Castle Law, Forgandenny Geophysical Survey

Preliminary Data Report

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1.0 Summary

As part of the Strathearn Environs and Royal Forteviot (SERF) project a geophysical survey of Castle Law, Forgandenny hillfort was conducted between February 16th and 22nd 2013. Despite the influence of the underlying geology on both the resistivity and gradiometry survey results, the data clearly highlights the different physical characters of the various construction elements of the fort. In particular, the banks appear to be built using a variety of materials. On the summit of the hill several possible areas of heat affected stone relating to the timber laced fort are suggested. Also in both resistivity and gradiometry survey results several distinct anomalies have been identified which correspond to hut platforms recorded by the RCAHMS survey. The two geophysical techniques employed complement each other and have provided further targets for excavation.

2.0 Introduction

A geophysical survey, using both gradiometry and resistivity, was carried out on Castle Law, Forgandenny (NO01NE 5; NO 0998 1554), between February 16th and 22nd 2013, in advance of proposed excavations on the fort as part of the SERF hillfort programme.

2.1 Aims

The aims of the geophysical survey were to use geophysical techniques:

- to define and compare the geophysical character of the visible archaeological features defining Castle Law, Forgandenny.
- to identify previously unknown archaeological features.
- to identify areas of soil accumulation and better understand the geophysical nature of the underlying geology.
- to help inform further archaeological work on the site.

2.2 Archaeological Description & Background

Castle Law, Forgandenny hillfort is defined by various ramparts, wall constructions and hut platforms, which certainly represent multiple phases of construction and use. Situated on a prominent location overlooking the Earn the site has been an important feature in the landscape for millennia. The fort had been described in the *Old Statistical Accounts of Scotland* from the late 18thcentury (OSA 1791-99, 309). Towards the end of the 19th century Castle Law, Forgandenny was subject to an investigation by Edwin Weston Bell (1892). Bell focused his excavations on uncovering the entrance and wall faces of the timber laced forts on the summit of the hill. During his explorations Bell noted the massive stone forts were largely composed of sandstone and that some of the timber elements of the walls had been burnt *in situ* (*ibid*). Bell did not find any diagnostic finds during his excavations and therefore the chronology of the site and its use is still unknown. After the excavations Bell left his trenches unbackfilled and these trenches are still visible today.

In 2010 the *Royal Commission on Ancient and Historical Monuments of Scotland* (RCAHMS) undertook a detailed survey of the hillfort (see NMRS NO01NE5: Sherriff 2010). The results of this survey were used to propose a potential phasing for the construction of the fort (see Figure 1). The RCAHMS suggested that the fort had been built and remodeled several times throughout its occupation, which included two separate phases of timber laced forts that dominated the summit of the hill, as well as a possible unenclosed phase of hut platforms (see NMRS NO01NE5: Sherriff 2010).

2.3 Geology, Topography & Vegetation

The underlying solid geology of Castle Law, Forgandenny is pyroxene andesite (BGS 1:50,000). Such igneous geology has the potential to greatly affect the magnetic readings of the gradiometry survey; however, the results from the gradiometry survey at Rossie Law, which was characterised by a similar igneous geology, demonstrated that in areas where there was accumulation of soil masking the bedrock possible archaeological features can be detected (Poller 2012). In the case of Castle Law there is potential for substantial soil accumulation. In addition, the timber-laced forts appear to be largely composed of sandstone transported from elsewhere and therefore the rubble from this construction may provide ample magnetic contrast to the bedrock.

The superficial geology is likely to have derived from glacial deposits, with greater accumulation of hillwash down slope.

Castle Law, Forgandenny is the most striking and visibly complex hillfort with the SERF research area. The fort is situated on a prominence which stands roughly 280m OD on the northern edge of the Ochil Hills. From the summit of this hill there are extensive views across the Earn valley to the NW, N and ENE. Towards the S and SE the rolling peaks of the Ochil hills limits any wide views and the site is overlooked by Culteuchar hill immediately to the SW.

The hill is currently grazed by a small group of livestock and the vegetation is largely characterised by short grass, with the density of tussocks increasing down slope. Areas of more ericaceous plants are noted in patches across the site. Active erosion of the hill slope through slumping is particularly visible on the SW side.

3.0 Methodology

3.1 Survey Methodology

The geophysical survey was conducted using both gradiometry (magnetic) and resistivity (electrical current) techniques. The location of the survey grids were recorded using a Leica Total Station 407, which was then georeferenced using OS MasterMap data and processed through ArcGIS software.

3.1.1 Gradiometry Survey

Gradiometry was undertaken using a dual sensor Bartington Grad 601. Readings were recorded within 20m by 20m grids and taken every 0.5m (traverse) by 0.25m (sample). Four main areas were targeted for survey in order to maximise coverage of the site. These areas included: the summit of the hill, an area to the E of the entrance, the lower banks to the S of the summit and a terraced area to the NE of the summit. The total area surveyed by gradiometry was approximately 26 000m^2 (*see Figure 2*).

3.1.2 Resistivity Survey.

The resistivity survey was conducted using a GeoScan RM15 with 0.5m probe separation. Selected areas across the site were targeted for resistivity survey. The targeted areas included: an area of possible hut platforms in the NW corner of the summit, an area to the E of the entrance, and the lower banks to the S of the summit. The data was recorded in 20m by 20m grids, approximately 10 000 m^2 was surveyed by taking readings every 1m by 1m; however, two areas, about 1500 m^2 in total area, were surveyed in finer detail, with readings taken every 0.5m by 0.5m (see Figure 2).

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3.2 Processing Methodology

3.2.1 *Gradiometry Processing*

All the gradiometry survey data was first downloaded using Grad 601 software and then imported into GeoPlot v3 for processing. Results were produced as grayscale images.

In order to reduce the effect of the very high magnetic readings the data was processed by setting the absolute readings to different ranges. Figure 4 shows the minimum set at -100nT and a maximum of 80nT, which highlights the features on the summit of the hill. However, were there is more soil accumulation on the lower slopes there is a less extreme data range and therefore the results were set with absolute minimum of -60nT and a maximum of 40nT (see Figure 5).

Further processing was needed to compensate for a 'staggered' effect between the readings of individual lines. This 'staggered' effect is due to the large number of measurements taken every metre and the difficulty of absolute consistency in the surveyor's walking pace. Therefore a 'destagger' was applied to the data.

3.2.2 *Resistivity Processing*

The resistivity data was downloaded directly into GeoPlot v3. The data was edge matched in order to compensate for slight differences in the background probe readings during probe movement. Then the data was clipped between 530 and 150 ohm in order to diminish the overpowering strength of the stone features on the summit of the hill (see Figure 7). A further high pass filter was applied to compare the results of more subtle readings (see Figure 8).

4.0 Results

4.1 Gradiometry Survey

(*Figures 3, 4, 5 & 6)*

The results of the gradiometry survey are presented as greyscale images, with strong positive magnetism displaying as black and strong negative magnetism displaying as white. More neutral magnetism will appear as grey. It is from these images the data is interpreted and particular features are highlighted.

Prior to survey it was thought that the underlying bedrock may be very magnetic, with the potential of completely overwhelming the data. The results show, however, that although the geology has a significant effect on the results it does not dominate the results and other features can be identified. The geology is most dominant in the NW section of the summit where it is visible as irregular bands of strong magnetism. These bands, however, seem to stop, or at least are not detected, within the area occupied by the two timber laced forts. Perhaps the massive accumulation of sandstone here creates a sufficient barrier over the magnetic bedrock. In other areas across the site the geology appears as more discrete positive curvilinear or circular anomalies.

