Geophysical Survey Report No. 41

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Mountjoy Fort, Brockagh,

Co. Tyrone

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with Ruth Logue, Grace McAlister & Ruairí Ó Baoill

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Image on the cover: Extract from '*Plan of Mountjoy Fort, Lough Sydneye'* by Richard Bartlett, *c.* 1602.

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Summary of results

Evaluation resolution electrical resistance and magnetic gradiometery surveys were carried out over a total area of *c.* 2.5 hectare in a two large fields on a promontory on the western shores of Lough Neagh. During a period of fieldwork from 10th April – 5th May 2017 on behalf of the Lough Neagh Landscape Partnership, funded by the Heritage Lottery Fund. The landscape along the south-western shores of Lough Neagh is low laying clays and prone to water-logging with shallow drumlins forming 'islands'. Further inland it is dominated by open pasture and mature hedgerows with the southern shoreline heavily modified by historic peat extraction. The survey area is located just above the 20m contour mark, the NISMR (TYR 047:020) places the 17th-century fortification in roughly the same location but slightly further south (Figure 4), along the Mountjoy Road (B161) just north of the hamlet of Brockagh. The road defines the western limit of the survey parcel tracing a distinctive dog-leg plan. The survey area is comprised of two fields. The northern has a regular trapezoid form typical of modern field patterns in the area. The southern field has a more unusual triangular pattern. The land to the east of its field boundary drops away sharply marking the edge of the historic lake shore. At the centre of the two land parcels is a domestic settlement the location of which has been recorded since the 1830s. The ground surface slopes gently from the northern field southwards. The location has a good aspect from the north-east over the lough clockwise through to the south. However it is limited to the west by a modest knoll upon which Mountjoy Castle (TYR 047:002) is located. Lowering of the lake levels since the mid-19th century have seen the shoreline recede 150m to the east reducing the pronounced nature of the promontory further (Figure 1).

The archaeological geophysical survey has identified a number of anomalies which appear in form and physical character to behave in a manner we would expect from a large earthwork monument. The presence of linear earthworks with angled returns are reminiscent of 17th-century military fortifications. However the plan represented by these anomalies does not match that recorded by Bartlett. Two possible banks are identified by the negative magnetic anomalies, suggesting it is non-magnetic material such as an earthen rampart. The outer bank, Bank 1, appears to have a plan with two angular returns. The interpretation is supported by the resistivity data which suggests that this negative magnetic feature also has higher resistance characteristics, more than likely a compact fill. Other linear electrical resistance features show evidence of the sod rampart which encased the soil core of Bank 1, reinforcing it and preventing slippage. The second bank, Bank 2, lies within and to the south of Bank 1 is associated with the negative magnetic returns and higher resistance readings suggesting that it is similar fabric as Bank 1 – compact soil. The area to the exterior of Bank 1 and between it and Bank 2 is comprised of series of higher magnetic linear features which indicate the presence of ditches. Although fragmentary in nature the subtle changes in the soils magnetic signature is characteristic of the subtle changes which occur as a consequence of the breakdown of organic matter. No evidence of internal structures, such as building foundations or hearth and kilns, where identified within the linear earthworks.

Site Specific Information

Site Name: Mountjoy Fort, Co. Tyrone

Townland: Magheralamfield

SMR No: TYR 047:020/TYR 047:002

Grid Ref: H 9056 6863

County: Tyrone

Date of Survey: 10th April – 5th May 2017

Surveyors Present: Siobhán McDermott, Grace McAlister, Ruth Logue & Ruairí Ó Baoill, Centre for Archaeological Fieldwork, School of Natural & Built Environment, Queens University Belfast.

Size of area surveyed: 2.5 hectares

Weather conditions: Changeable but mainly mild

Solid Geology: Lough Neagh Clays & Lignite

Superficial Geology: Glacial Sand and Gravels

Soil Type: Stagnosols

Current Land Use: Farmland

Intended Land Use: N/a

Survey methodology overview

Survey type
Magnetic gradiometery
Instrumentation:
Bartington Grad601-2 magnetic gradiometer
Probe spacing:
1m
Grid size:
30m x 30m
Traverse interval:
1m
Sample Interval:
0.125m
Traverse Pattern:
Zig-zag

Electrical resistance
Instrumentation:
Geoscan RM85
Probe spacing:

Multiple five probe array (1m x 2, + 0.5m x 4)
Grid size:
30m x 30m
Traverse interval:
1m/0.5m
Sample Interval:
1m
Traverse Pattern:
Parallel

Lecia TS06-plus total station
Survey grid setup:
Established with differential GNSS
Survey Internal Accuracy:
Survey grade accuracy (<3cm)
Georeferencing:
The EDM data will be used to georeference the geophysical survey datasets exported from Geolplot v.4/TerraSurveyor in ArcMap 10.3.

Data processing:
The geophysical data was processed in TerraSurveyor with the electrical resistance data composited in Geoplot v. 4 software. The primary processes applied were high pass filtering (HPF) to remove geological 'background' noise and low pass filtering (LPF) which helps to eradicate minor spikes in the data. The datasets were also interpolated which creates a smoothing effect.

Visualisations:
The datasets were visualised within TerraSurveyor using shade, trace, compression and relief plots. Processed datasets and bitmap graph plots were exported from TerraSurveyor and imported into ArcGIS 10.3. Once georeferenced statistical analysis were carried out on the rasters within ArcGIS 10.3 and they were interpreted in relation to the available historical Ordnance Survey maps of the area and orthorectified aerial imagery.

Digital archive:
The geophysical datasets were collected, processed and archived in accordance with Archaeological Data Services best practice.[1]

[1] Schmidt, A. & E. Ernenwein, 2011, Guide to good practice: Geophysical data in Archaeology [Online] http://guides.archaeologydataservice.ac.uk/g2gp/Geophysics_Toc

Introduction

Characterisation resolution earth resistivity and magnetic gradiometery surveys were carried out over a total area *c.* 2.5 hectare within two large fields situated to the north of the hamlet of Brockagh along the Mountjoy Road. The archaeological character of the area is dominated by the 17th-century. To the immediate south is the recorded location (TYR 047:020) of the early-17th-century Tudor fortification which has now been identified within the study area. Mountjoy Castle (TYR 047:002) is situation just under 500m to the west, on a modest knoll, monumentalising Tudor victory in this part of Ulster. The location of the fort occupies a small, modest promontory, the character of which has been lost by the receding shoreline. The surrounding landscape is relatively flat, water-logged and low laying with shallow drumlins. Situated above the 20m contour mark, the area targeted for survey (Figure 1) is composed of two large fields. The northern field has a regular plan and a higher elevation sloping gently southwards. The southern field has an unusual triangular plan and a flat topography more prone to flooding. The ground to the east of each field drops away steeply revealing the nature of the historic shoreline. The western limits of the survey area is defined by a distinctive dogleg bend in the Mountjoy Road.

The two geophysical survey methods were applied together to maximise their potential to identify and evaluate the archaeological character of the site. The electrical resistivity data was surveyed at Mountjoy using a 2m beam collecting six readings at each sample position which were then correlated into two separate datasets at two probe spacings: 0.5m and 1m. Resistivity is measured in ohm-meter (Ω-m) or the resistance of one meter cube of the material when a potential difference of one volt is applied.[2] So conductors such as copper have low resistivity whereas insulators, such as clay and stone, have high resistivity. Electrical resistance survey is especially useful for identifying buried stone walls and foundations, and cut features with higher resistance fills than the surrounding soils. It can also identify ditches and pits with more waterlogged soils, which have lower rates of electrical resistance. It requires direct contact with the ground and is a slower, with a consequently lower resolution, form of geophysical survey. Magnetometer survey identifies thermoremanent magnetized features such as kilns and hearths as well as in-filled ditches and pits. Soils and features become thermoremanent magnetized when they are heated to a very high temperature which facilitates distinctive, significant, changes in their magnetic signature. The majority of anomalies of archaeological potential identified using magnetometry tend to be associated with more subtle changes in the magnetic signature, such as in-filled ditches and pits magnetized as a consequence of the breakdown of organic matter.[3] It does not usually positively identify wall foundations, unless such foundations contrast magnetically with the surrounding soil, for example fired bricks but walls can leave negative magnetic signatures. Both techniques were applied over the possible location of the fort to best identify the stone and earthen elements expected of a substantial early modern military structure with associated domestic dwellings as well as any other features such as foundation trenches, enclosures and heaths or kilns.

[2] Clark, O. A. 1997, *Seeing beneath the soil* (New York), p 27.
[3] Aspinall, A., Gaffney, C., & Schmidt, A., 2009, *Magnetometry for* archaeologists, Alta Mira Press: Plymouth, pp 1–8.

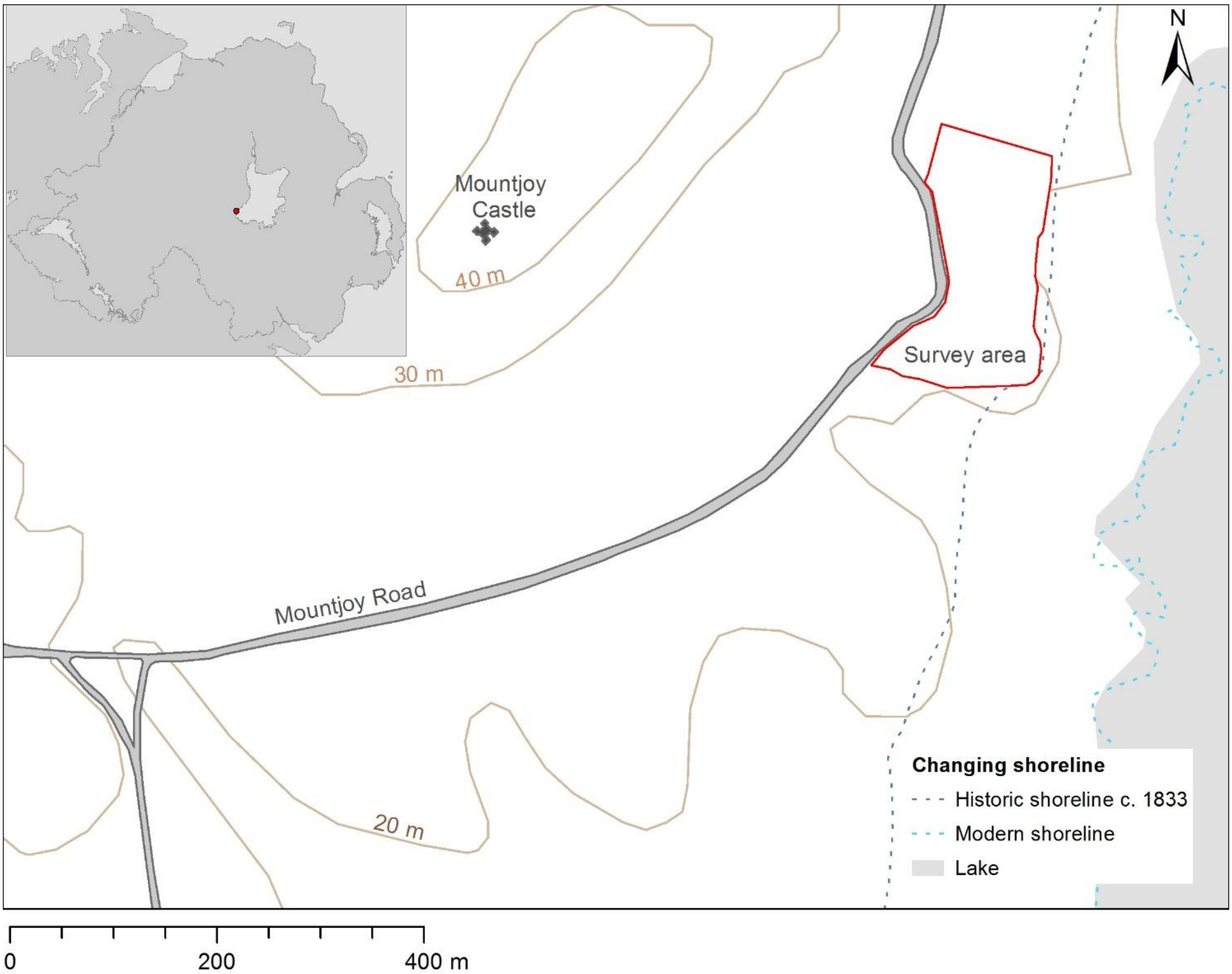

Figure 1 Location and landscape setting of the geophysical survey (marked in red).*

