, however, about six ring ditches suggesting round and oval barrows on either side of the tributary valley immediately to the west of the Avon. The Sheer Barrow, a plough-damaged long or oval barrow (McOmish *et al* 2002, fig 2.13), lies about 1.7km east-south-east of the barrows described here.

The finds recently ejected from the central mound by badgers indicate that the barrows were established in the Early Bronze Age if not before. The morphology of the barrows suggests some phasing within the mounds which is visible on the surface. The evidence from geophysical survey also suggests a phased construction and the presence of elements of different material, or voiding, within the central mound. Significantly, the geophysical evidence also suggests that the badger sett entrance which is producing all the finds is connected with tunnels that are not penetrating deep into the mound; if this is so it implies that the Early Bronze Age artefacts are from deposits relatively high in the mound structure and lends weight to the idea that this mound at least might have early origins. The earthwork evidence indicates that the top metre or more of the mound represents a secondary phase of construction, strengthening the suggestion that the material excavated by the badgers is not the primary deposit.

These barrows have not been discussed before and are not noticed in the extensive antiquarian literature for this area. Slight hollows in the tops of two of the mounds might conventionally be interpreted as the result of antiquarian excavations. However, in this case the geophysical evidence does not, necessarily, suggest that the hollow on top of Figheldean 2 penetrates to any considerable depth; this suggests that if it was due to digging the excavators soon gave up, perhaps because they met a layer of more solid material; the geophysical evidence would support such an interpretation. Alternatively, the hollows might be tree throw holes rather than antiquarian shafts; given that the location has been wooded in recent times this is not an extravagant idea (and other tree throw holes are clearly visible in the area) but, given the mound top location of these particular hollows it could even be suggested that they are the result of ornamental tree planting from a time before the general woodland cover, perhaps associated with Netheravon House, a hunting box built for the Duke of Beaufort in 1734, from which they would have been visible.

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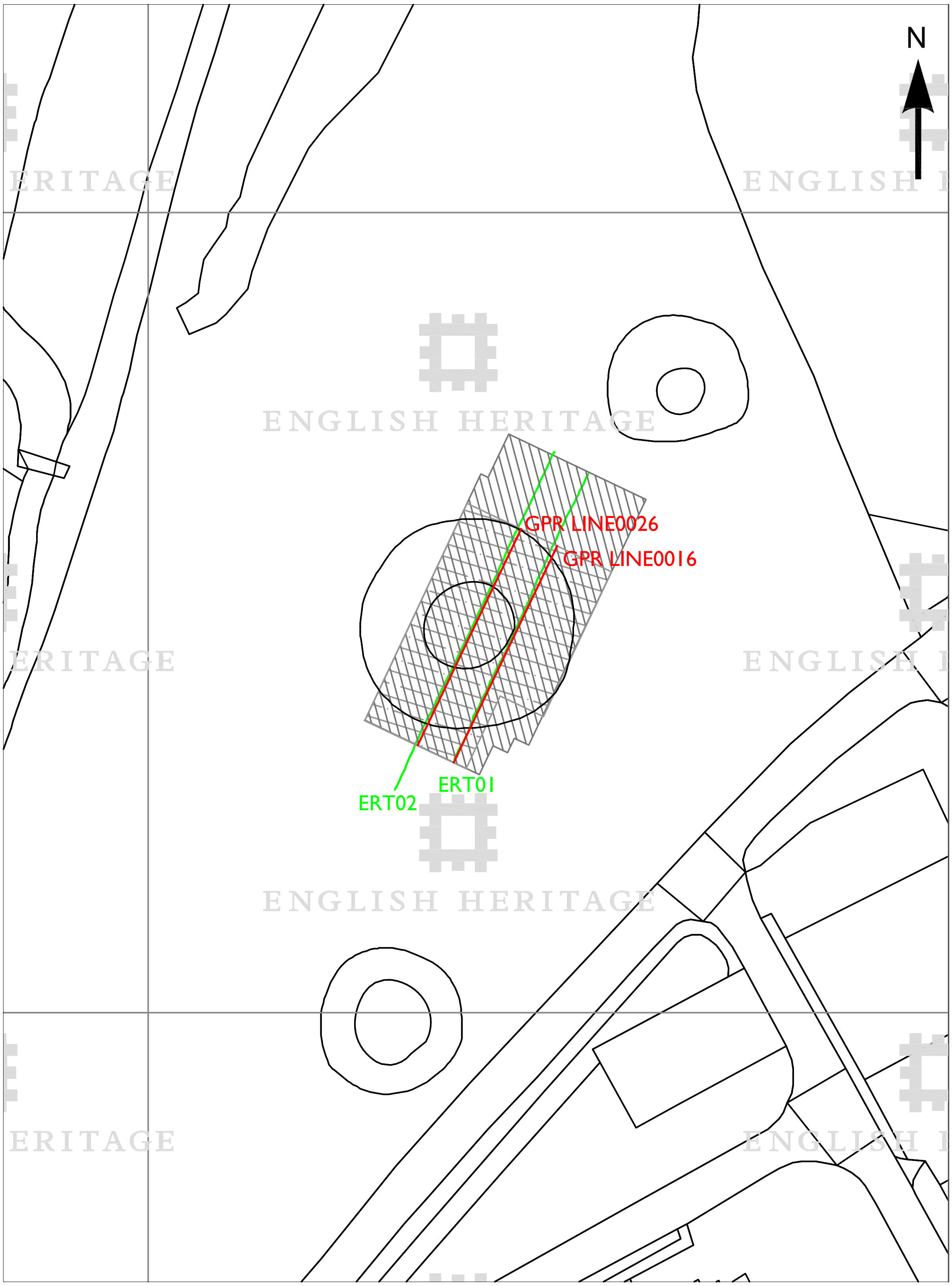
Figure 3