On the summit of the hill Bell's excavation trenches, which follow the line of the walls of the inner timber laced fort and part of the outer timber laced fort can be identified as slightly negative curvilinear bands. The walls of the forts, reported by Bell to have been composed largely of sandstone, did not produce a strong or consistent magnetic response. Loose stone on the surface of the ground and rubble near the surface produce small variable magnetic anomalies of both positive and negative magnetism, and which looks like concentrations of scattered black and white dots. Amongst these areas there are larger positive anomalies. Some of the stronger positive anomalies may be vitrified stone or igneous stone used for the construction of the fort. More subtle positive areas found may be areas of burning within and associated with the timber-laced forts. There are noticeable positive areas along the southern side of the outer timber laced wall, particularly in the SE corner. Several very strong anomalies of both positive and negative magnetism (dipoles) are recorded along the stone walls, notably at either end of the wall which connects the inner and outer timber laced fort at the E entrance. These dipoles may be metallic objects or material that has been subjected to significant heat.

The banks to the N and W of the timber laced fort and curving around the contour of the hill produced variable magnetic responses. Interestingly, in the SW the inner bank (Bank 1) is characterised by a strong positive band with a strong negative halo. However, from the entrance gap towards the N and E the character of this bank changes dramatically to a more variable magnetism (which is visible as a scattering of small anomalies of positive and negative anomalies). The difference in character of this bank may be due to different material used for its construction. The SW side has a more consistent magnetism and perhaps suggest that at this point *in situ* igneous stone outcrops is utilised. In the N and E the bank may be composed largely of loose stone and rubble. The wide spread of variable magnetism highlights the natural weathering and erosion of rubble down slope. The spread of stone is most visible across the E entrance area.

Further down slope from Bank 1 in the NW corner of the summit there is a band of slightly negative magnetism which is likely an area of silt accumulation and beyond this there is the remains of another bank (Bank 2) which is characterised by anomalies of variable magnetism. The outer bank continues to the S of the entrance, beyond a flat platform defined by a positive anomaly. Here the magnetic nature of the bank is punctuated by areas of less variable and weaker magnetism. This difference in character again may demonstrate a difference in construction.

Just inside these banks the geology is largely characterised by irregular bands and anomalies of positive and negative magnetism. The many hut platforms recorded by the RCAHMS in this area do not seem to directly correspond consistently to any particular magnetic signature. However, in areas were the background geology readings are weaker or more neutral, thin curvilinear and slightly positive features can be identified. These features may represent the edges of hut platforms. Areas of positive magnetism within these possible hut platforms may relate to areas of burning rather than geology, which may produce similar intensity readings and therefore are difficult to distinguish.

The background readings of the area to the E and S of the summit are more consistently neutral (gray). This consistency is likely due to a greater accumulation of soil down slope. Despite this there are areas of strong magnetism which likely reflects bedrock outcrops close to the surface.

To the E of the entrance of the timber laced forts there is a subtle linear variable magnetic band running E-W and may be a low stone and earth bank. This feature, however, stops at an area with strong positive anomalies. Further down slope the magnetic response is defined by vague areas of increased magnetism and discrete positive anomalies which likely reflects the geology.

The edges of the lower banks to the S of the summit are defined by more subtle bands of positive magnetism. The outermost banks are very subtle and have a corresponding slightly negative band reflecting a greater silt content of these features (Banks 4 & 5). In the SE corner, where the contour of the slope turns N, there is a linear band of strong positive and negative magnetism. This response directly relates to an outcrop which may have been used as the foundation of a bank. Just within this band of strong magnetism is a circular area of variable magnetism which relates to a circular low stone and earth bank feature noticeable on the ground. Other positive magnetism surrounding this feature are irregular in shape and may be outcrops or erosion scars. A distinct circular positive anomaly between the outer banks corresponds to a protruding small feature and again may be geological.

The terrace area to the NE did not produce any clear anomalies. However, within the areas of scattered variable magnetism there may be the remains of a possible circular stone and earth feature, but this cannot be confidently distinguished from rubble which have eroded from the summit.

4.2 Resistivity Survey — *Cathy MacIver*

(*Figures 7, 8, 9 & 10*)

The results of the resistivity survey targeted three areas. On the summit of the hill some of Bell's trenches were visible as low resistance. An area in the NW corner of the innermost timber laced fort produced high resistance readings spread both within the wall and outside, relating to spoil heaps from Bell's trenches. Interestingly the stone walls of the timber laced forts did not yield particularly high resistance readings and the line of the outer fort could not be detected.

To the NW of the timber laced forts areas of high resistance do not form coherent anomalies and likely relate to the underlying geology. The curved shape of the high resistance on the N side forms the base of the bank. The bank itself is surprisingly low resistance, though some variation is noted and therefore indicates it is not a smooth soil accumulation.

A circular low anomaly bordered by a semi circle of higher resistance probably represents a structure, it coincides with one of the hut circles depicted on the RCAHMS plan. A linear strip of low resistance appears to the SE of the hut circle and could be a related part of the structure.

The survey to the E of the entrance showed several areas of slight high and low resistance, forming roughly linear features running NE-SW. It is unclear what these represent. This area of survey also depicts the high resistance of the edge of the spoil heap remaining from Bell's 19th century excavations.

The survey in the south concentrated on an area of possible hut platforms between two outer banks. The ditch was visible as an area of low resistance in the N of these grids. Bank 3 is represented by a small area of high resistance on the northern edge of the feature and an area of much lower resistance at the peak of the bank.

One possible hut circle or structure is identified by a circular high resistance anomaly surrounded by several areas of lower resistance. This location corresponds with a hut circle depicted on the RCAHMS survey and a very high reading from the gradiometry survey.

A very high resistance reading can be seen through the grids in the S and E. This corresponds largely with an area of visibly outcropping bedrock noted during the survey. The response varies from the high resistance geological anomalies seen elsewhere on the site so has been noted as a separate feature on the interpretive plot.

5.0 Conclusion & Recommendations

The results of the two geophysical techniques are complementary, highlighting the diverse character of the archaeological features which define the hillfort. Furthermore, the results of the survey provide a good comparison to the field survey recorded by the RCAHMS (see Figures 11 & 12). The geophysical surveys provide further detail of the physical character of the features identified by the RCAHMS and in some instances, propose that individual elements may be composed of different material, such as the Phase 3 bank.

Areas of excavation can be proposed to test the results of the results of the geophysical data in relation to the RCAHMS survey and what can be observed on the ground. Alongside the excavations which will explore the physical nature of the ramparts and timber laced walls anomalies, such as the high positive feature neighbouring a possible hut platform on the S side of the hill could easily be incorporated in the excavation proposal.

Geochemical sampling of various features and deposits during excavation and their subsequent analysis would add another layer of complementary data to further enhance the interpretation of the geophysical results.

6.0 Acknowledgements

The author would like to thank Dupplin Estate and Mr. Michael Blanche of Culteuchar Farm for their support and giving us permission and access to the site. The survey, which some days was extreme, was conducted with the able assistance of Cathy MacIver, Carmen Cuenca-Garcia, Scott Morris, Joss Durnan, Gert Petersen and Lorraine McEwan. Further thanks to Cathy MacIver for contributing her analysis of the resistivity survey. The SERF project is sponsored by Historic Scotland.