Historical & archaeological background

The early 17th-century military fortification at Magheralamfield was constructed as part of the Tudor military campaign to secure, then subjugate, Gaelic Ulster during the Nine Years War (1594 – 1603). The region had remained distinctly native and stubbornly autonomous to the Tudor State prior to this period. It was a prolonged and bloody struggle between members of the Ulster Gaelic elite, led by Hugh O'Neill, and representatives of the expanding Tudor state. Eventually culminating in the Gaelic defeat at Kinsale, 1601, ground battles occurred mainly in the territory of Ulster. Both sides used a tactic of secure fortifications to establish a protected position from which to launch attacks, with the Gaelic troops preferring guerrilla-style ambushes and skirmishes on venerable supply lines rather than open, staged battles. As well as its military role to secure hostile territories the Tudor campaign fort was also a tool to expand the colonial state through the acquisition of territory. Lord Mountjoy, after whom the fortification at Magheralamfield was named, was the Crown's representative in Ireland and architect of the Tudor military campaign. The campaign fort functioned as part of Mountjoy's wider political and military aims, which included the establishment of permanent garrisons within Ulster and the defeat of the Ulster Gaelic Lords.[4] Contemporaries, such as Fynes Moryson (1566 – 1603), often cited classical examples of the fortified garrisons as a military tactic in order to give weight to their employment by Mountjoy. Renaissance influences were evident particularly in respect of Machiavelli who advocated the use of fortified garrisons as colonial nuclei, especially in border conflict zones. [5] Lough Neagh, being an easily navigable body of water, granted easy access by Tudor military forces from the east of the province to the heart of mid-Ulster while also allowing them to disrupt communications between the Gaelic rebels, O'Neill in Tyrone and O'Donnell in Donegal. Land access was proving to be more difficult for the Crown forces as the Ulster landscape was water-logged with large expanses of wetlands and vegetation from which ambushes could be launched. O'Neill's forces were also au fait with the military use of fortification, the consequence of which is that the shoreline of Lough Neagh was studded with a mix of Gaelic and Tudor military installations. For example the Gaelic forces appear to have fortified the ruinous parish church at *Point Dromboe*, Ardboe, nine kilometres to the north-east, depicted under siege from Tudor rigged ship by Bartlett in 1603 (Figure 2).[6] The same map illustrates *Forte Mountioie*, Mountjoy Fort, further south along the shores of Lough Neagh occupying a modest promontory along the water's edge.

Figure 2 Extract from the Bartlett map of South Ulster (National Archives; Kew MPF 1/36)

[4] Hayes-McCoy, G.A., 1976, 'Tudor conquest and counter-reformation, 1571-1603'. In, T.W. Moody, F.X. martin & F.J. Byrne (eds), *A new history of Ireland: volume iii: Early Modern Ireland 1534-1691.* Oxford. p 129.
[5] McGurk, J., 2001, 'Terrain and conquest 1600-1603'. In P. Lenihan (ed.), *Conquest and resistance: war in seventeenth century Ireland.* Leiden. pp 96 - 100.
[6] Bartlett, R., *Map of the southern part of Ulster…* c. 1602-3 [National Archives: Kew, MPF 1/36]. See

This is the only fort named after Mountjoy to be found on the shores of Lough Neagh, often referred to as Lough Sydney by the Tudor administrators. The distinct ground plan is evident even at this scale but it can be fully appreciated in a detailed map produced by Bartlett in 1602 (Figure 3) presumably drawn shortly after its rapid completion.[7] North is marked to the top-left of the manuscript. The fort is shown with a large outer eight sided bawn projecting inland protecting an inner citadel on the lake shore and a lessor annex to the north. These three areas are interlinked to varying degrees with a further area to the very north that is part of the complex but from which the rest of the fortification cannot be reached. This combination of highly defended inner citadel, with an outer bawn protected by bastions was favoured by Mountjoy during his Ulster campaign.[8] The interior contains substantial slate and thatch buildings and more modest thatch structures. These were often distinguish by surveyors during the period as 'English' and 'Irish' -style dwellings, with the latter being the smaller more modest structures.[9]The English-style houses are characterized as substantial dwellings with slate and thatch roofs. Presumably the slate houses are also stone walled so that they can bear the heavier roofing load. Most of them, slated and thatched, have chimneys, often in the middle of the roof and on some occasions at the gable. They have multiple windows, and some are two storey. The thatch English-style dwellings have hip gables indicating the use of cruck, vertical load-bearing timbers, construction. These English-style dwellings are organised around courtyards with echoes of a rudimentary street system. The Irish-style dwellings differ notably. They are smaller sometimes with only a doorway and no widows. They have no chimneys and all are single storey. There is no evidence of gable suggesting they may be '*creats*'. These small circular or oval houses of interwoven rods or stakes were daubed with an amalgam of locally sourced earth or clay which could be rapidly built and disassembled. There is a lessor sense of planning in their arrangement.

The eight-sided outer bawn is protected by with three angled bastions mounted with guns to provide flanking fire, wet ditches and counter scarps. There is one gate to the south allowing direct access to the interior of the main bawn. The angled bastion increased the effectiveness of flanking fire, allowing effective deployment of military personnel. Evidently the focus for defence is landward with the threat from a naval attack less anticipated. Within this outer bawn (Area A see Figure 3) is a mixture of slate and thatched roofed 'English-style' housing. To the east is the citadel (Area B) built on the headland and raising above two ruined linear features on the lake shore which Hayes-McCoy identifies as possibly an earlier O'Neill fortification. It can only be entered from the bawn. It is defended by a wet ditch and counter scarp to the west positioned between the citadel and the outer bawn. A larger stone and slate structure situated to the centre of the inner citadel is two storey. The thatch buildings beside it have chimneys and hip gables suggesting they are built in the English vernacular style .To the immediate north of the bawn is another area (Area C) defended by wet ditch and counter scarp with only English style slate structures. It can be entered internally from the outer bawn and has a gate leading outside. The most northerly enclosure (Area D) does not appear to have a wet ditch defence on its outer limits but is instead separated by one from the rest of the complex. Nor does it have direct communications with the interior of the fort but rather there appears to fencing restricting access from it to the counter scarp. It contains only 'Irish-style' houses. The spatial arrangement of communication routes and house types within the compound strongly suggests that those inhabiting the most northerly annex were set apart from the rest of the complex possibly culturally as well as physically.

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[7] Hayes-McCoy, G.A. (ed.), 1964, *Ulster and other Irish maps c. 1600.* Dublin. pp 13-4.
[8] Ibid p 18.
[9] Robinson, P., 1979 'Vernacular housing in Ulster in the seventeenth century. *Ulster Folk life* **25**, pp 1-14.

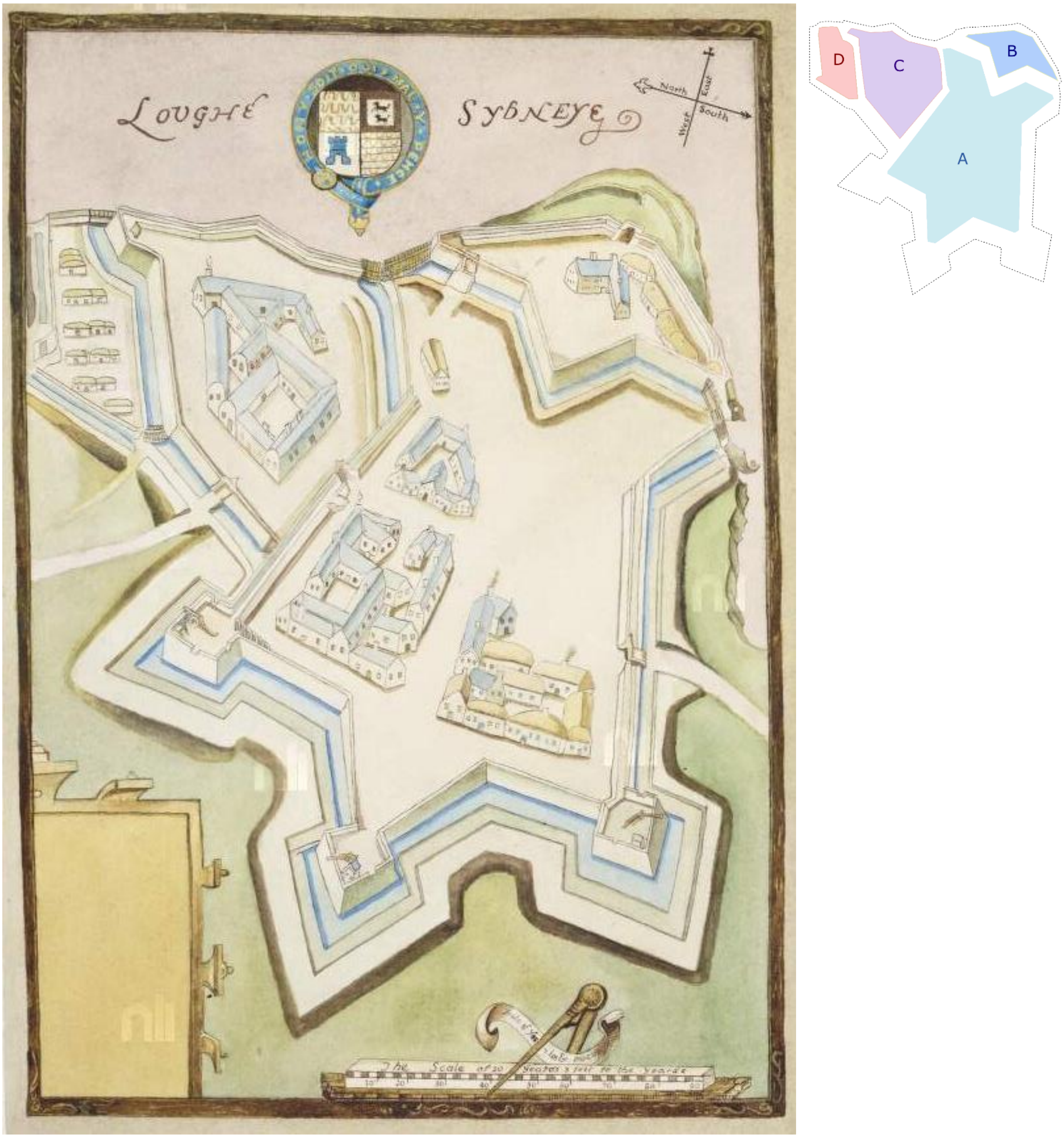

Figure 3 Mountjoy Fort, Lough Neagh as depicted by Bartlett, c. 1602. *Plan of Mountjoy Fort, Lough Sydneye* (National Library Ireland, Dublin MS 2656 (7)). Insert (top right) showing areas as referred to in the text.