NETHERAVON BARROWS, FIGHELDEAN, WILTSHIRE
Location of geophysical surveys, April 2014

SU1548



GPR area survey
Twin probe resistance survey
GPR profiles
ERT transects

0 30m
1:750

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Figure 4

Earth resistance survey, 0.5m mobile probe spacing, April 2014

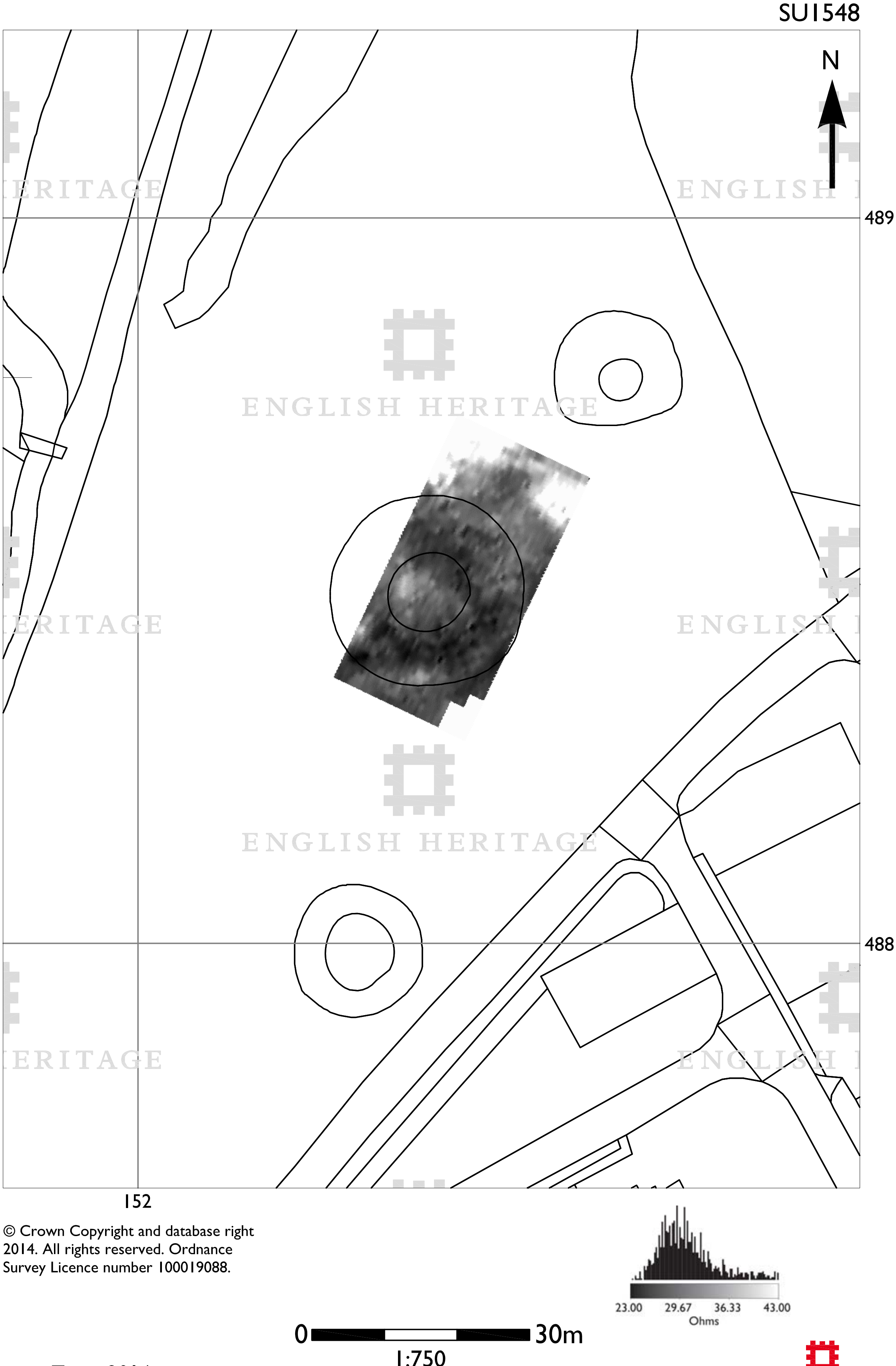

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Figure 5

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GPR amplitude time slice between 36 and 42ns (1.2 - 1.4m)

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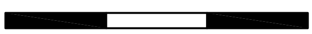

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Figure 6

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Earth resistance survey, April 2014