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http://canmore.rcahms.gov.uk/en/site/26583/details/castle+law+forgandenny/

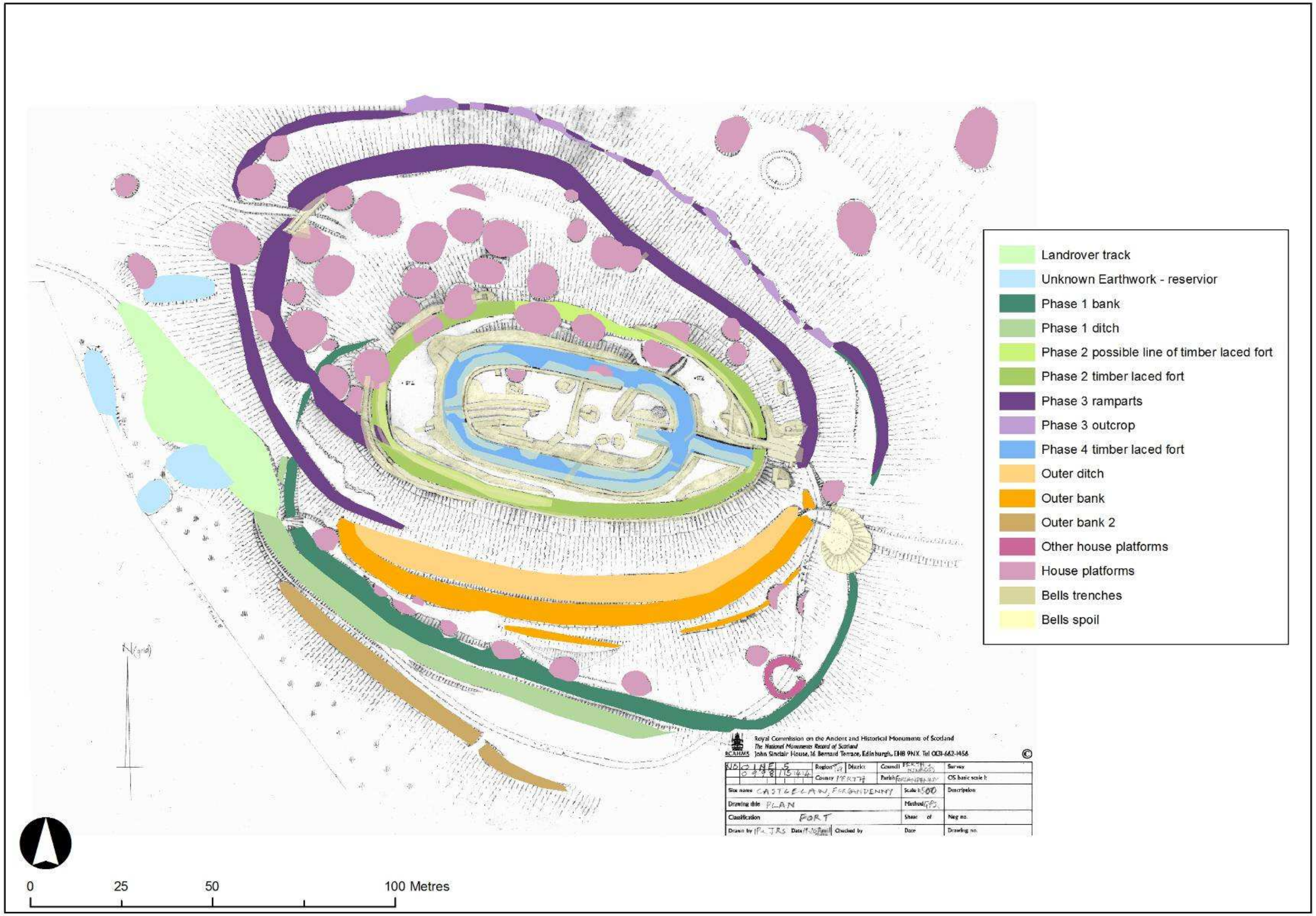

Figure 1: Phasing of archaeological features based on survey by RCAHMS, © RCAHMS