The possible location of the fort has been discussed by a number of researchers.[10] It is widely understood that the fort was positioned between Mountjoy Castle and the shoreline on a small promontory in the general location recorded by the NISMR (Figure 4). Fee and Mayes have went further to suggest that the distinctive triangular form of the southern field in the survey area and the dogleg return along the route of the Mountjoy Road can be used to more closely locate the fort. Using the surviving field patterns, historic shoreline, topographic contours and the plan of the Mountjoy Road it is possible to georeference the Bartlett map more correctly using GIS software. Bearing in mind that the 17th century survey is a bird's-eye view of the fort, at roughly a scale of 1:625, but without the metric controls of modern surveying techniques. The georeference map (Figure 5) has a significantly larger scale then that recorded by Bartlett, with 10 yards (9.14m) as marked by latter measuring 15 yards (13.7m) once georeferenced. This would give the complex overall dimensions of 354m (NW – SE) from the outside edge of the wet ditch on the most westerly bastion to the shoreline of the headland and 296m (N – S) from where the outer bawn meets the shoreline to the northern limit of the most northerly annex. It is doubtable that Bartlett would have made such a significant error when recording the fortifications. His map of Mountjoy was the only one of his Ulster maps to record the scale bar in yards as opposed to paces or ratios.[11] The georeferenced map is at best an approximation of where the fort should be (Figure 5) but it clearly identifies the two fields surveyed for this project as key targets for geophysical survey. An evaluation geophysical survey was carried out by Alexander over a portion of the southern field in 2011. It identified linear features which were interpreted as the ramparts of the fort. This correlates with the information gathered by the larger survey upon which this report focusses. However the earlier geophysical data was not integrated into GIS and as such important information about the nature of the archaeological features, and their relationship to the historical manuscripts, remained unexplored.

[10] Alexander, S. [2011] 'Locating the Lost Fort of Mountjoy and a Study of Mountjoy Castle, Magheralamfield, Co. Tyrone.' [Unpublished] Undergraduate thesis submitted to the School of Archaeology and Palaeoecology, Queen's University of Belfast: Fee, A. and Mayes, F. (2010) "Mountjoy Fort and Mountjoy Castle," The Bell: Journal of the Stewartstown and District Local Historical Society No. 12, pp 18-32; (2012) "Mountjoy Fort and Mountjoy Castle, County Tyrone", Ulster Journal of Archaeology (Third Series) Vol. 71 (2012), pp 118-129.

[11] Andrews, J. H. (2008) *The Queen's Last Map-Maker: Richard Bartlett in Ireland, 1600 – 3.* Geography Publications: Dublin.

Figure 4 Main landscape features used to georeference the Bartlett map: contours, historic shoreline, Mountjoy Road and field patterns. Location of fort (TYR 047:020) identified by NISMR marked in yellow.

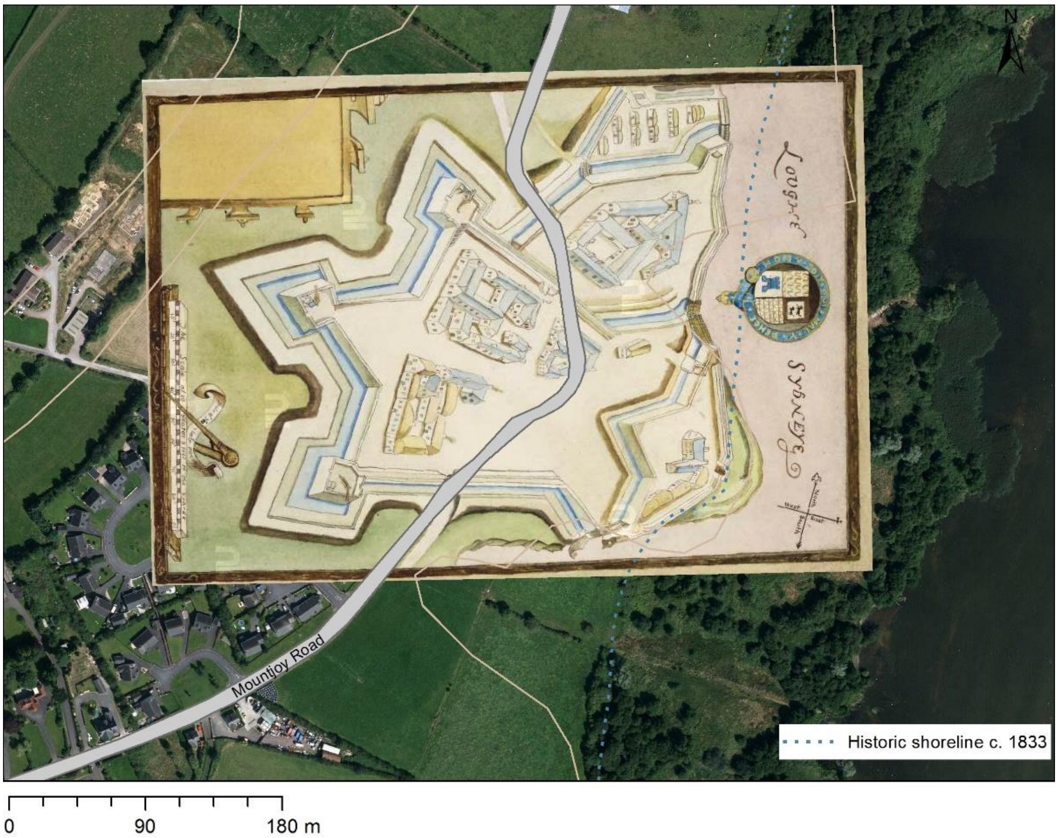

Figure 5 The georeference Bartlett map. Image was moved into place but not warped or interpolated.

Description and interpretation of anomalies

In general the geophysical data was poor. With the magnetic survey providing the best evidence of archaeological potential although it suffered from high contrast and magnetic noise (Figure 11). This is probably partly due to the geology, the presence of ferrous material in the field boundaries and a large concentration in the farm buildings to the south. The main magnetic anomaly (m_1) is a pronounced negative linear but some of the others (m_5) were more subtle. The bedrock geology is clay overlay with a superficial geology mix of clay, silt and sand changing to Glacial sand and gravel as you move back from the shoreline. The site is dominated by two soil types stagnosol over the southernmost third of the southern field and the rest of the area is cambisol. The former is typified by stagnating surface water in relatively flat, temperate conditions whereas the latter is more aggregated with a higher content of weatherable minerals and better drained. The stagnosol soils may result in a leaching of the mineral content of the soils which reduce the magnetic contrast between archaeological deposits and the surrounding soil matrix. The combination of the various geological elements, magnetic interference, clay bedrock and the low contrast character of archaeological features, do not create the best conditions for magnetic survey.

The electrical resistivity survey results were poor. What useable information could be gathered helped to aid the interpretation of the magnetic dataset but could not be interpreted easily independently. The dataset is dominated by high readings (mean 106/99 Ohm for 1m/0.5m probe spacings respectively) probably the consequence of April 2017 being one of the driest in four decades.

Table 1 Description and interpretation of magnetic anomalies (Figure 6).

MAGNETIC ANOMALIES		
CODE	**DESCRIPTION**	**INTERPRETATION**
m_1	Inverted Y-shaped negative (mean -6.83 nT, min -36 nT) linear mapped in the northern half of the southernmost field that makes up the survey area. The strongest returns from the most northerly arm of the anomaly running NE to SW for a distance of *c.* 41m. Abutting its southern limit running perpendicular is a v-shaped linear. Its path can be mapped running SE to NW for *c.* 62m before turning 90 degrees CCW towards the SW, for *c.* 34m, it changes direction again, 45 degrees CW, for a distance of *c.* 29m. The magnetic signature is concentred towards at the apex of the V-shape with the strength of the magnetic readings weakening towards the southern limits. It has a fairly consistence wide of *c.* 3.5m. There is a possible break in the south-eastern arm. The negative readings are defined, along the northern arm, by a halo of positive returns (m_2). It correlates with the position of r_1, r_6 and r_8.	The plan of m_1 strongly indicates that it is related to the defensive ramparts of the early 17th-century Mountjoy Fort. Superficially the linear plan with angled returns echoes that of the angled bastions recorded by Bartlett. The magnetic returns which compose the angled linear m_1 are negative. Some of the lower readings deviate by five Std Dev from the mean. Further m_1 has an irregular halo of positive readings (m_2), notably along the northern arm and on the external face of the angled returns. While the negative anomalies m_3 and m_5 also appears to be related to the fortifying process. The negative responses are generally understood to result from less magnetic material in this case possibly the remnants of bank material now ploughed out.
m_2	Positive halo of returns (mean 11.67 nT) which wraps m_1 and m_5 Traceable as discrete patches for a distance of *c.* 120m along the northern face of m_1, *c.* 12m along the western face of m_5 and for a distance of *c.* 40m between m_1 and m_3..	Possible in-filled ditch material relating to the fortifications.
m_3	Negative L-shaped anomaly nestled within, and to the south of, m-1. It appears to run parallel to m_1 at a distance of *c.* 3.5m. Traceable for a distance of *c.* 37 m, max width *c.* 4m. The returns from this feature are more subtle (mean -3.5 nT) then m_1. It appears to partially overlay r_2 a higher resistance anomaly.	Possible bank material associated with the fortifications.

m_4	Negative (mean -3 nT) linear recorded in the southern third of the northerly field. Mapped for an overall distance of *c.* 126m moving NW to SE for *c.* 74m before turning 45 degrees CCW towards the NEE. Width ranges from 3m to 4m. The signals that comprise m_4 are uneven although the path of a feature can be discerned especially in trace diagrams. Does not appear to correlate with any resistance readings.	May be bank material perhaps related to the 17th-century fortification. Appears to lay outside the area of the Bartlett map once it is georeferenced using the geophysical anomalies m_1, m_2, m_3 & m_5 and r_1.
m_5	Negative (mean -0.9 nT) linear anomaly to the west of the south-westerly limit of m_1 in the western third of the northern survey area. The signatures are very subtle and best identified using a trace diagram. Appears to correlate with the position of r_7 a higher resistance linear anomaly.	May be bank material related to the fortification.
m_6	Large dipolar anomaly to the middle of the northern field. Measuring *c.* 8.6m W – E, by 8m N – S.	Possible buried ferrous object? Does not have the plan expected of a kiln or furnace. Not sinuous enough to be a lightning strike.
m_7.	Extensive area of high magnetic readings with negative halo. Occurs along the southern edge of the southern field. To the south is a series of galvanised steel out housing associated with a modern farm.	Modern magnetic contamination.
m_8a & m_8b	Two subtle negative linear anomalies positioned to the east of m_1 in the northern quarter of the south field, running NE – SW. the northern linear (m_8a) can be traced for a distance of *c.* 21m. The southern signature (m_8b) for *c.* 19m.	Possible relict bank material – does not appear to conform in form with any banks mapped by Bartlett.
m_9	Subtle linear anomaly comprised of slightly negative and positive returns. Can be mapped running roughly E – W along the southern limit of the most southerly field for a distance of *c.* 64m.	Does not appear to correlate with any objects from the historical mapping or aerial imagery. Does not appear to conform in form with anything mapped by Bartlett.
m_10	Subtle negative linear anomaly identified in the northern half of the north field. Running E – W it can be traced for a distance of *c.* 56m.	Unknown linear – may be anthropogenic or possible edge of geological feature. .

	It appears to correspond with the position of r_5.	
m_11	Straight linear anomaly comprised of dipolar response occurring in the southern quarter of the northern portion of the survey. Traceable for a distance of *c.* 34 m running WNW to ESE. Aligns with an isolated tree and the path of r_9. Appears to converge on the path of m_12. Follows the path of a field boundary recorded on the 3rd Edition County Series Ordnance Survey map, *c.* 1906.	Early 20th-century field boundary.
m_12	Straight linear anomaly comprised of dipolar response occurring in the southern quarter of the northern portion of the survey to the east of m_11. Traceable for a distance of *c.* 29 m running SW to NE. Appears to converge on the path of m_12. Runs roughly 5m north and parallel to a land boundary recorded on the 2nd Edition County Series Ordnance Survey map, *c.* 1853.	Late 19th-century field boundary.