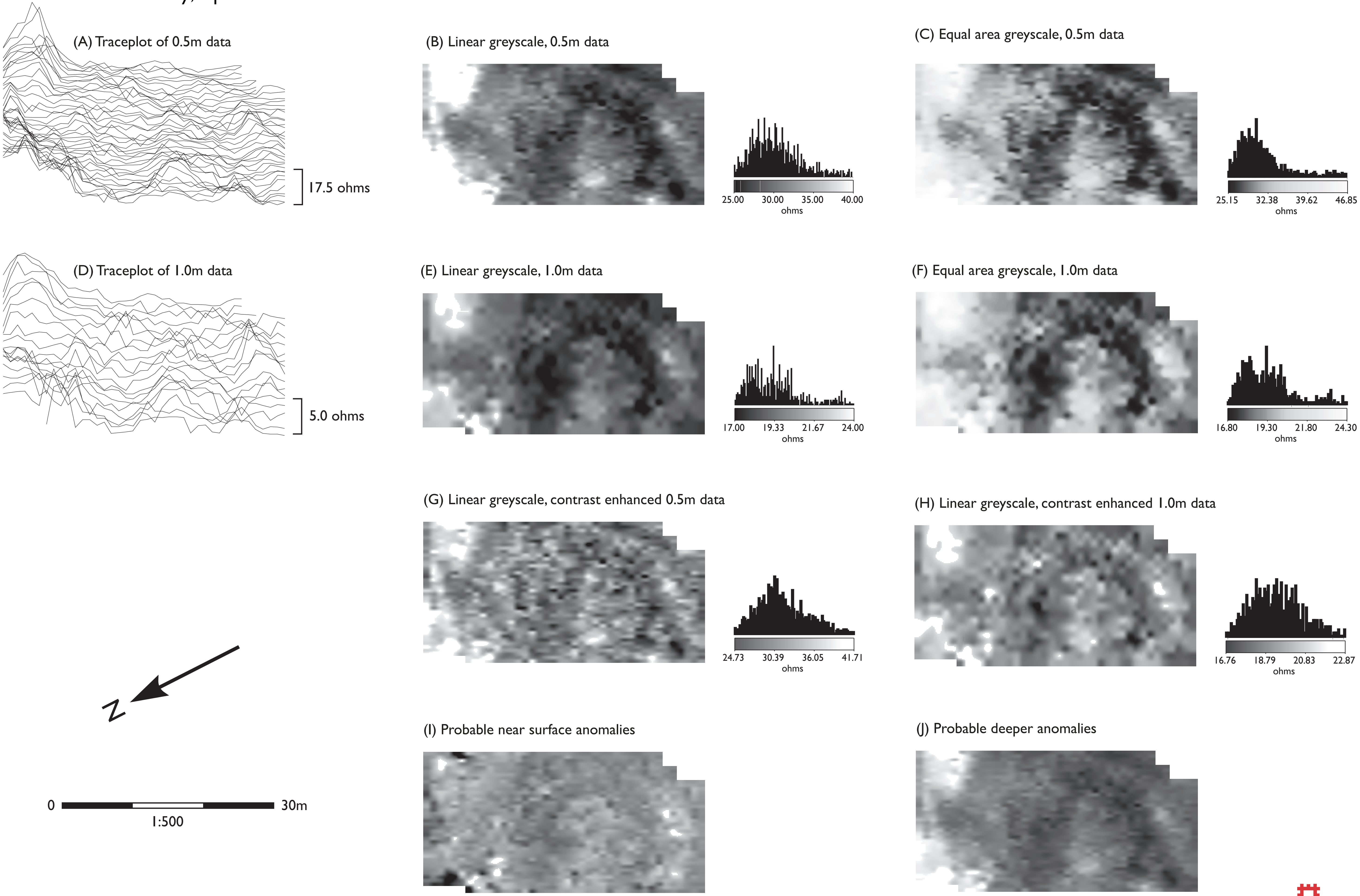

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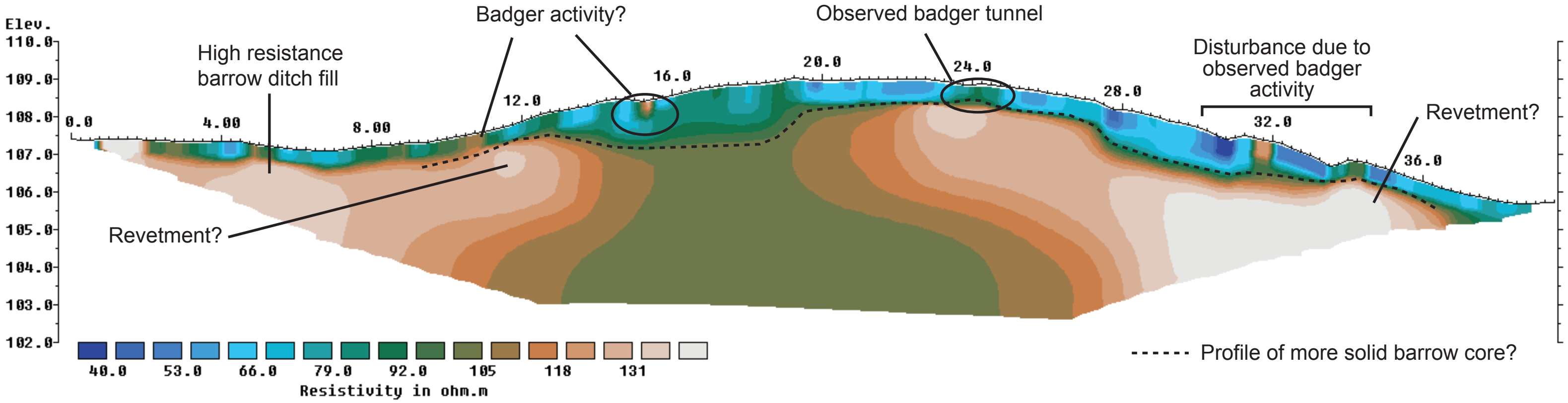