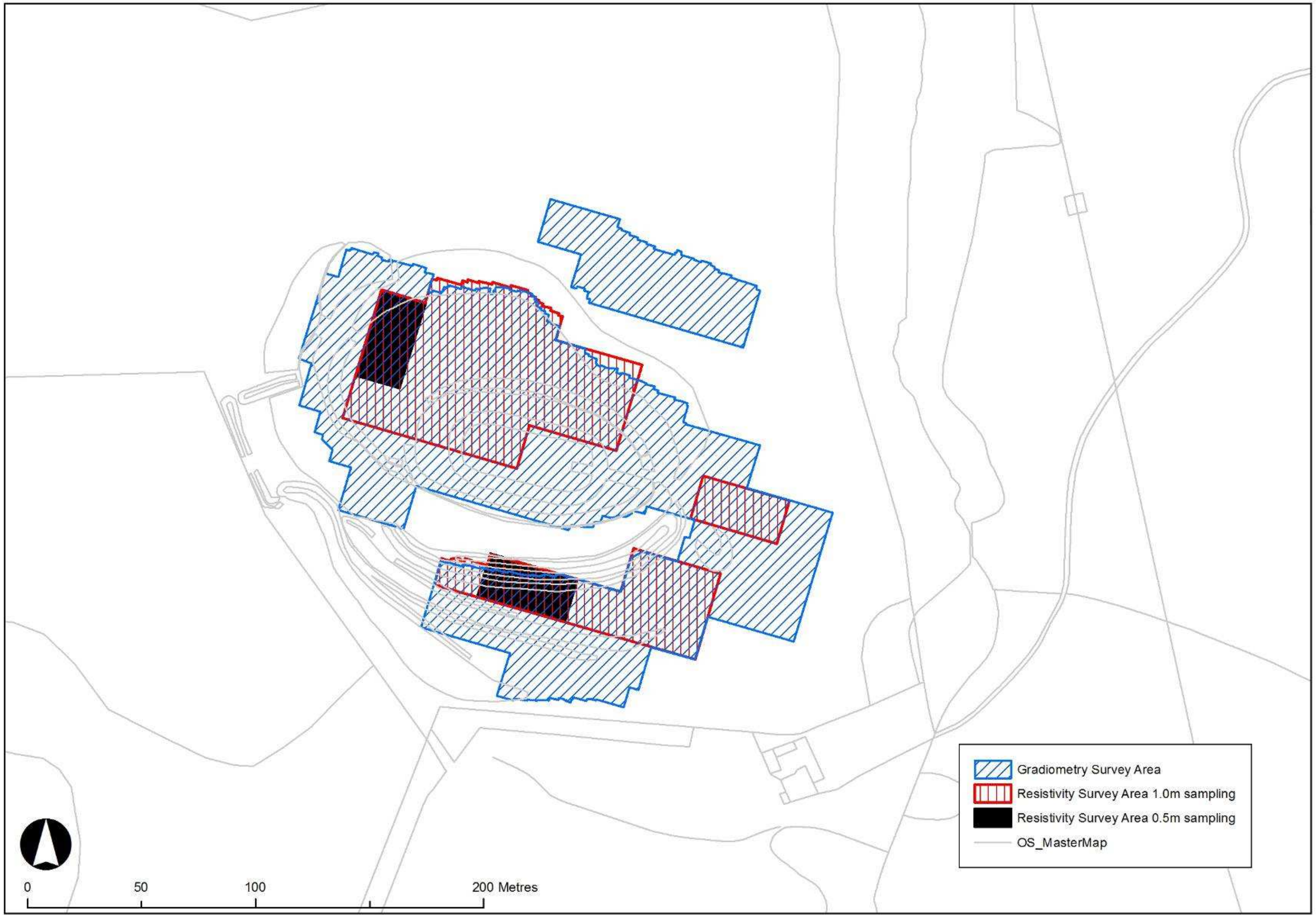

Figure 2: Location map of the geophysical surveys

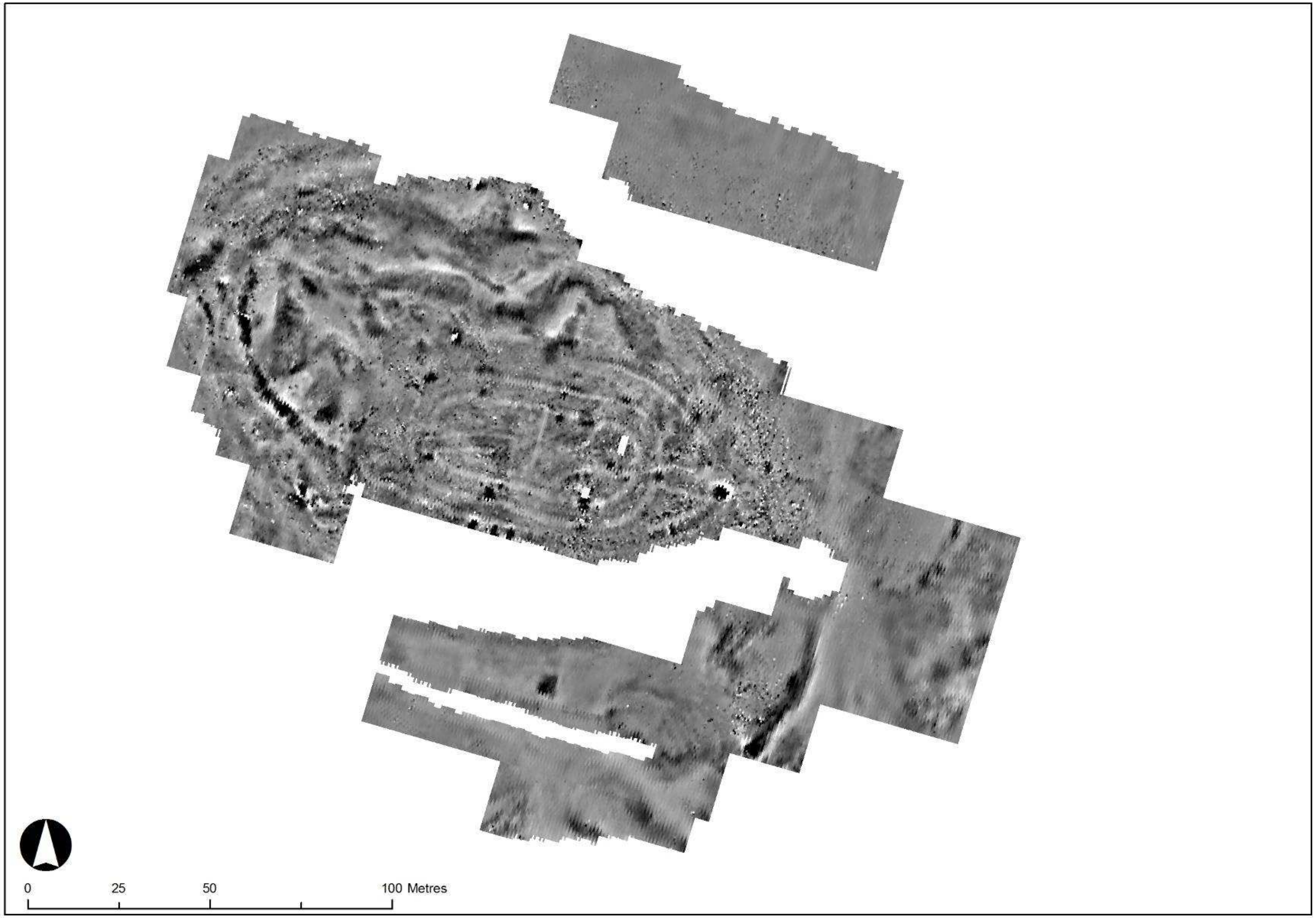

Figure 3: Raw gradiometry data

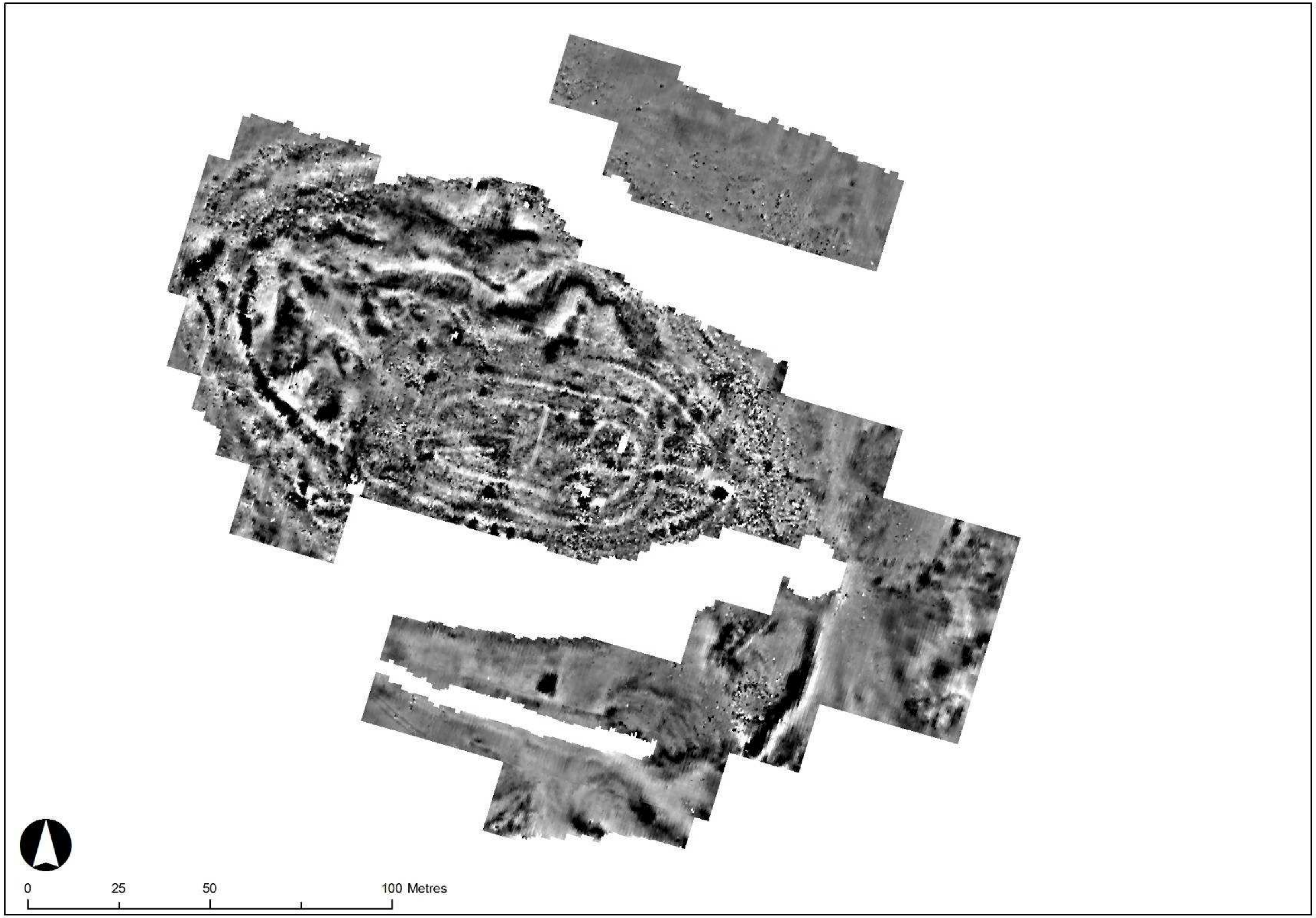

Figure 4: Processed gradiometry data(Absolute -100/+80 nT)