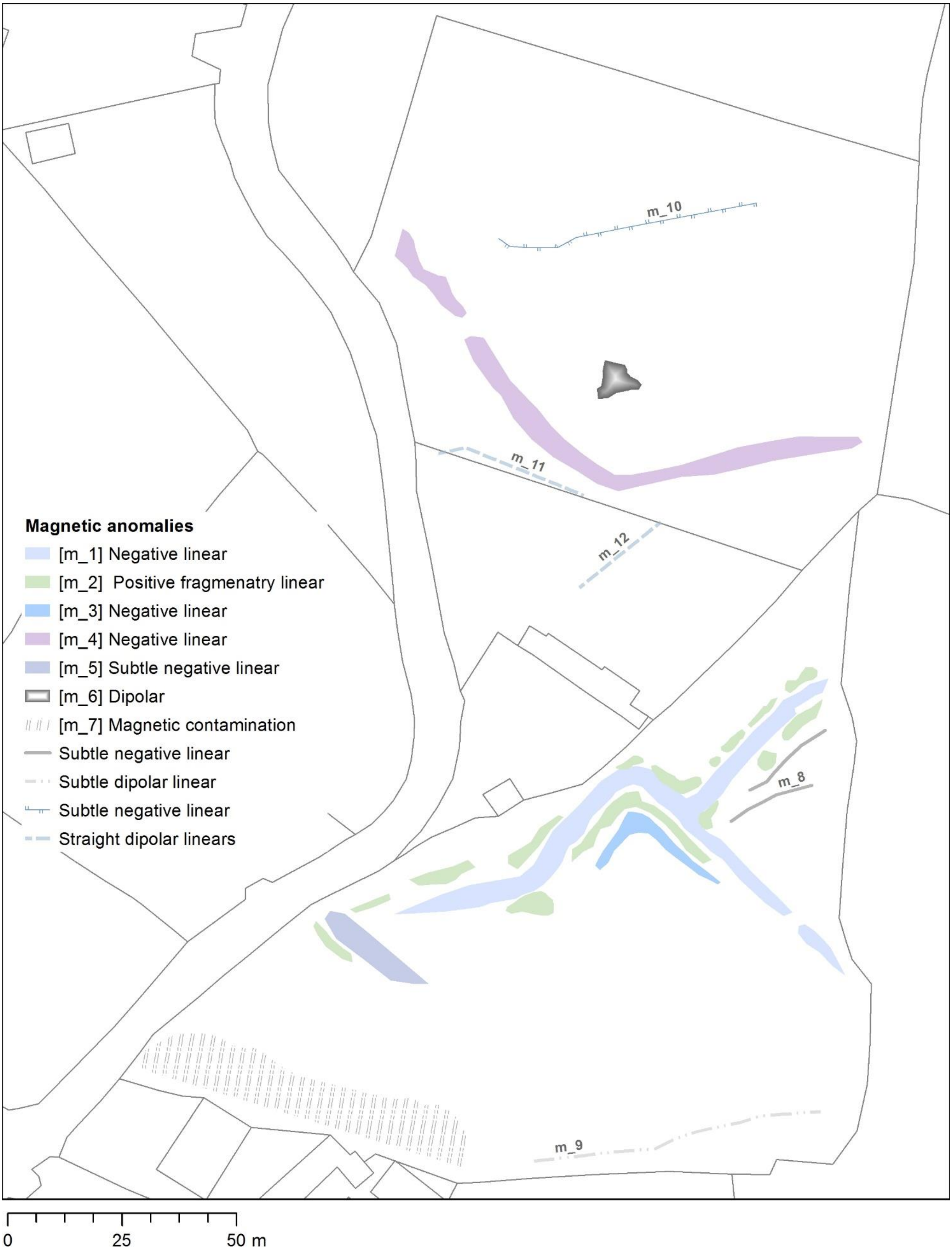

Figure 6 Diagram of magnetic anomalies identified.

Table 2 Description and interpretation of electrical resistance anomalies (Figure 7).

ELECTRICAL RESISTANCE ANOMALIES		
CODE	**DESCRIPTION**	**INTERPRETATION**
r_1	Subtle (mean 64 Ohm-m, min 49 Ohm-m, max 84 Ohm-m) linear mapped in the northern half of the southernmost field that makes up the survey area. The strongest returns from the most northerly arm of the anomaly running NE to SW for a distance of *c.* 41m. It has the same form as the northern portion of m_1. It has a fairly consistence wide of *c.* 4m. The subtle linear r_6 appears to follow the path of the south-eastern arm of m_1. The anomaly appears as having a slightly higher resistance then the surrounding readings although it is actually lower than the mean average for the dataset. The dataset in general is dominated by very high readings in the northern field which are probably geological in nature. It is better appreciated on the 1m probe spacing data. Suggesting if may be more deeply buried.	Corresponds with the position of m_1. Suggesting that the feature has a slightly different compaction then the surrounding soil matrix – probably more compact.
r_2	Subtle, L-shaped higher resistance return about 3m south of r_1. Can be traced for a distance of 10m SE to NW before turning 90 degrees CCW to run for a distance of 22m towards the SW. Appears to respect the path of r_1 with its northern portion correlating with the western section of m_3.	Could be a false anomaly created by the interpolation process – it becomes more apparent during processing. It overlays portions of m_3 and m_2 which we would be expecting to behave in different ways in our resistance data. The negative magnetic anomaly m_3 is expected to be bank material and therefore compact higher resistance. The positive anomaly m_2 is expected to be ditch material and could be either filled with a higher resistance fill or a more conductive water-logged fill.
r_3	Higher resistance (mean average 140 Ohm-m) linear with an acute angled return to the south west of r_1. Anomaly is traceable for a distance of 28m SE to NW before turning sharply through towards the SE for a shorter distance of *c.* 10m.	Possible compact material interpreted by its position relative to m_1 as the compact fill of a ditch. No presence of a magnetic signature suggested that in-filling was relatively quick with little time for silting and associated microbial activity.

	Appears to respect the path of m_1 and m_5 running parallel and to the east of them.	
r_4	High resistance (154 Ohm-m) anomaly situated to the west of r_3. Has a triangular plan with an acute angle to the west. Overall dimensions of 16m E – W and 13m N – S.	An area of high resistance. From what we understand of these military fortifications we would expect a series of angled, linear banks and ditches. The position of r_4 at the western arm of the magnetic anomaly m_1 would suggest it is part of the same linear feature. However it appears to intersect m_1 and does not have a clear magnetic signature. Could this be an episode of rebuilding or reinforcing the acutely angled feature associated with the anomalies m_3, r_3, the western portion of m_1 and r_4. An acutely angled bank may require a different construction technique then a simple linear bank to prevent slippage and slumping, or repair it this does occur.
r_5	Irregular high resistance linear towards the north of the northernmost section of the survey area. Running roughly E – W for a distance of 57m. Roughly correlates with m_10.	Unknown – may be anthropogenic or possible edge of geological feature.
r_6	Subtle higher resistance linear which appears to from the SE extension of r_1.The anomaly is traceable running SE to NW for a distance of *c.* 26m. Appears to correlate with the SE arm of m_1.	Indicates that the lower magnetic, possible bank material, identified as m_1 is also more compact. The higher resistance anomaly, r_6, appears to occur along the northern limit of this section of m_1. Could this be evidence of construction techniques, such as revetting the exterior of the bank to prevent slippage?
r_7	Subtle higher resistance linear to the SW of r_1 and W of r_2. The anomaly is traceable for a distance of 16m running NE to SW. Appears to run along the northern edge of m_1.	Occurs in a similar situation to r_6 above. Could this be a similar situation – revetting a bank against slippage?
r_8	Low resistance linear running roughly E to W in the southern quarter of the northern survey area. Traceable for a distance of *c.* 36m. Correlates with the position of m_11.	Early 20th-century field boundary – waterlogged fill of a ditch.

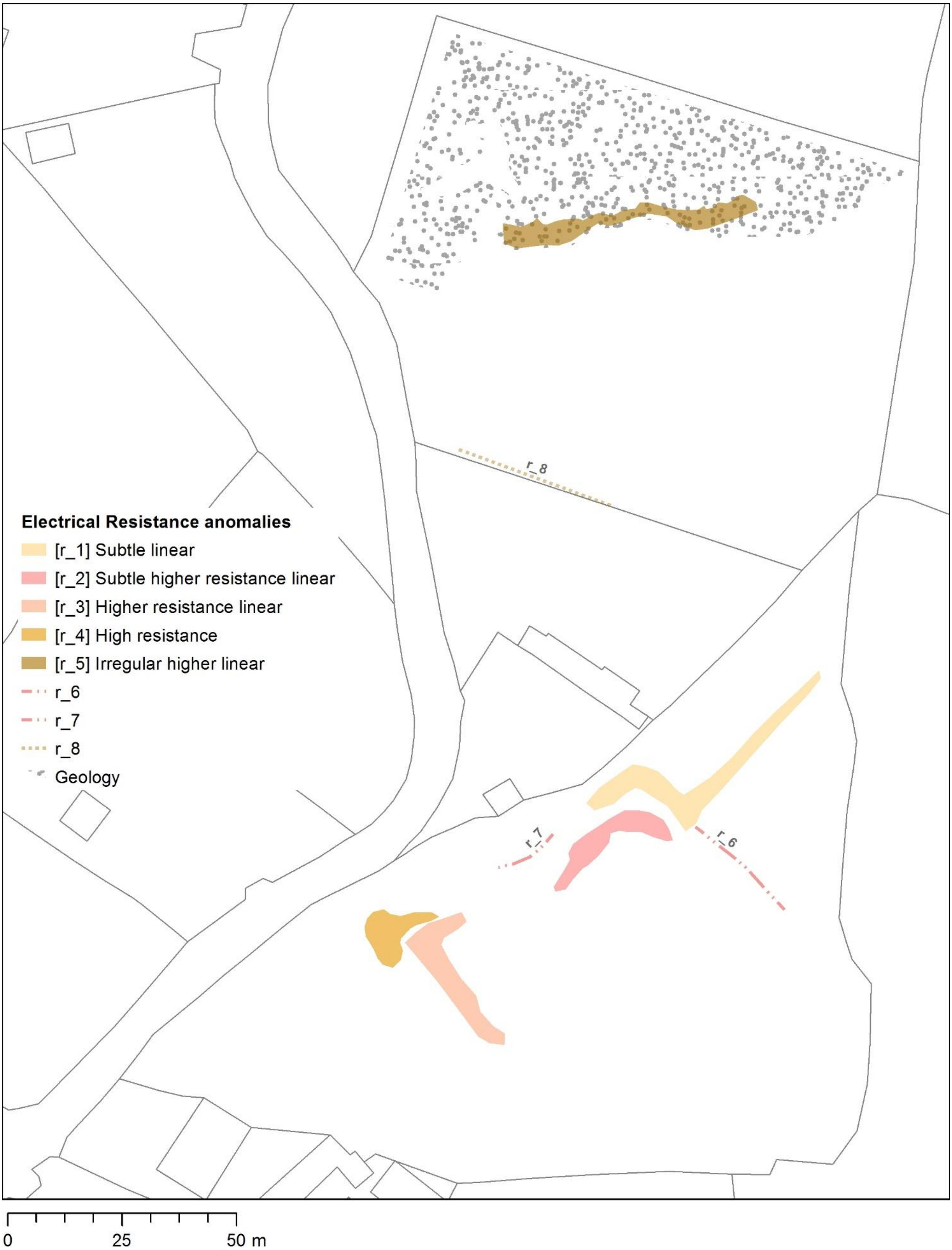

Figure 7 Diagram of earth resistivity anomalies.