Figure 7

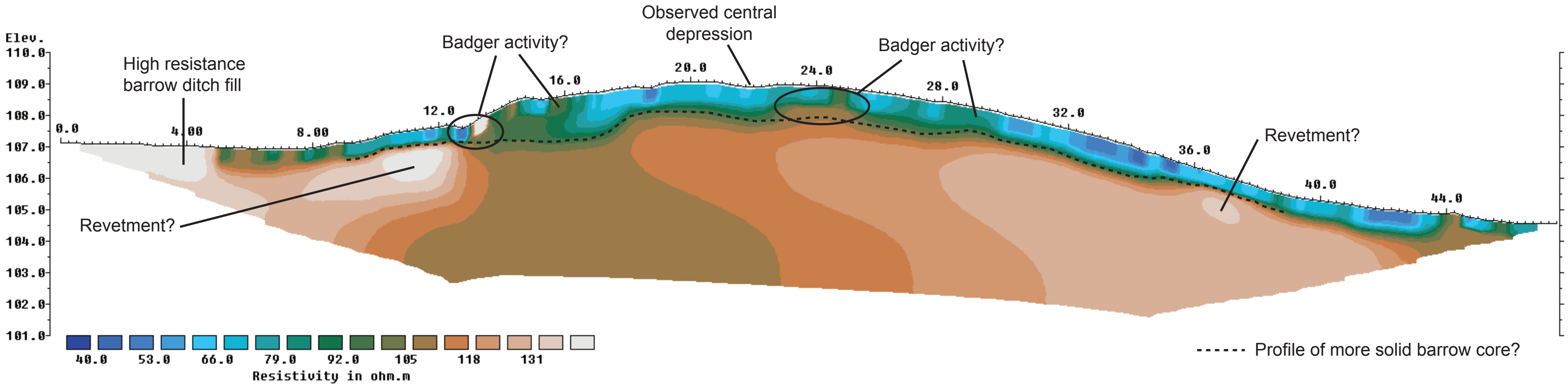
Linear colourscale plots of earth resistance tomography sections after inversion, April 2014