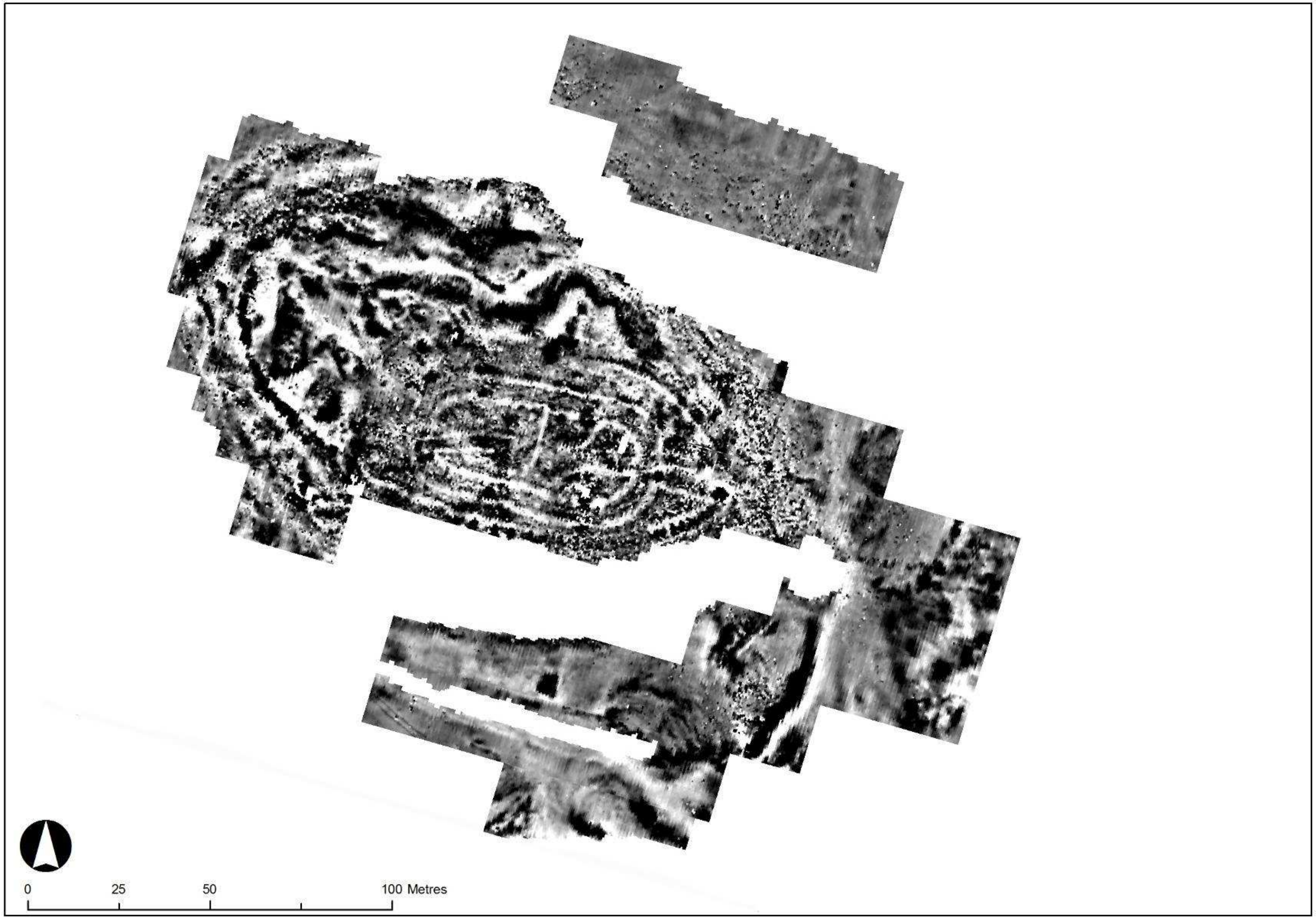

Figure 5: Processed gradiometry data (Absolute -60/+40 nT)