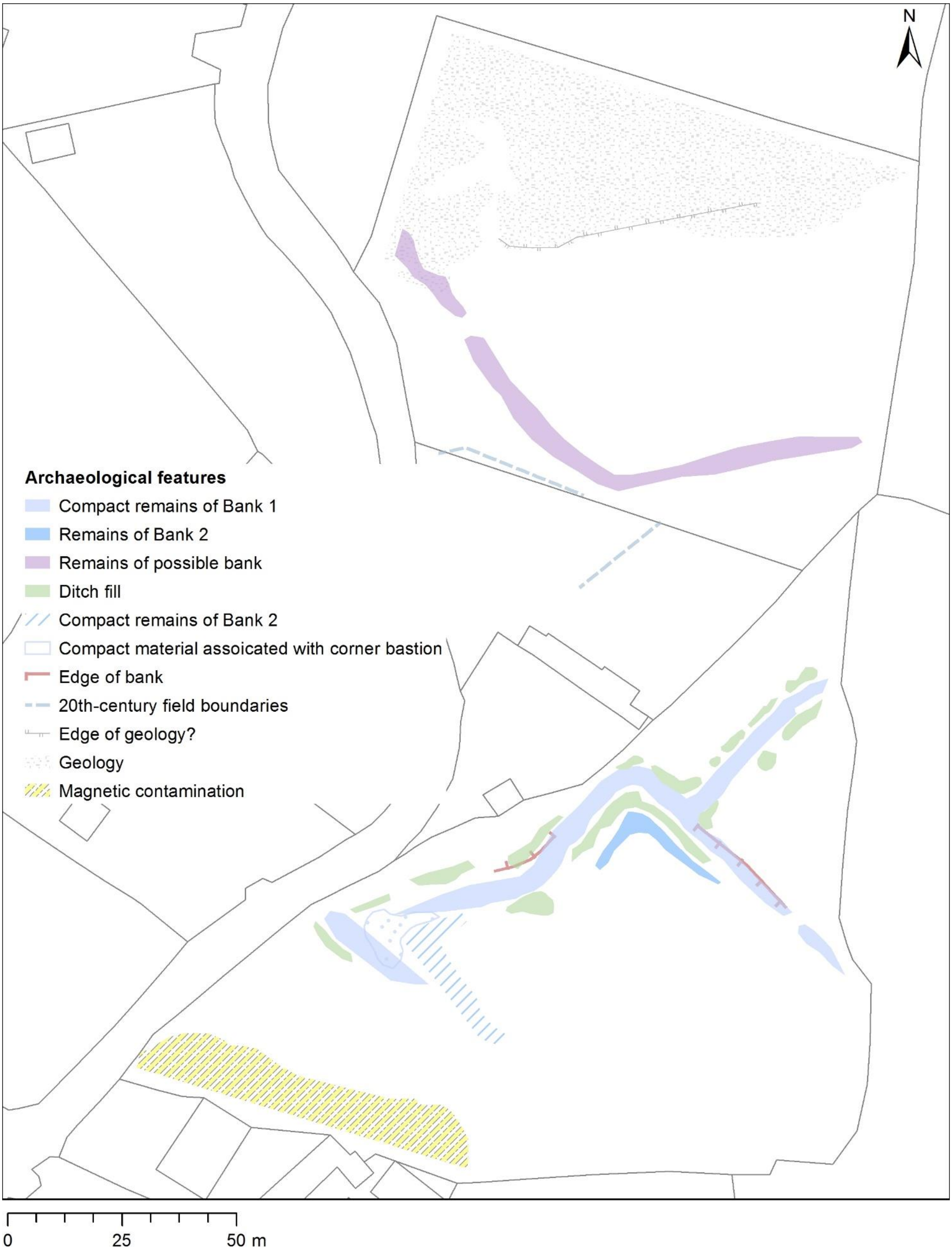

Figure 8 Diagram of interpreted anomalies for both magnetic gradiometer and electrical resistance survey data.

Discussion

The geophysical survey data captured at Brockagh indicates the presence of linear earthworks with angled returns. However the plan represented by these anomalies does not match that recorded by Bartlett – or at the very least is removed from his interpretation. Two possible banks are identified by the negative magnetic anomalies (m_1, m_3 and m_5 see Figure 8 & Figure 9). Bank 1 is represented by an alignment of m_5 and m_1 which produces a plan with two angular returns. An acute return (55°) to the west (Bastion A) can be interpolated from the position of m_5 and the western limits of m_1. Bank 1 continues east where it forms a more obtuse angle (108° Bastion B) before the bank branches into two at a 90° angle with one arm heading NE and the other SE. This feature is clearly defined at its easternmost limits by the negative magnetic anomaly m_1. This type of magnetic signal is usually associated with wall footings or bank material. The interpretation is supported by the resistivity data. The earth resistivity anomalies r_1, r_4, r_6 and r_7 which occur along the path of Bank 1 suggest that this negative magnetic feature also has higher resistance characteristics, more than likely a compact fill. The linear features r_6 & r_7 may be evidence of the sod rampart which encased the soil core of Bank 1, reinforcing it and preventing slippage. The second bank, Bank 2, lies within and to the south of Bank 1. It is associated with the negative magnetic anomaly m_3. Its path can only be identified magnetically at the more oblique eastern return, where it has an angle of 96°. The second banks presence is alluded to at the western acute return by the higher resistance anomaly r_3 which indicates that it is similar fabric as Bank 1 – compact soil. The area to the exterior of Bank 1 and between it and Bank 2 is comprised of series of higher magnetic linear features which indicate the presence of ditches. Although fragmentary in nature the subtle changes in the soils magnetic signature is characteristic of the subtle changes which occur as a consequence of the breakdown of organic matter.

It is evident that the earthworks identified by the geophysical survey do not easily correlate with those recorded by Bartlett. Suggesting that Bartlett's plan was an aspiration rendering of a more erratic reality. A similar conclusion was reached in the wake of the excavations at Inisloughlin, Co Antrim[12] which identified defensive features securely dated to the early 17th century. However the morphology, construction and orientation of these features appear to differ significantly to those mapped by Bartlett. An electrical resistivity survey of the site identified targets for excavation,[13] including a low resistance linear anomaly which it transpired was an early 17th-century ditch enclosing the Gaelic fort, but did not capture the full plan of the fortification. At the time the geophysical data could not be easily reconciled with the historical sources. Further the excavation data was not integrated into geospatial software which may have aided the interpretation of the spatial information more fully. In hindsight the plan of the fortification may be more complex than that speculated by the excavator, although even this does not readily map onto Bartlett's survey.

In an attempt to reconcile the Bartlett map of Mountjoy Fort and the geophysical anomalies it is suggested that the outer ditch recorded by m_2 correlates with the wet ditch mapped by Bartlett (Figure 9). This would mean that the earthwork identified as Bank 1 corresponds with the eight sided rampart that makes up the core of the fortification, with the northernmost annex positioned (Area D see Figure 3) to the north and

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[12] Macdonald, P., McHugh, R., Mussen, S., and Brown, D.M. (2012) 'Archaeological excavation at Inisloughlin, County Antrim: Identifying the Gaelic Fort of 'Enishlanghen' in *UJA*, **71**, pp 88 – 117.
[13] McHugh, R. [2008] 'Inisloughlin Fort'. [Unpublished report]. CAF Geophysical Report XVI.

beyond this. The geophysical surveys identified two angular returns which may be the two north-westerly bastions (Bastion A and B) mapped by Bartlett. If this is correct then they would not appear to be as regularly planned as Bartlett depicted. There is a break in the south eastern arm of m1 which may correspond with the position of a gate between areas C and A. However Bartlett does not record an inner ditch nor is there a second bank (m_3). If the Bartlett map is nudged into place using the anomalies identified by the geophysical survey north remains correctly orientated with the scale improving. So that 90 yards as marked by Bartlett roughly correlates with 90 yards as now measured on the ground. Georeferencing the map in this way raises further questions. It would appear that half of the fortification, as mapped by Bartlett, falls over the edge of the historic shoreline. It is unlikely that the water levels of Lough Neagh rose significantly between the 1600s and the 1830s, only to recede again shortly thereafter. The historic shoreline can be traced topographically by a sharp drop around the 17m contour mark. It is more likely that the fort illustrated by Bartlett was very different than the one constructed by Mountjoy. It was smaller in scale and executed in a less orderly manner. After all these documents were generated to keep the English authorities across the Irish Chanel informed of the progress of the war and the safety of their investment. Evidently the geophysical survey has identified anomalies which conform in plan and physical characteristics of those we would expect from an early 17th-century earthwork fortification. However they do not appear, initially at least, to resemble those mapped by Bartlett.

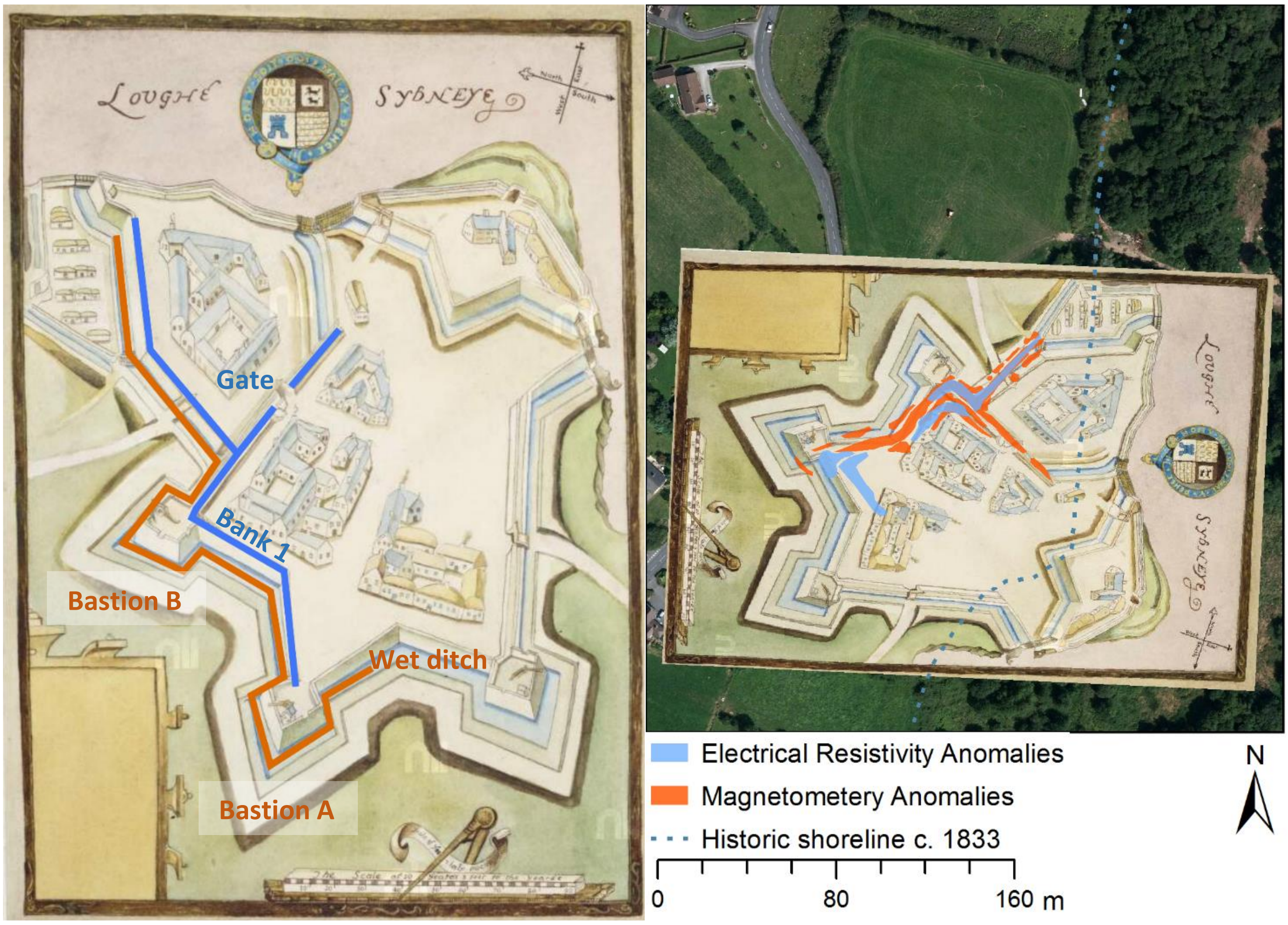

Figure 9 (Left) Geophysical anomalies reconciled with Bartlett's depiction of Mountjoy Fort. (Right) Bartlett's map georeferenced using the anomalies identified by the geophysical survey.