NE ←

(A) ERT01: Across SE flank of barrow and observed badger tunnel (absolute error between model and field measurements = 2.0%)



(B) ERT02: Across centre of barrow 4.5m NW of ERT01 (absolute error between model and field measurements = 1.8%)



0 15m

1:200

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NETHERAVON BARROWS, FIGHELDEAN, WILTSHIRE
Selected GPR profiles, April 2014

Figure 8

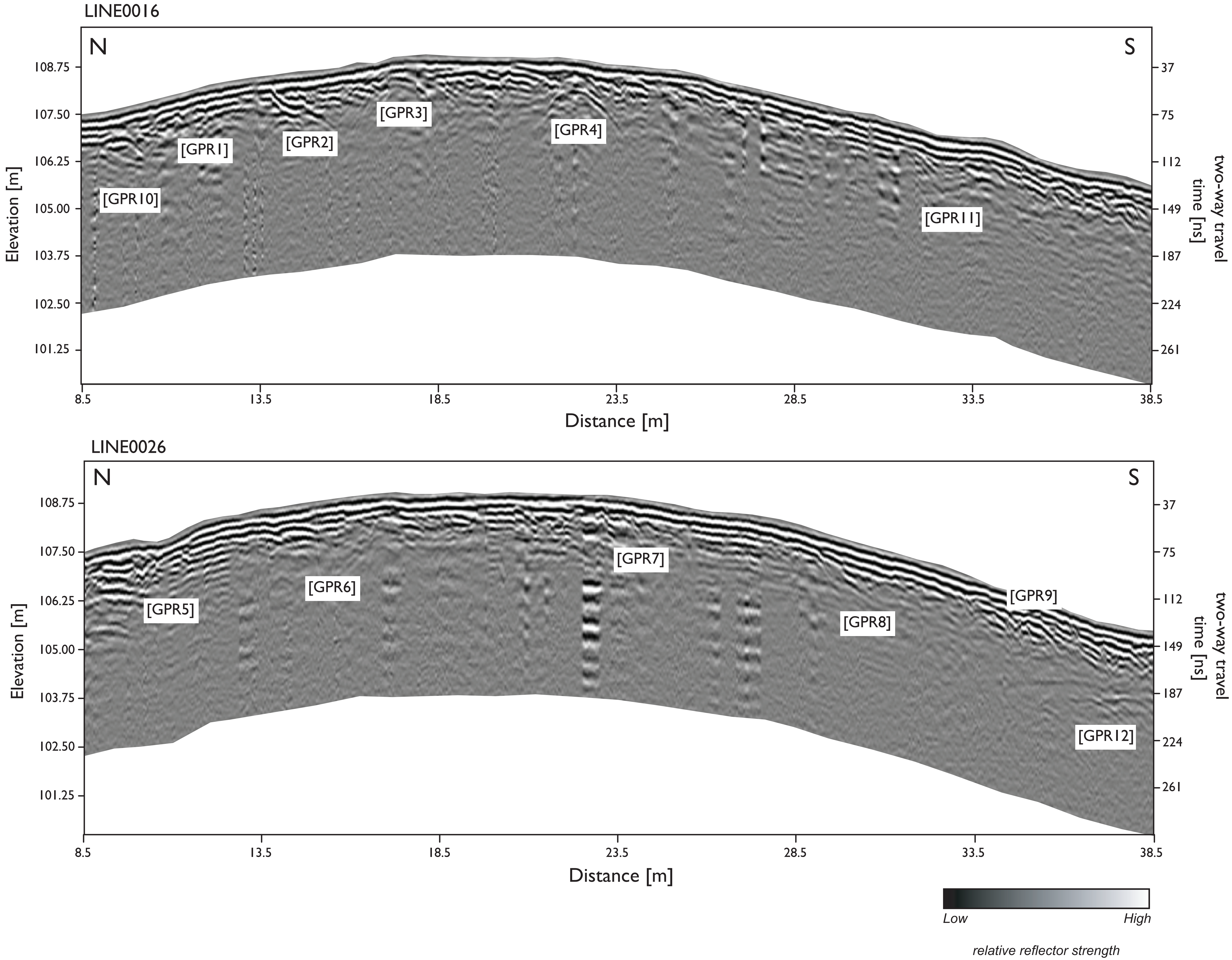