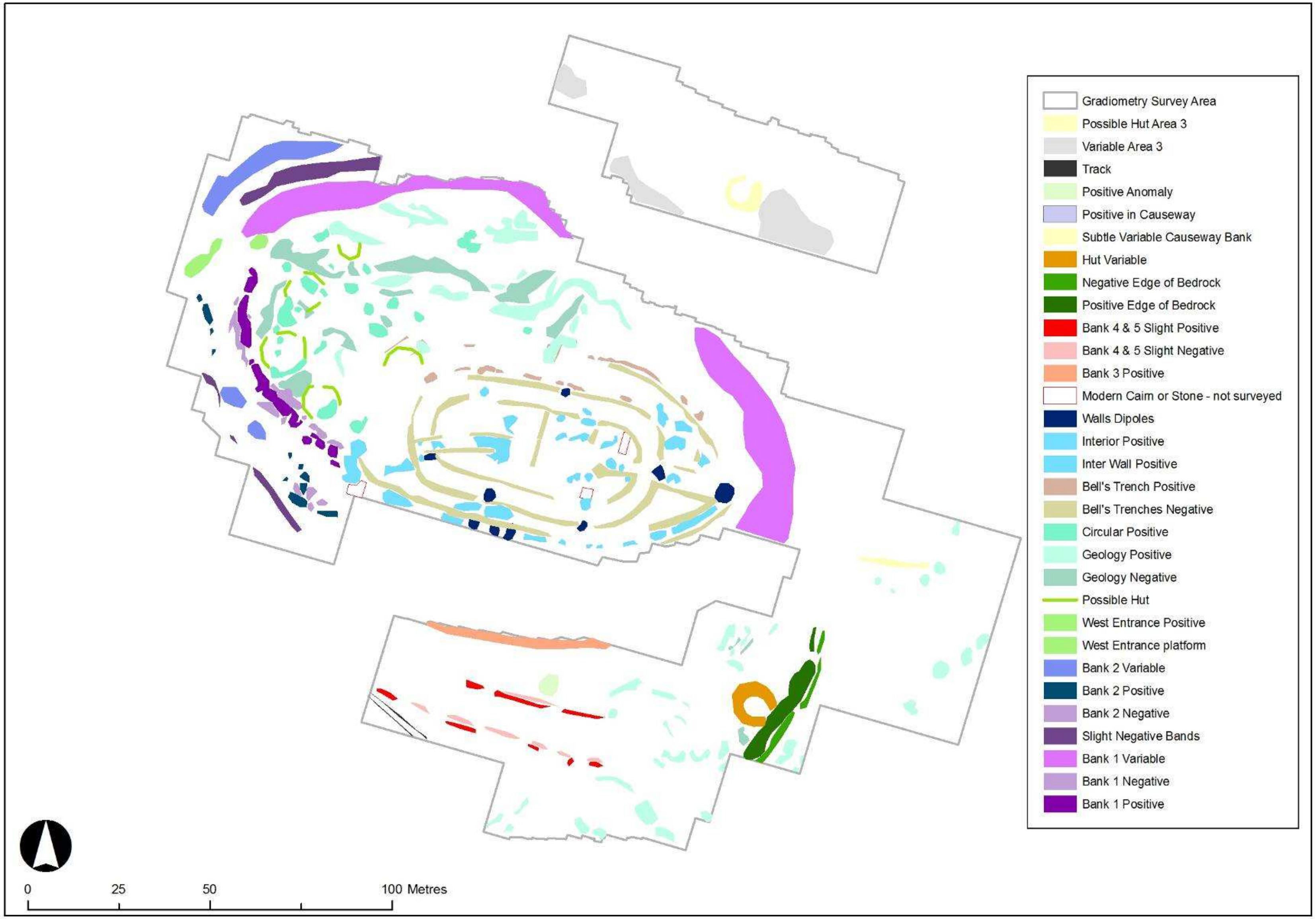

Figure 6: Interpretation of processed gradiometry data

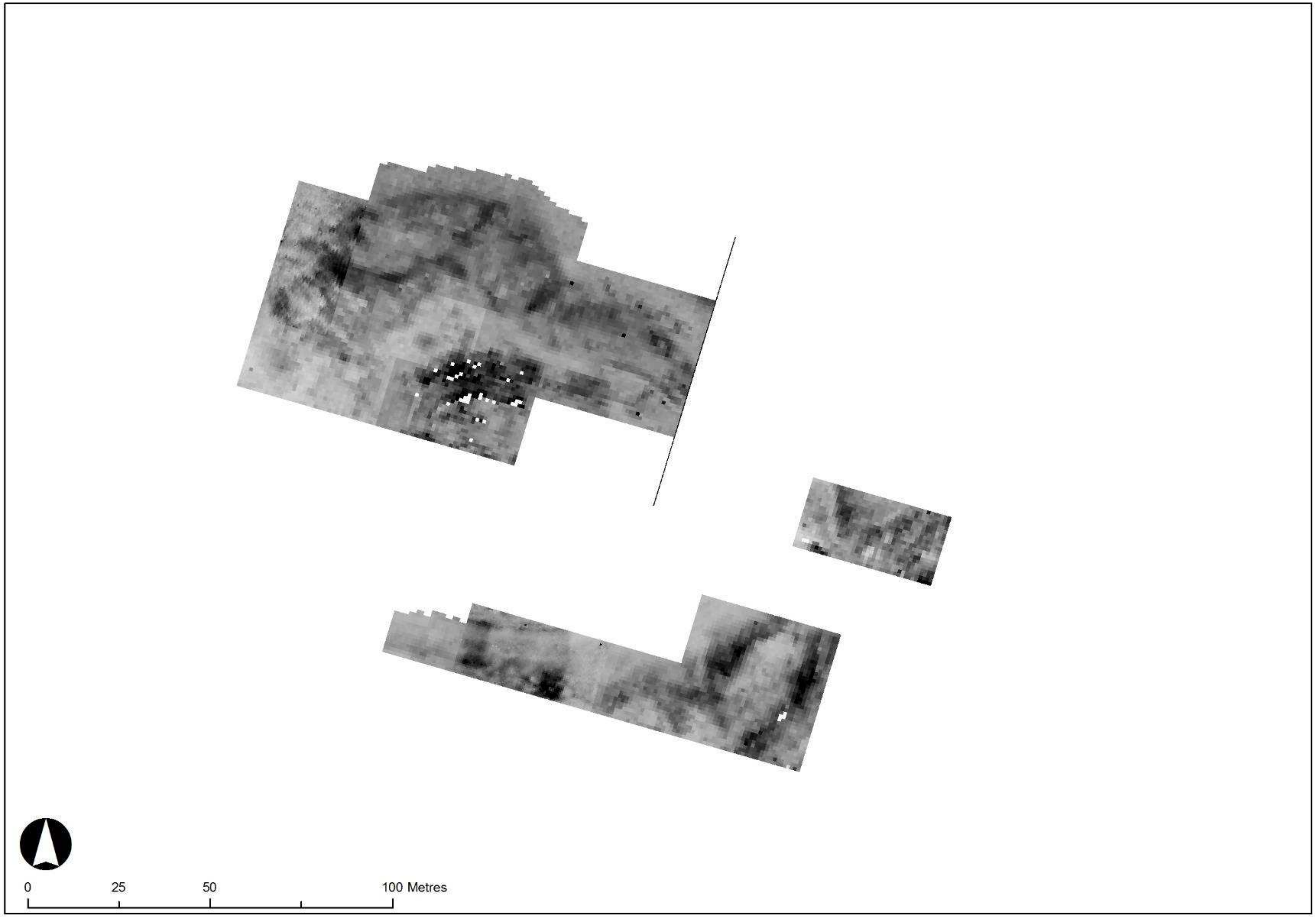

Figure 7: Raw resistivity data

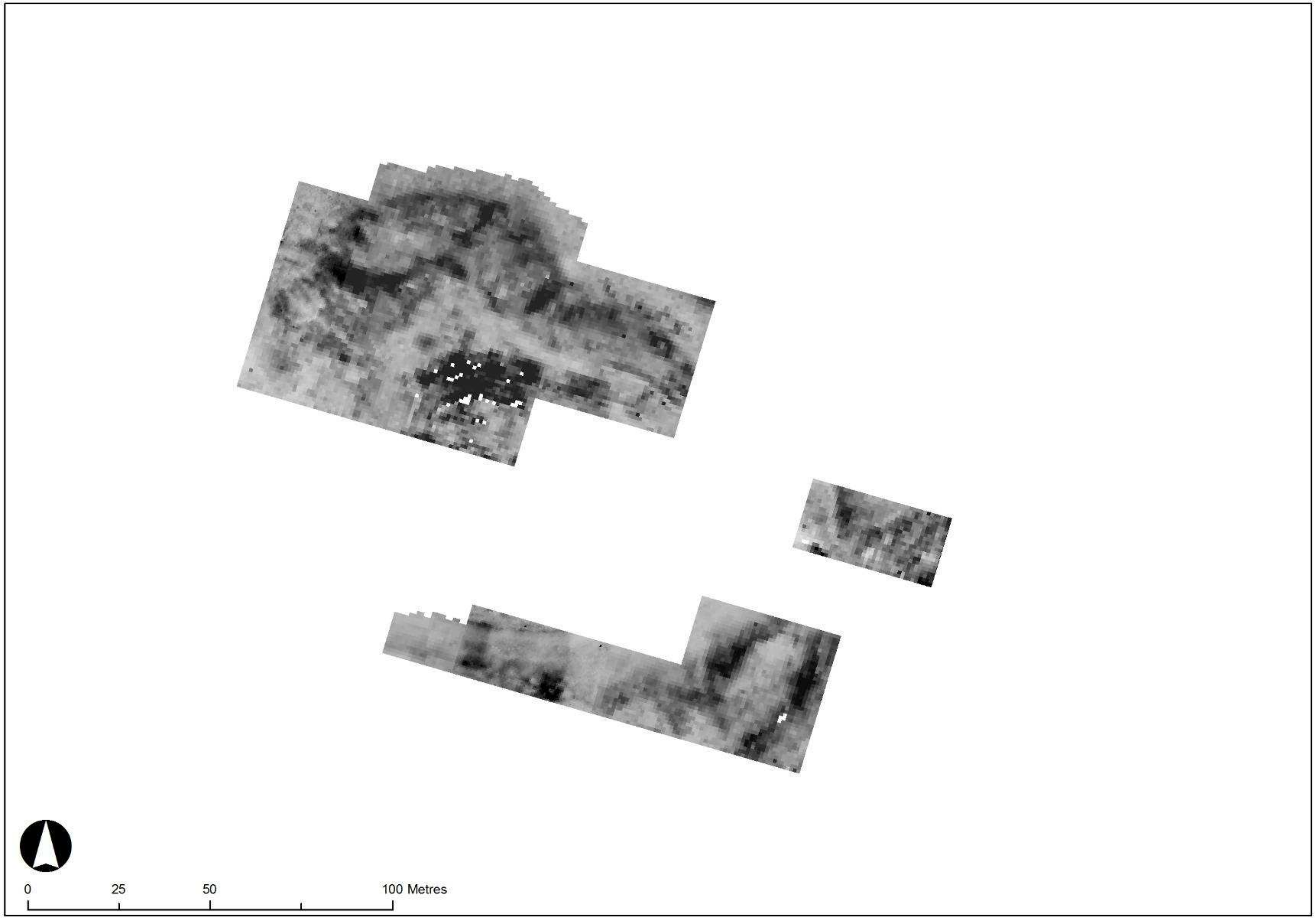

Figure 8: Processed resistivity data (clipped 530 to 150ohm)