Recommendations

1. A micro-topography of the survey area would greatly aid the interpretation of the geophysical data. This could easily be captured using UVA flown SfM photogrammetry when vegetation is low. However given the heavy growth of foliage along the relict shoreline, and the importance of this feature for the interpretation of the site, a discrete Terrestrial Laser Scan survey might be more beneficial.

Acknowledgements

Thank-you to Grace McAlister & Ruth Logue, Centre for Archaeological Fieldwork, Queen's University Belfast, who carried out the fieldwork for this survey. Thank-you also to Liam Campbell, Lough Neagh Landscape Partnership, for his support throughout the project.

Appendix one: Georeferenced geophysical survey grid

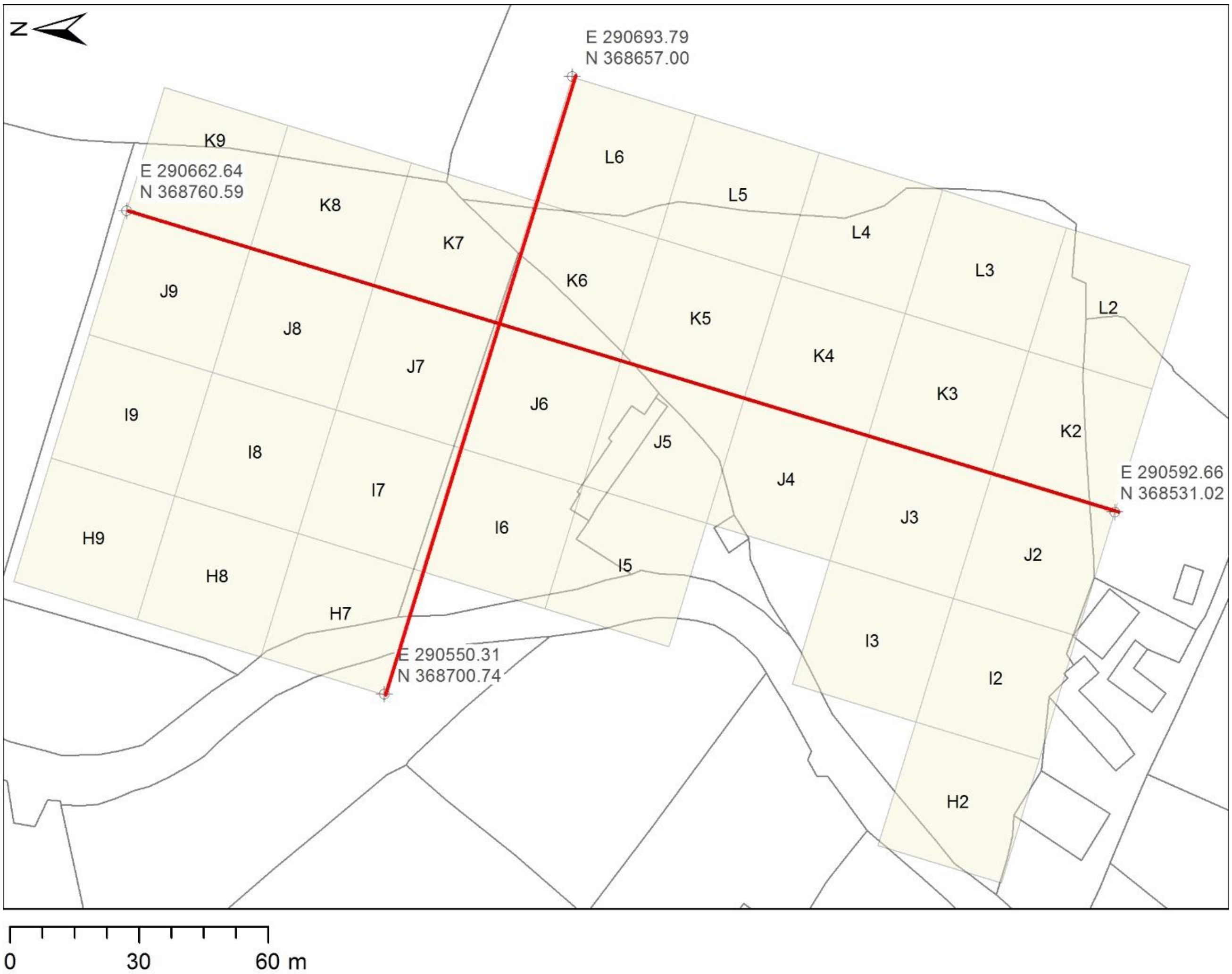

Figure 10 Irish National Grid coordinates for geophysical survey grid (30m x 30m) baselines. *

Appendix two: Raw geophysical survey plots

Magnetic Gradiometery Data

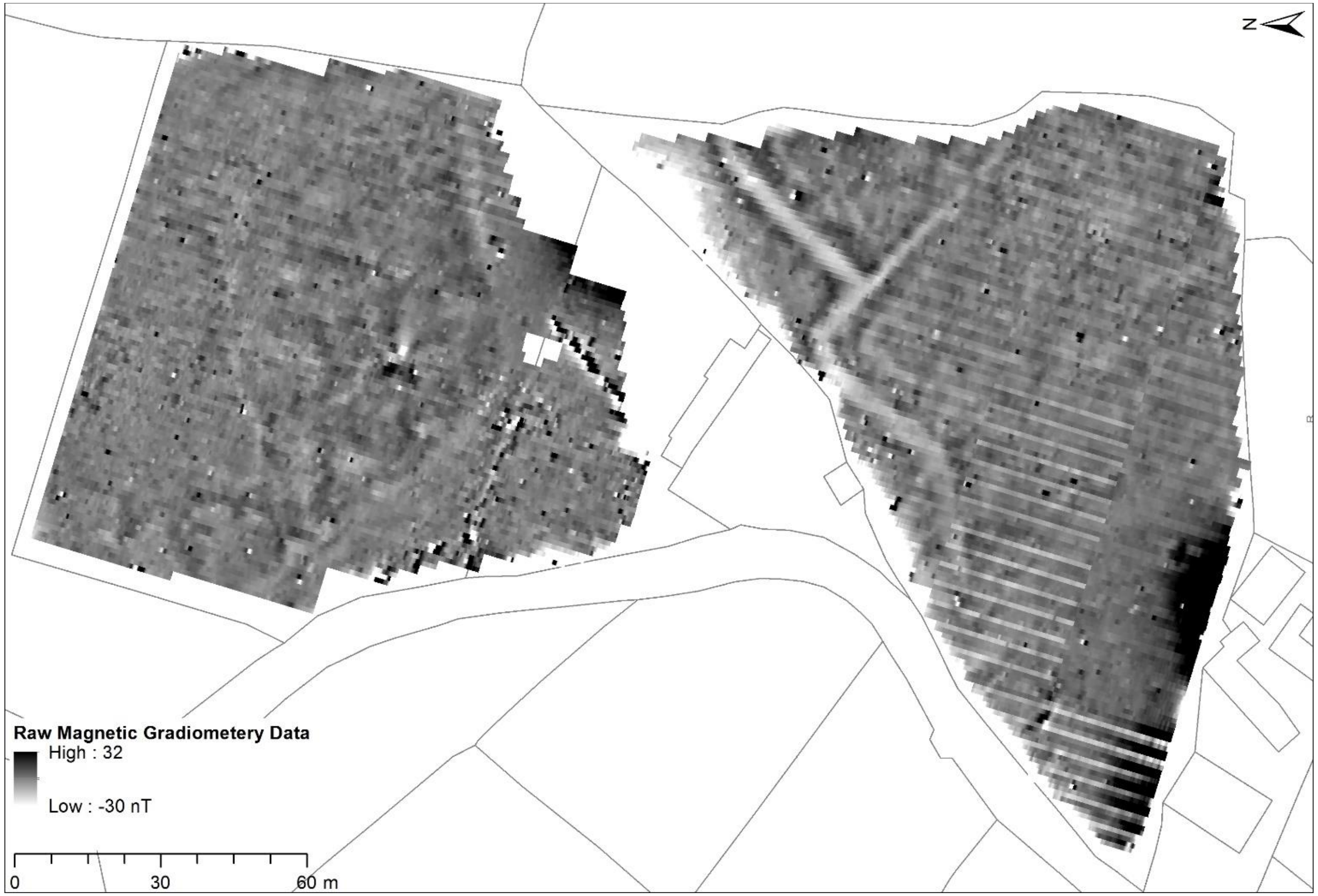

Figure 11 Greyscale plot of raw magnetic data. Clipped to +/- 2 Std. Dev. Statistics: Mean: 1 nT, Std Dev.: 15 nT.*

Electrical Resistance Data

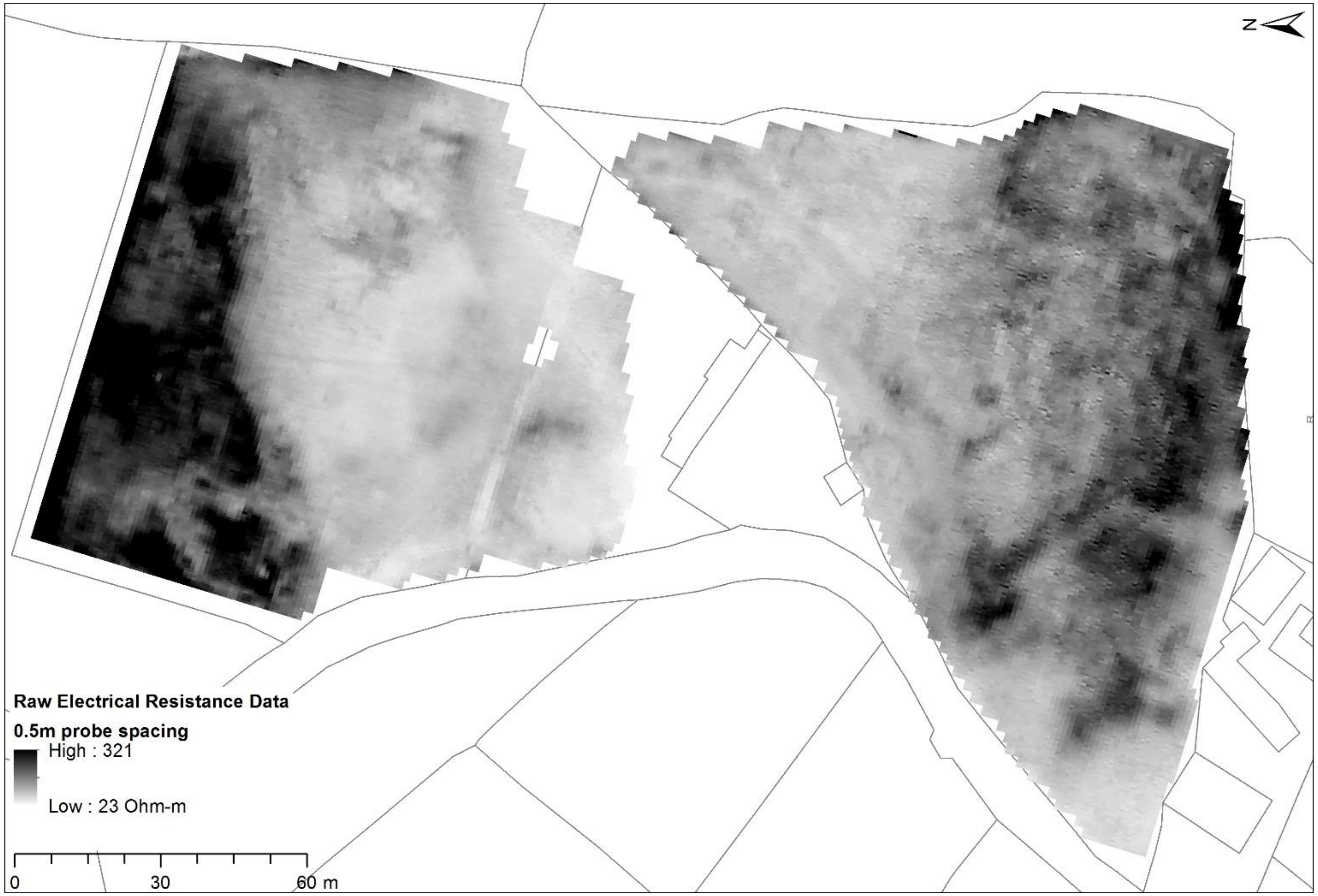

Figure 12 Greyscale plot of raw resistivity data gathered with 0.5m probe spacing. Data despiked and converted from resistance readings (Ω) to resistivity (Ω-m). Statistics: Mean: 99 Ω-m, Std Dev.: 47.*