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Figure 9

NETHERAVON BARROWS, FIGHELDEAN, WILTSHIRE

GPR amplitude time slices from between 0.0 and 90ns (0 - 3.0m), April 2014

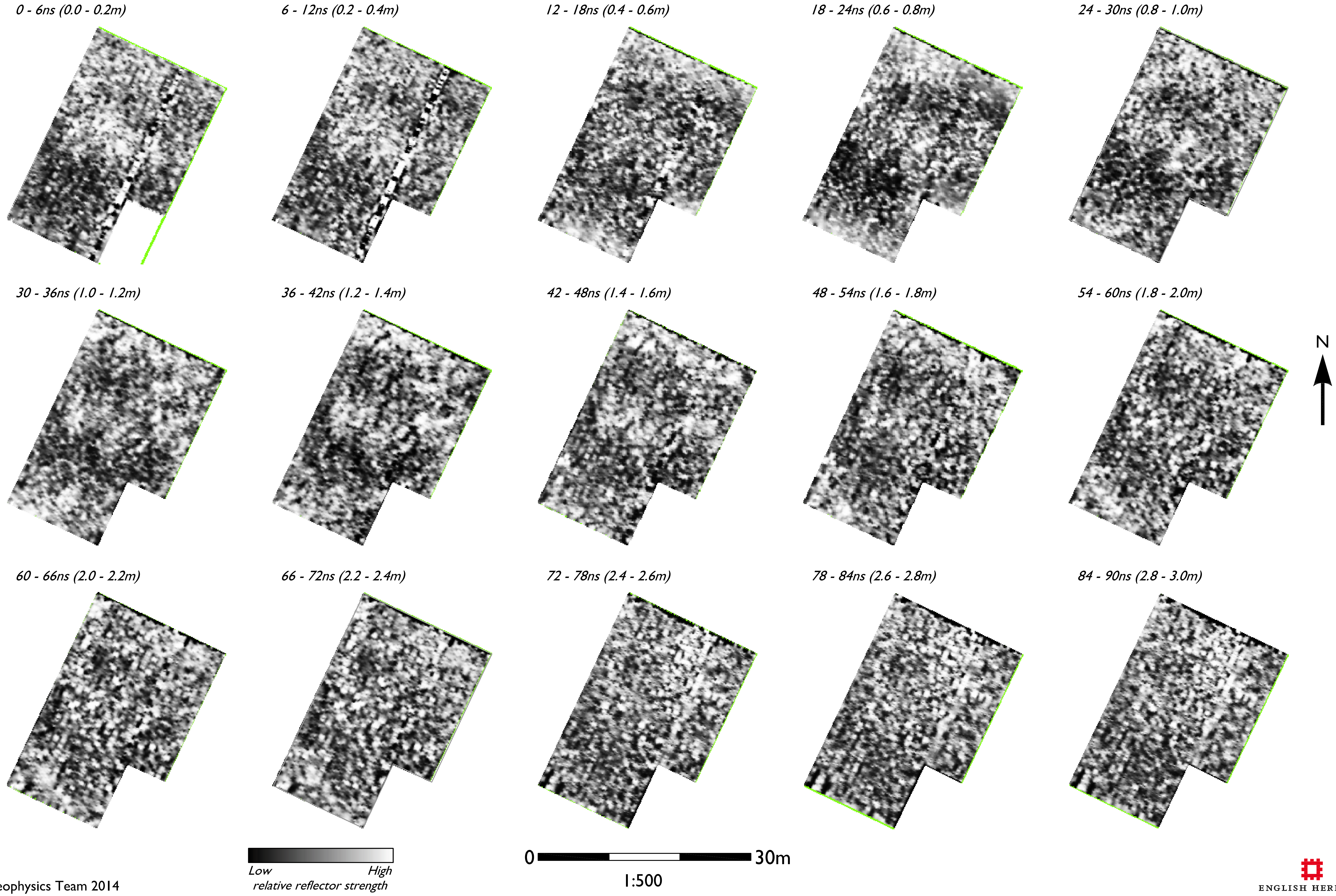

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Figure 10

NETHERAVON BARROWS, FIGHELDEAN, WILTSHIRE

Summary of signficant earth resistance anomalies

SU1548

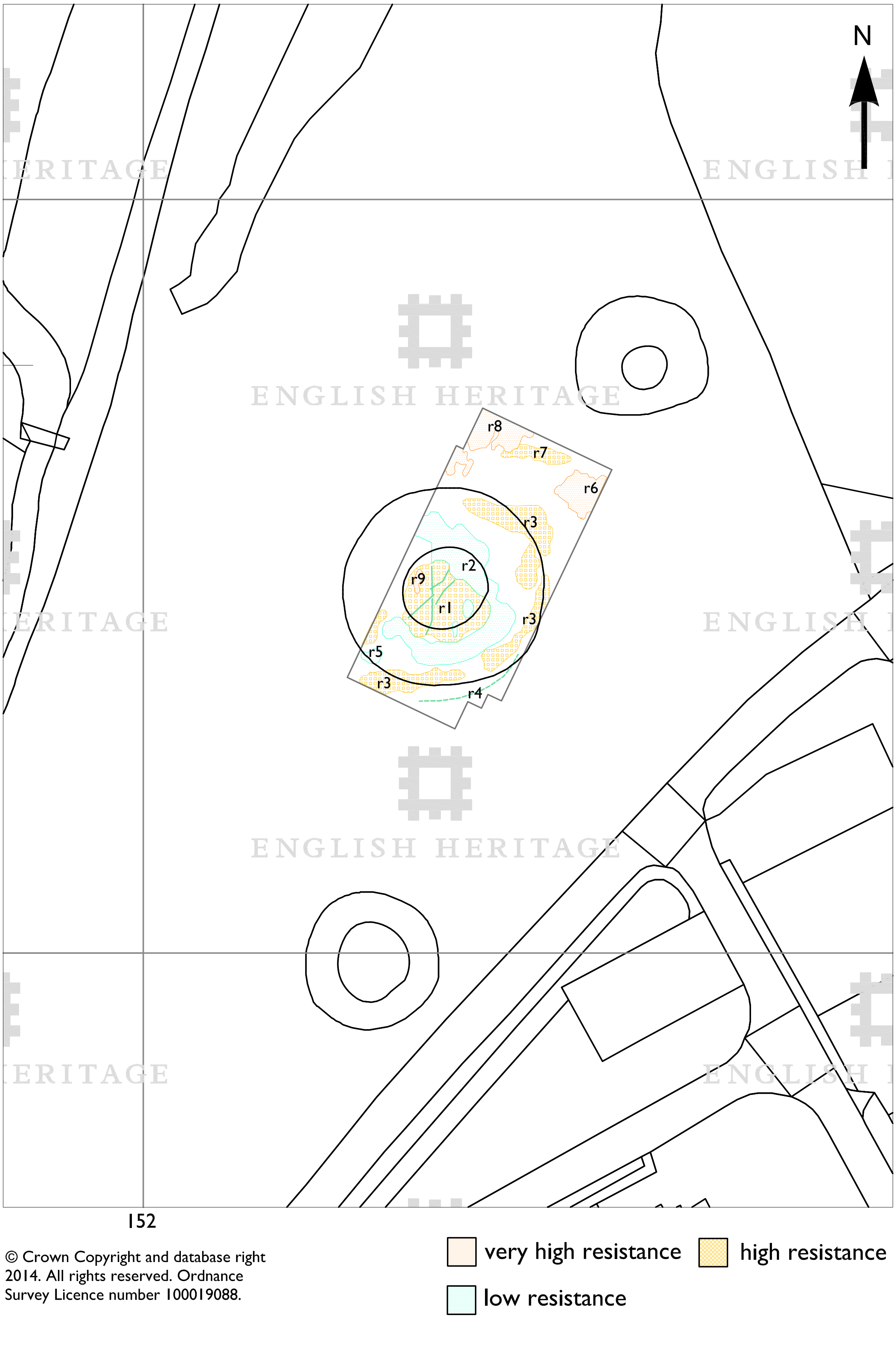

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Figure 11