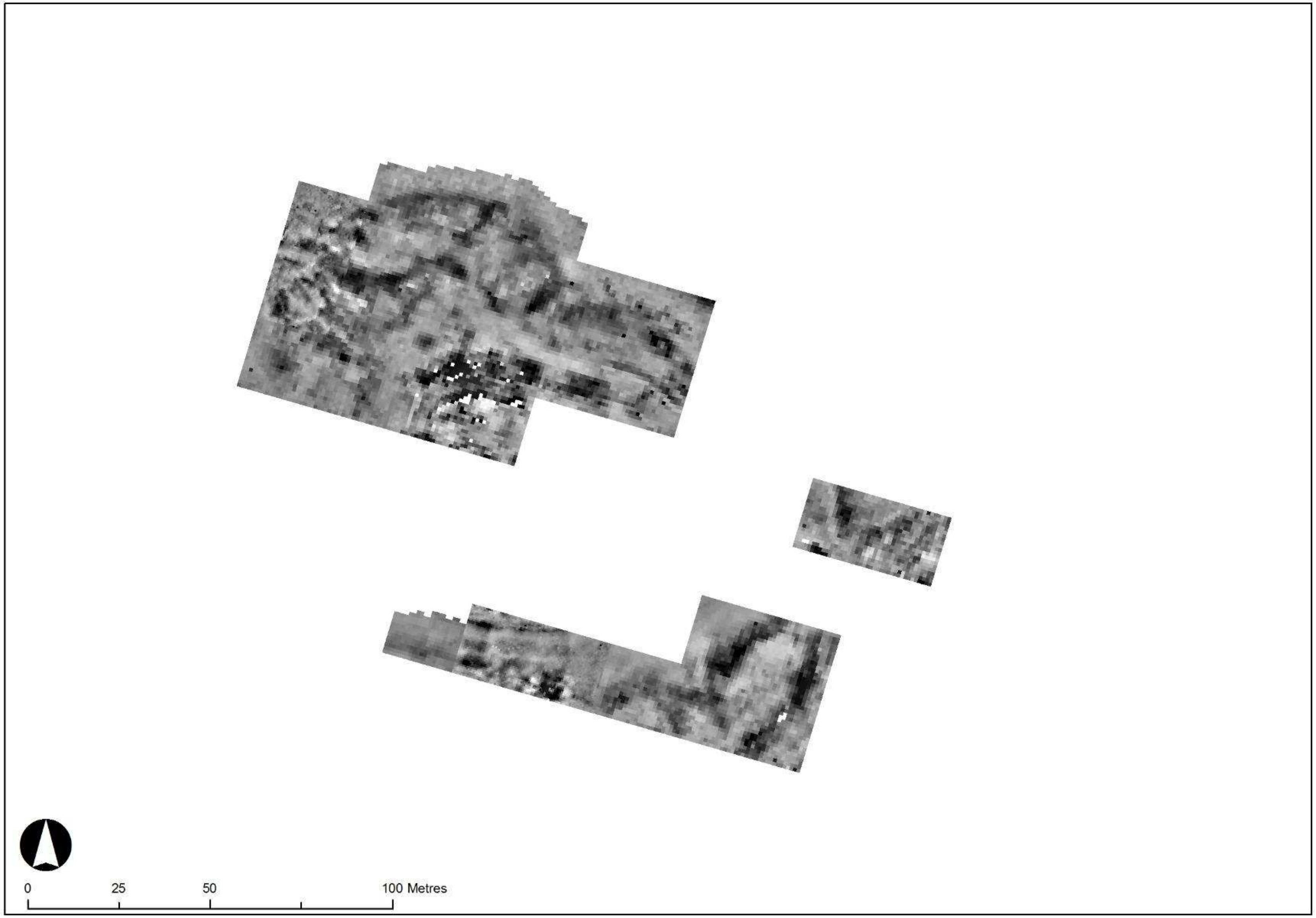

Figure 9: Processed resistivity data (high pass filter)