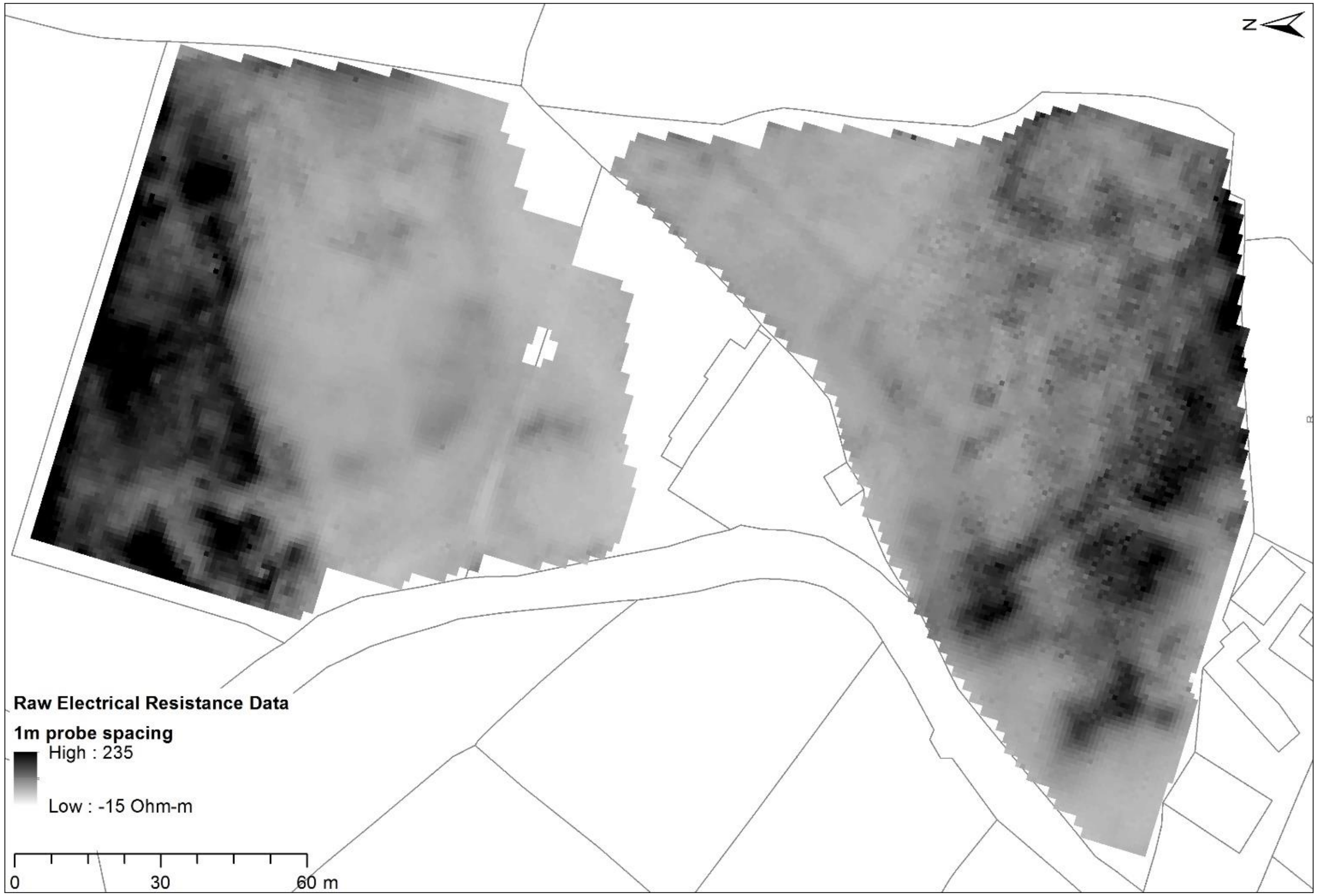

Figure 13 Greyscale plot of raw resistivity data gathered with 1m probe spacing.* Despiked and converted from resistance readings (Ω) to resistivity (Ω-m). Statistics: Mean: 106 Ω-m, Std Dev.: 49.*

Appendix three: Processed geophysical survey plots

Magnetic Gradiometery Data

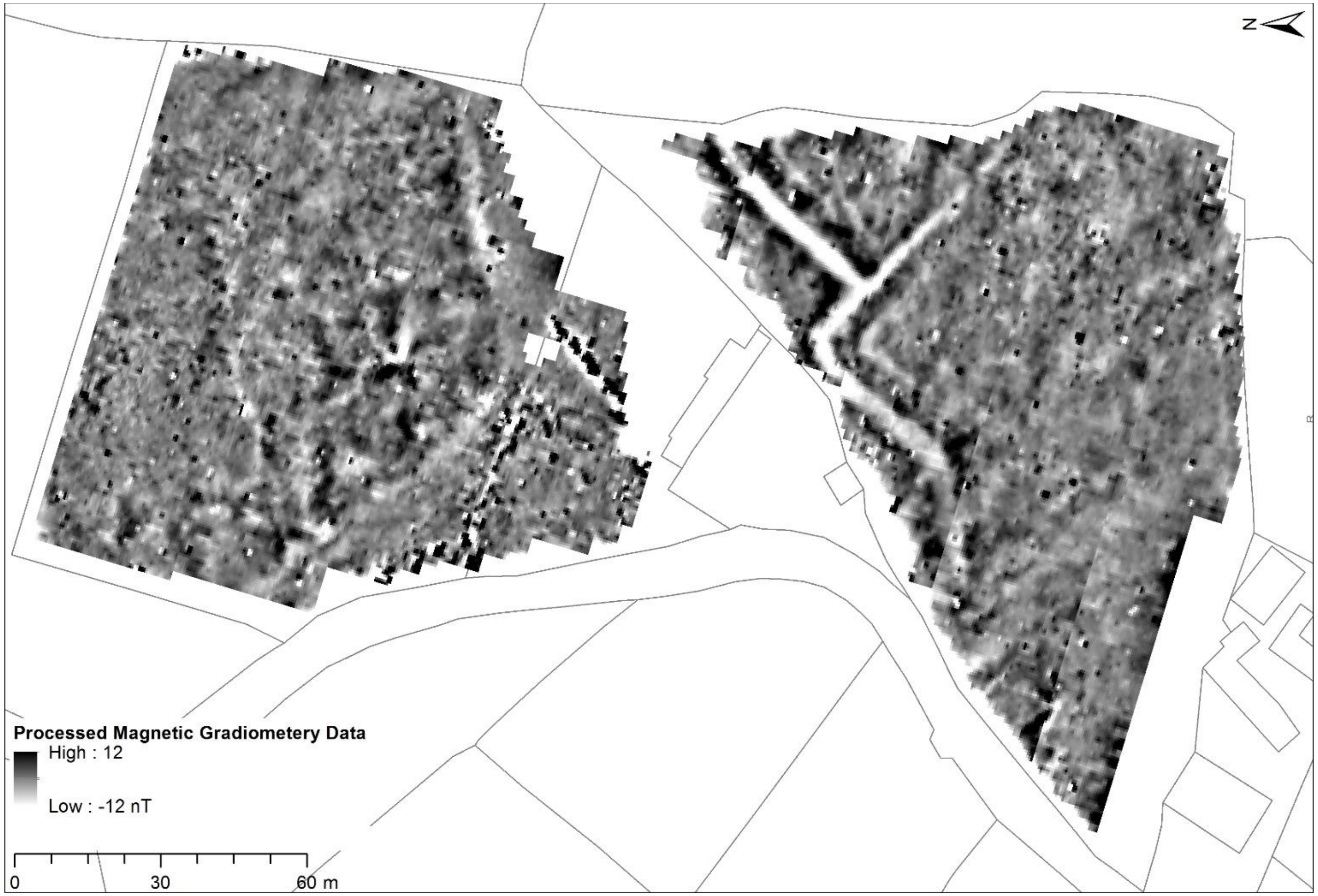

Figure 14 Greyscale plot of processed magnetic data. ZMT applied and despiked. Statistics: Mean: 0 nT, Std Dev: 5.88.*

Electrical Resistance Data

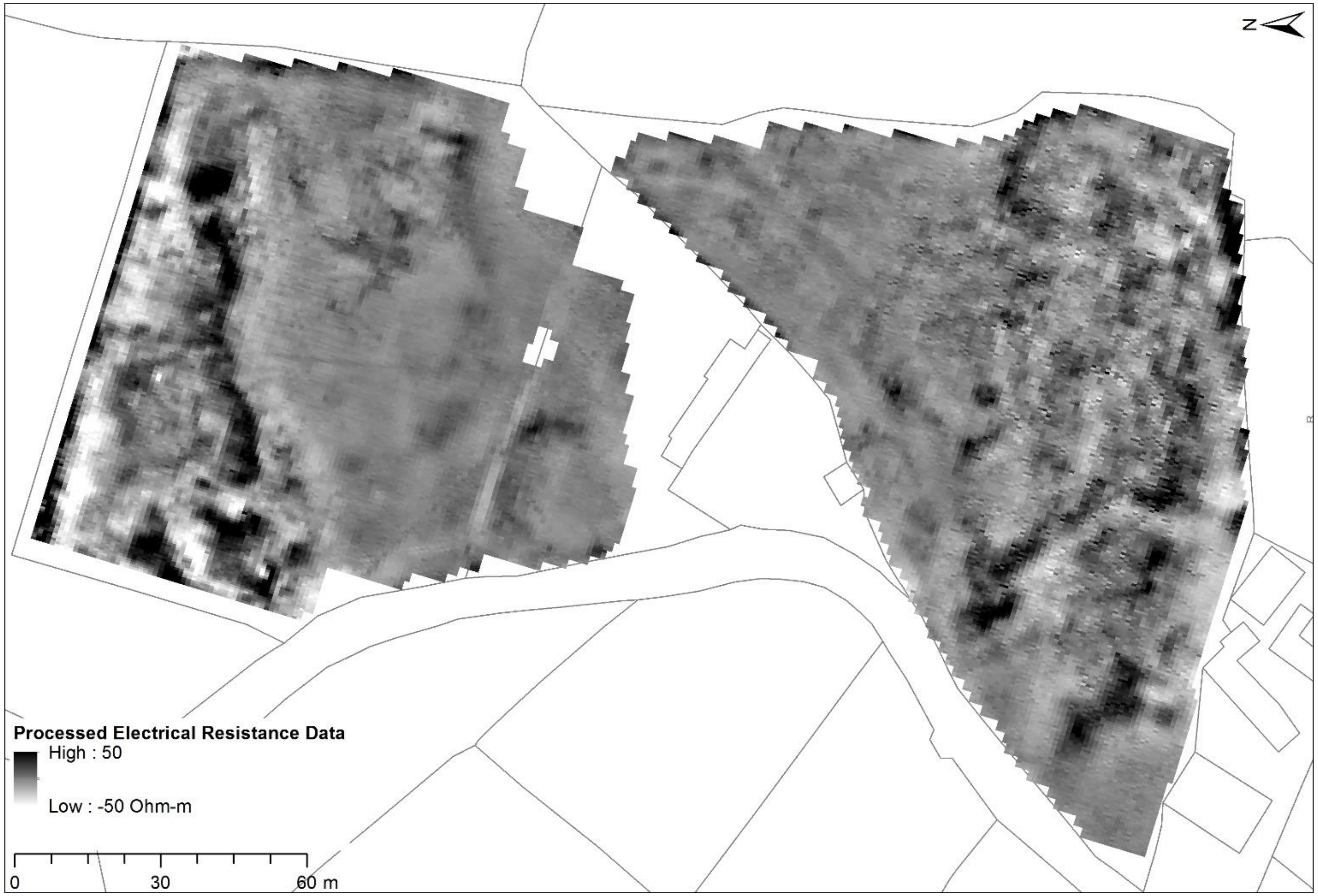

Figure 15 Greyscale plot of processed electrical resistance data gathered with 0.5m probe spacing. HPF (Uniform weighting applied on the x- and y-axis). Statistics: Mean: -0.75 Ω-m, Std Dev: 16.72.*