NETHERAVON BARROWS, FIGHELDEAN, WILTSHIRE

Summary of signficant GPR anomalies

SU1548

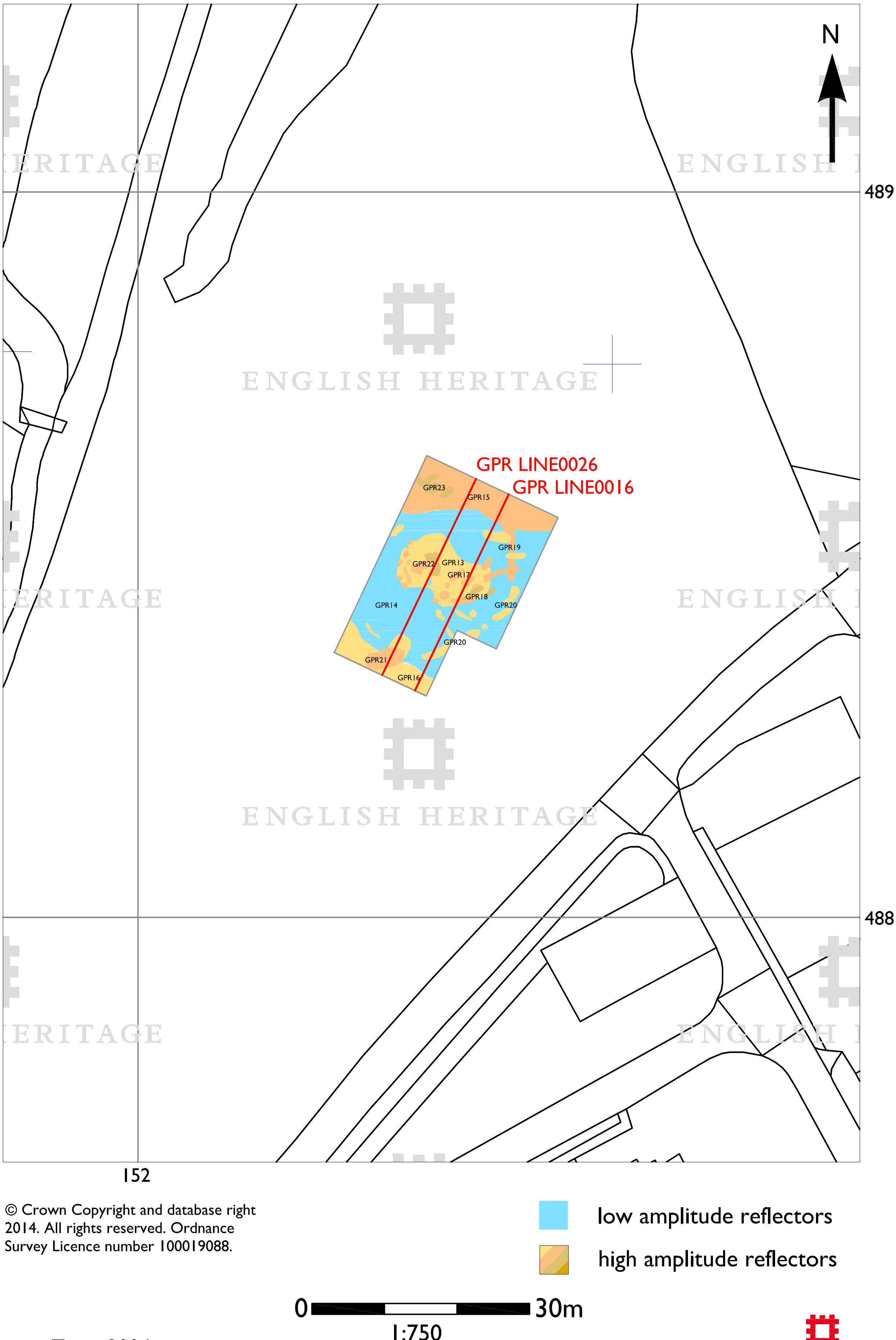

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Figure 12

NETHERAVON BARROWS, FIGHELDEAN, WILTSHIRE

Significant geophysical anomalies relative to barrow topography

very high resistance
high resistance
low amplitude reflectors
low resistance
high amplitude reflectors

0 30m
1:750

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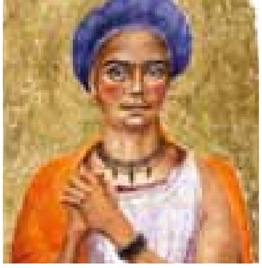


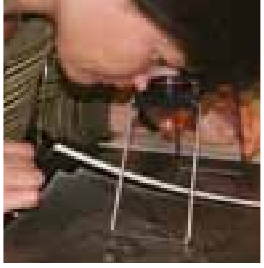


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- Assessment (including Archaeological and Architectural Investigation, the Blue Plaques Team and the Survey of London)
- Imaging and Visualisation (including Technical Survey, Graphics and Photography)
- Remote Sensing (including Mapping, Photogrammetry and Geophysics)

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