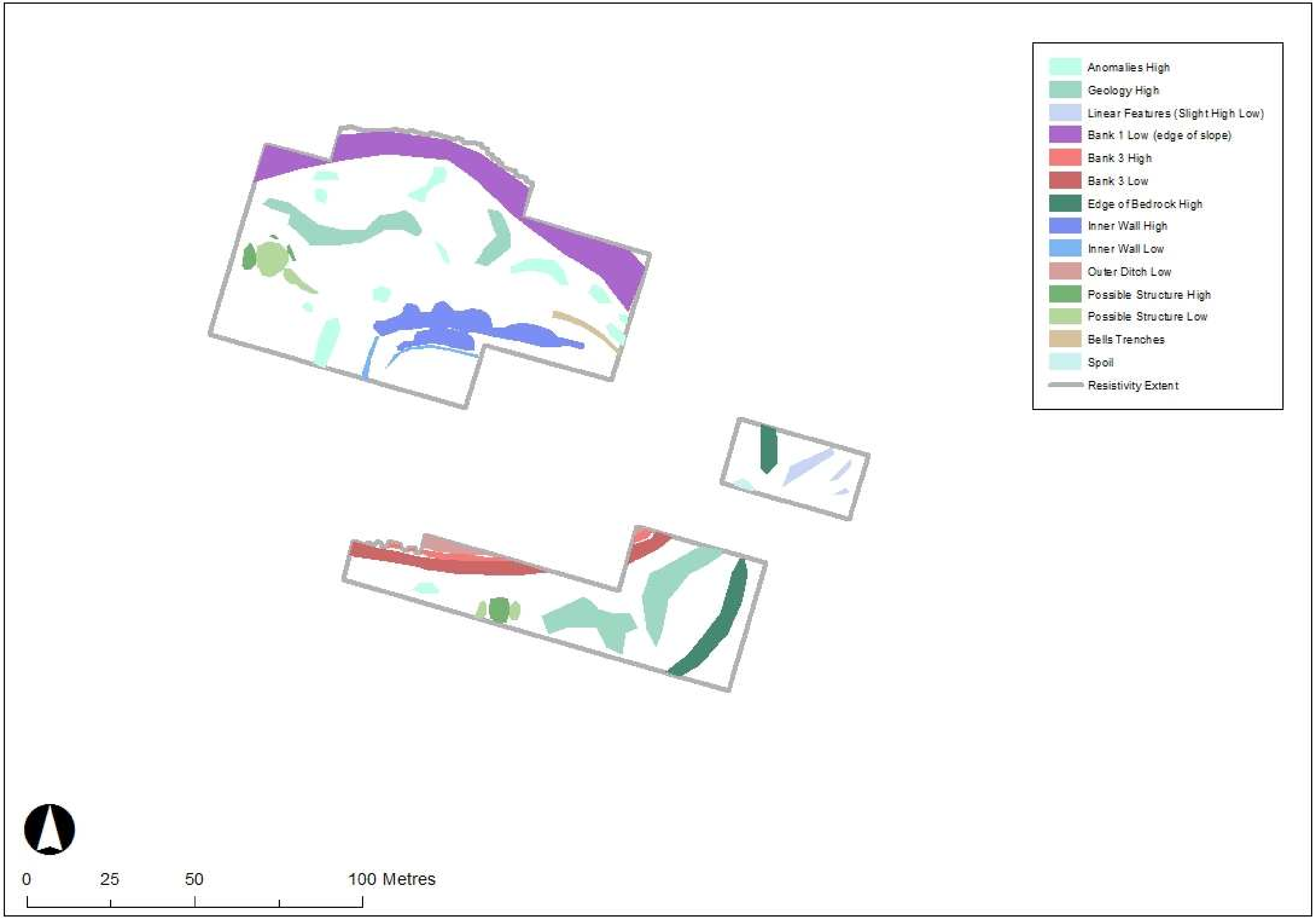

Figure 10: Interpretation of resistivity data

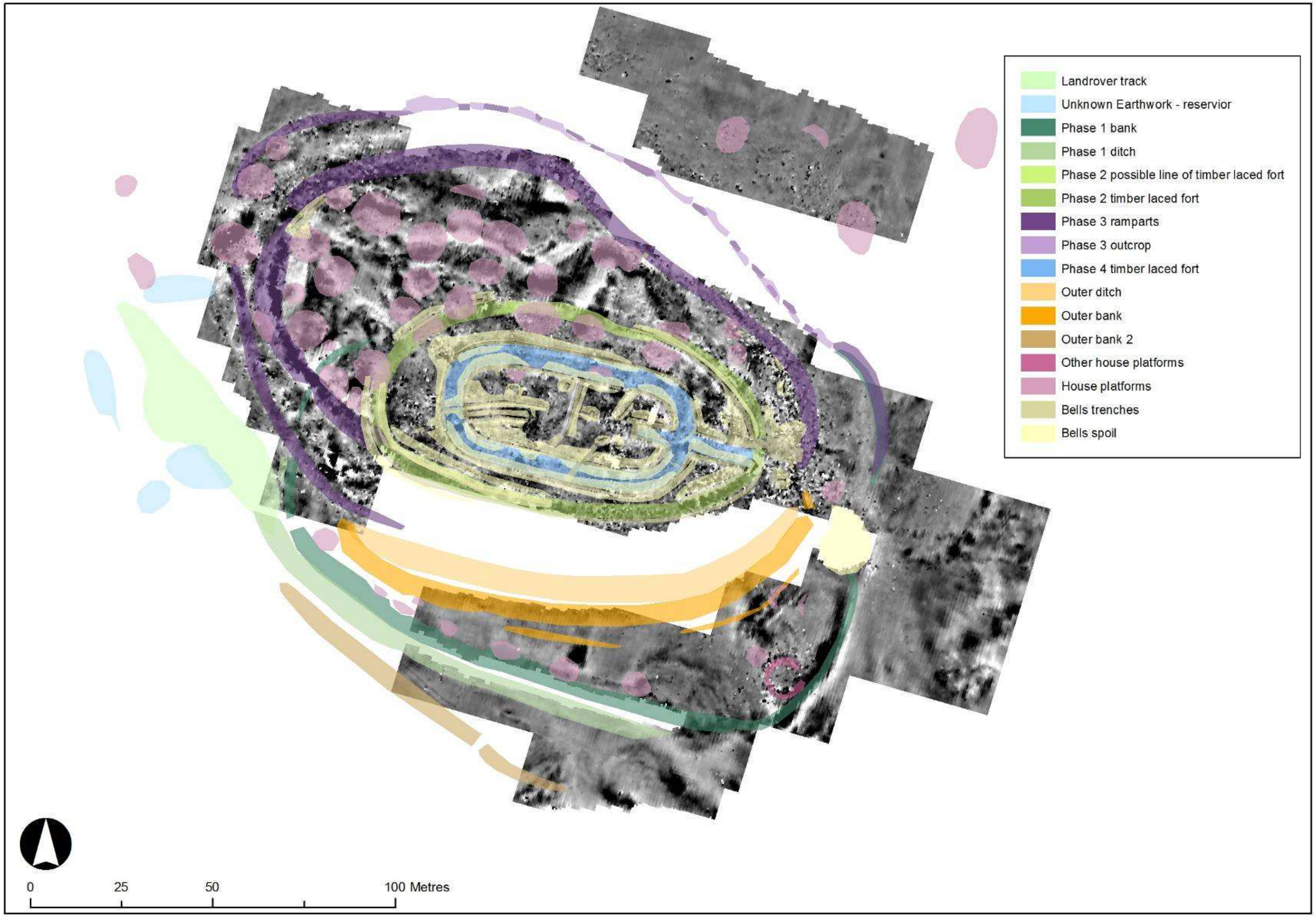

Figure 11: Gradiometry data with phasing of archaeological features based on RCAHMS survey overlay © RCAHMS

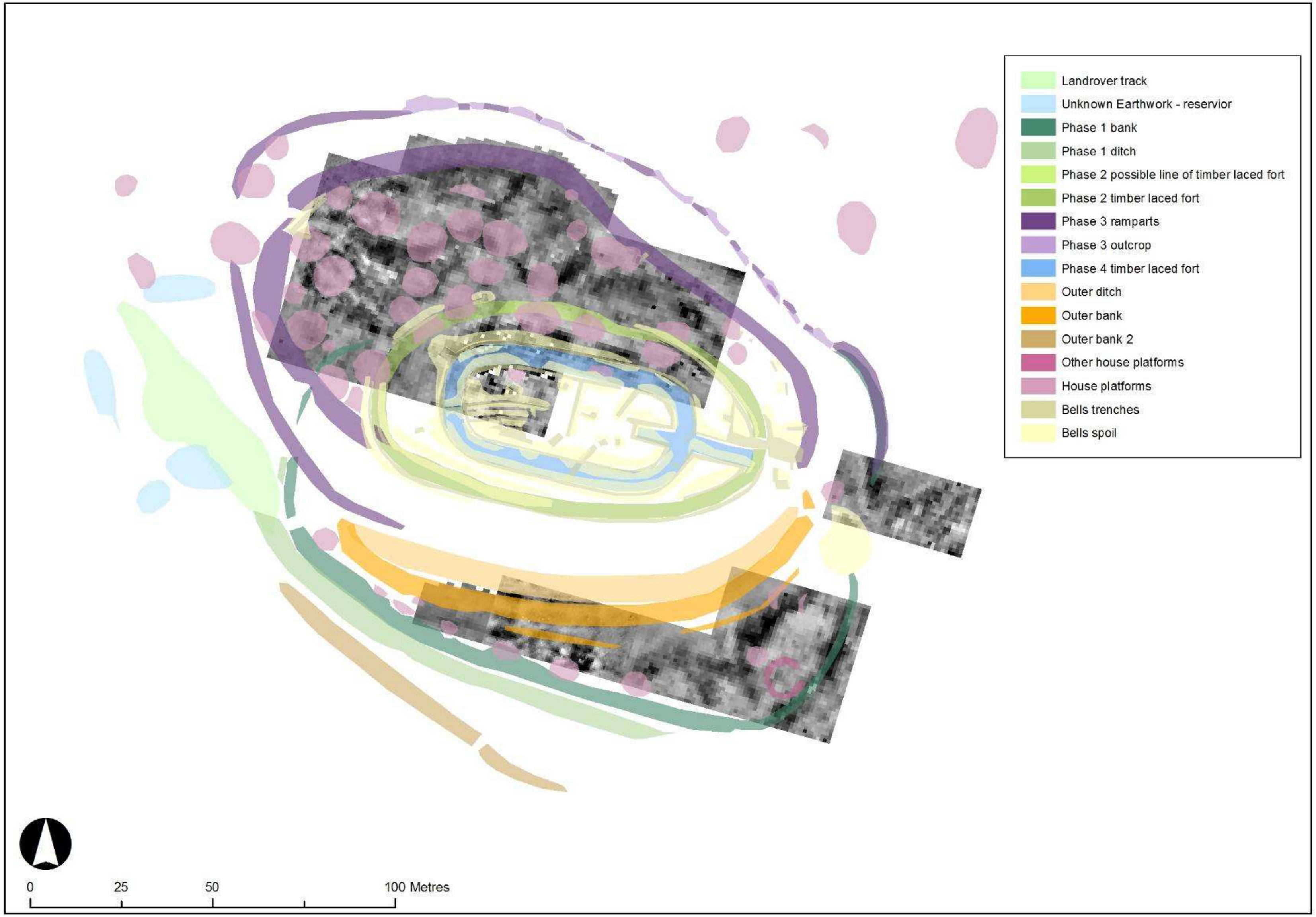

Figure 12: Resistivity data with phasing of archaeological features based on RCAHMS survey overlay © RCAHMS