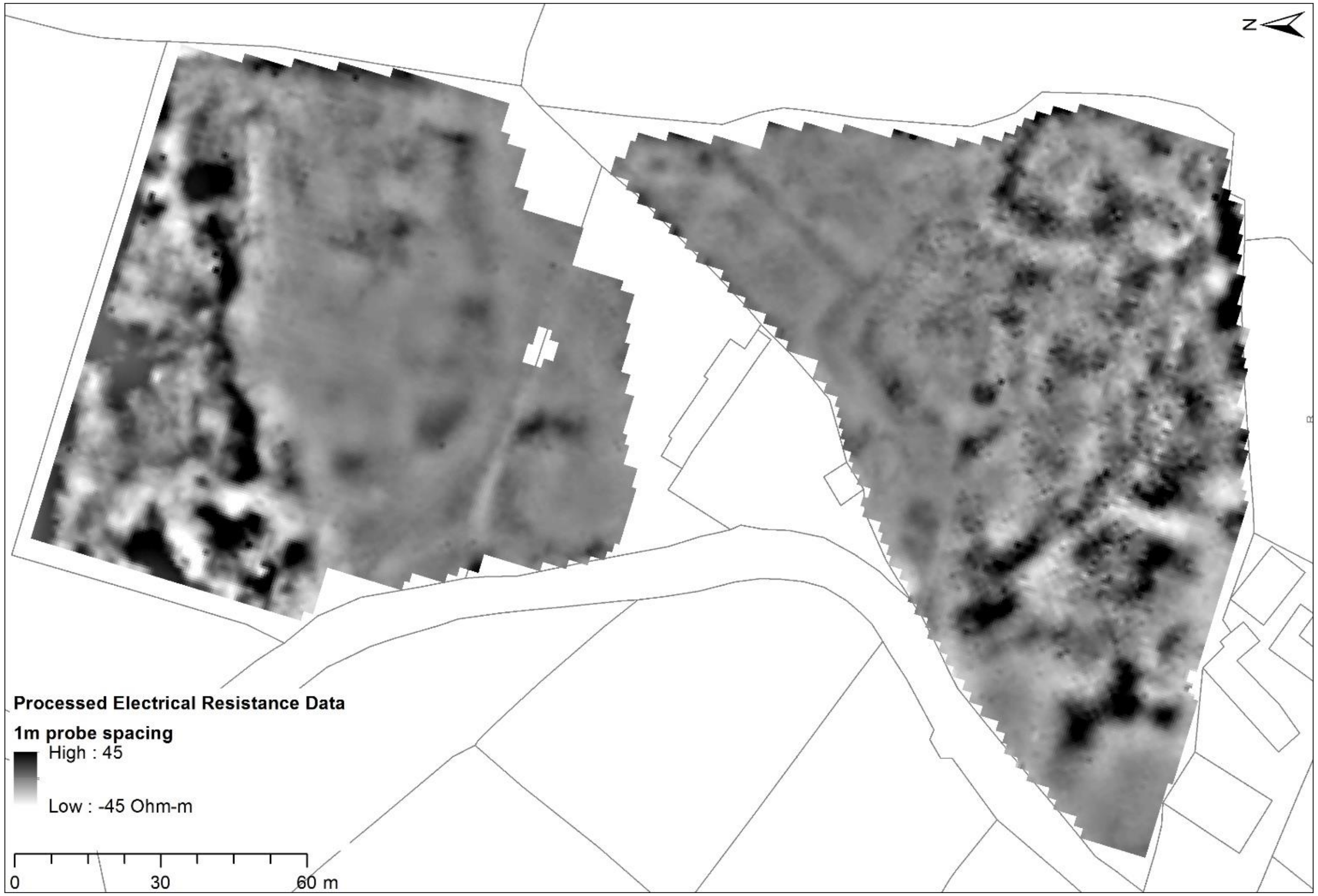

Figure 16 Greyscale plot of processed electrical resistance data sampled with 1m probe spacing. HPF (Uniform weighting applied on the x- and y-axis), and sin(x)/x interpolation on x- and y-axis. Statistics: Mean: -0.22 Ω-m, Std Dev: 14.51.*

Appendix four: Historical mapping

Figure 17 Survey area as depicted by the First Edition Ordnance Survey County Series map, *c.* 1833.*

Figure 18 Survey area as depicted by the Second Edition Ordnance Survey County Series map, *c.* 1853*

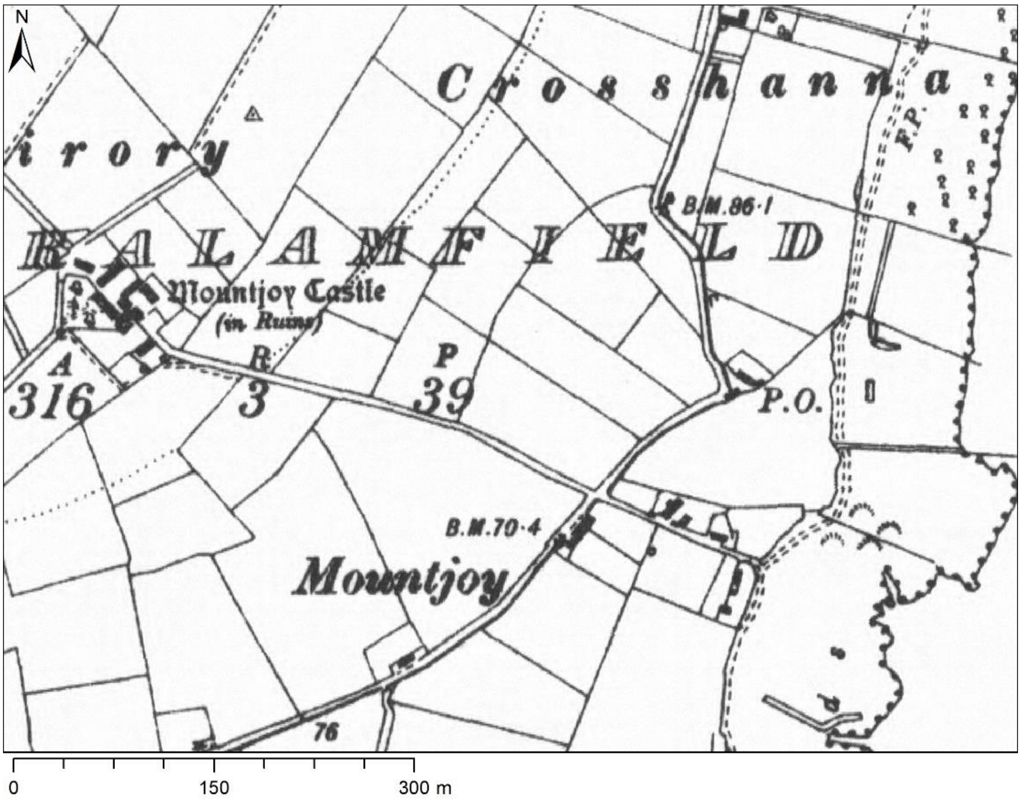

Figure 19 Survey area as depicted by the Third Edition Ordnance Survey County Series map, *c.* 1906.*

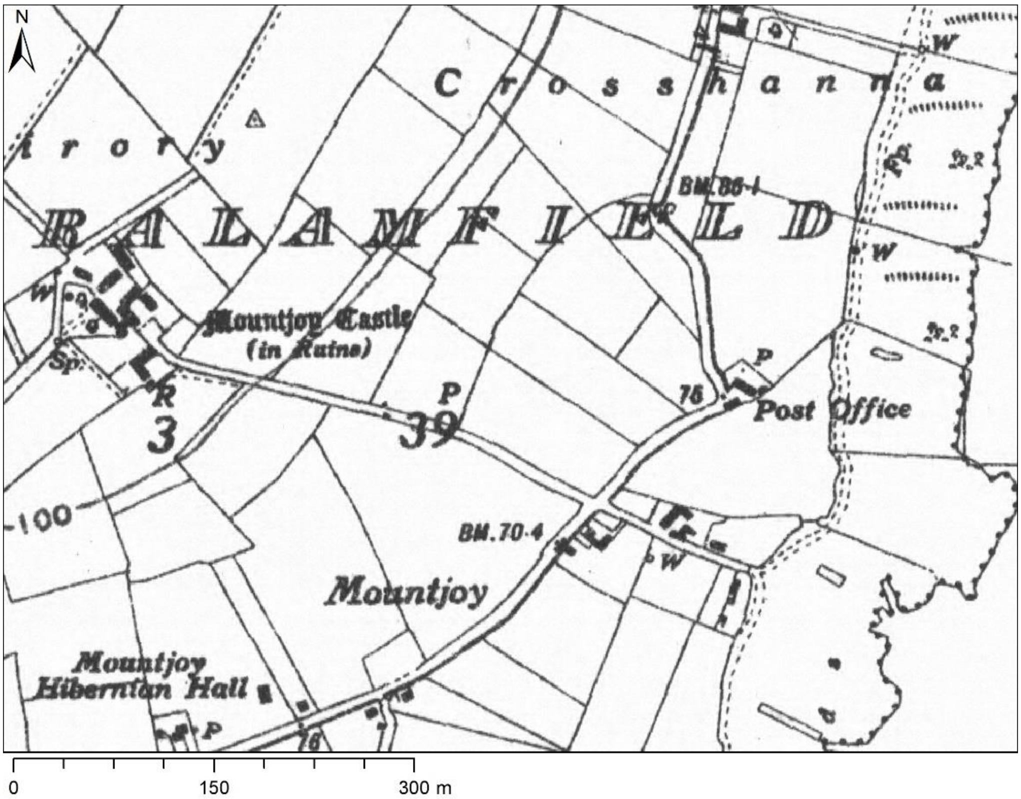

Figure 20 Survey area as depicted by the Fourth Edition Ordnance Survey County Series map, *c.* 1935.*

Appendix five: Aerial imagery

Figure 21 The survey area as captured by 2006 ortho-rectified aerial photography.*

Figure 22 The survey area as captured by 2010 ortho-rectified aerial photography.*

Figure 23 The survey area as captured by 2014 ortho-rectified aerial photography.*