Geophysical Surveys at Drumburgh, Cumbria 2021

Report by Alex Turner

Extract from a Johann Blaeu map of Cumberland, 1645

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Introduction

As part of the Hadrian's Wall Community Archaeology Project, a fluxgate gradiometer survey was undertaken over three days 7th to 9th April 2021. Due to the restrictions caused by the Covid19 pandemic, the surveys were undertaken by Alex Turner rather than by volunteers.

Location

The site is located within the village of Drumburgh, between the villages of Glasson, 1.5 kilometres to the west and Easton, 1.5 kilometres to the east (Figure 1). The nearest major settlement is Carlisle 17 kilometres to the east. Part of the survey area lies within the area of the Roman fort and subsequent medieval enclosure. The site is centred on Ordnance Survey grid reference NY 26430 59900.

The survey area was laid to pasture and divided by a series of hedge rows that divided the survey area into 3 main sections. Metal gates, wire along the field boundaries and feeding troughs were problematic for

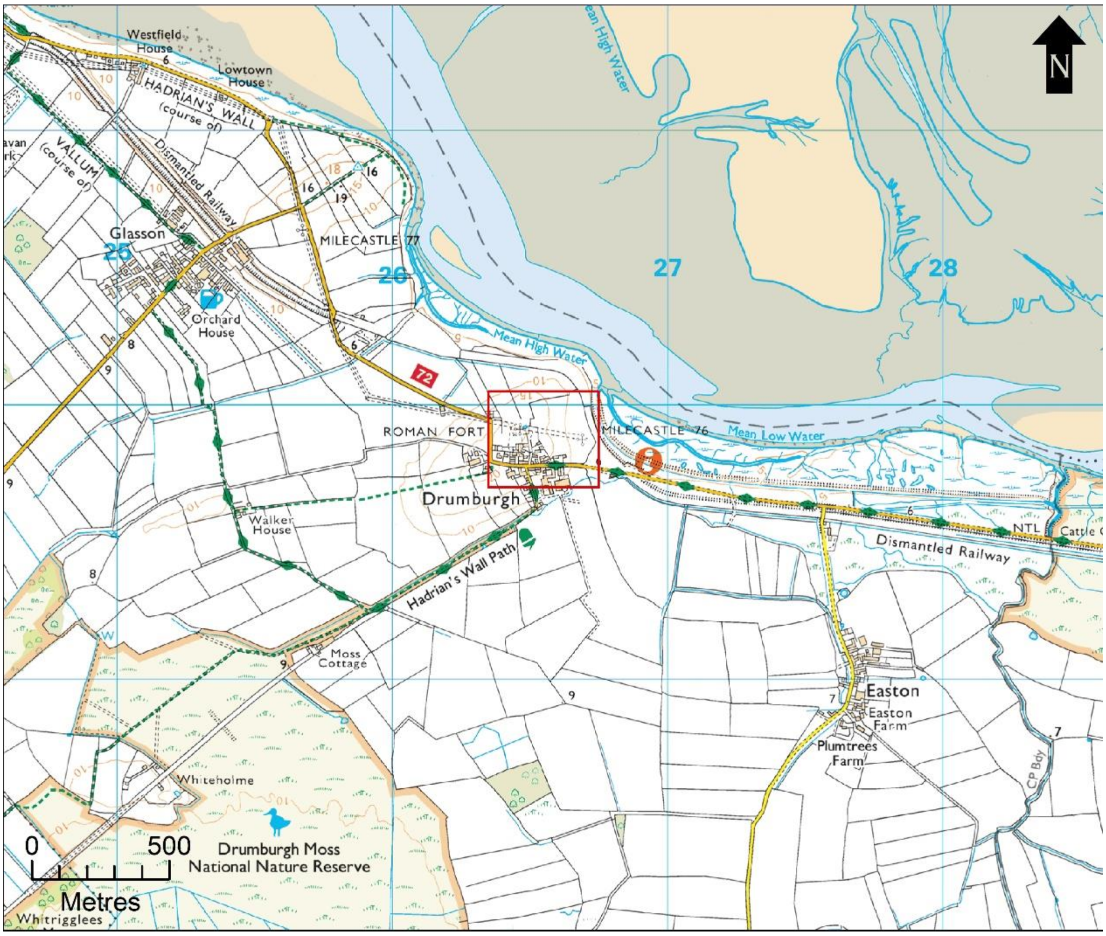

Figure 1 - Location of Drumburgh. The area of interest lies within the red rectangle.

gradiometer survey. Due to Drumburgh's position on a raised knoll the ground conditions remained dry during the survey. The only area that wasn't surveyed due to waterlogging was the northern edge of the medieval grange ditch. The overhanging trees in this area also precluded any survey in this area (Figure 2).

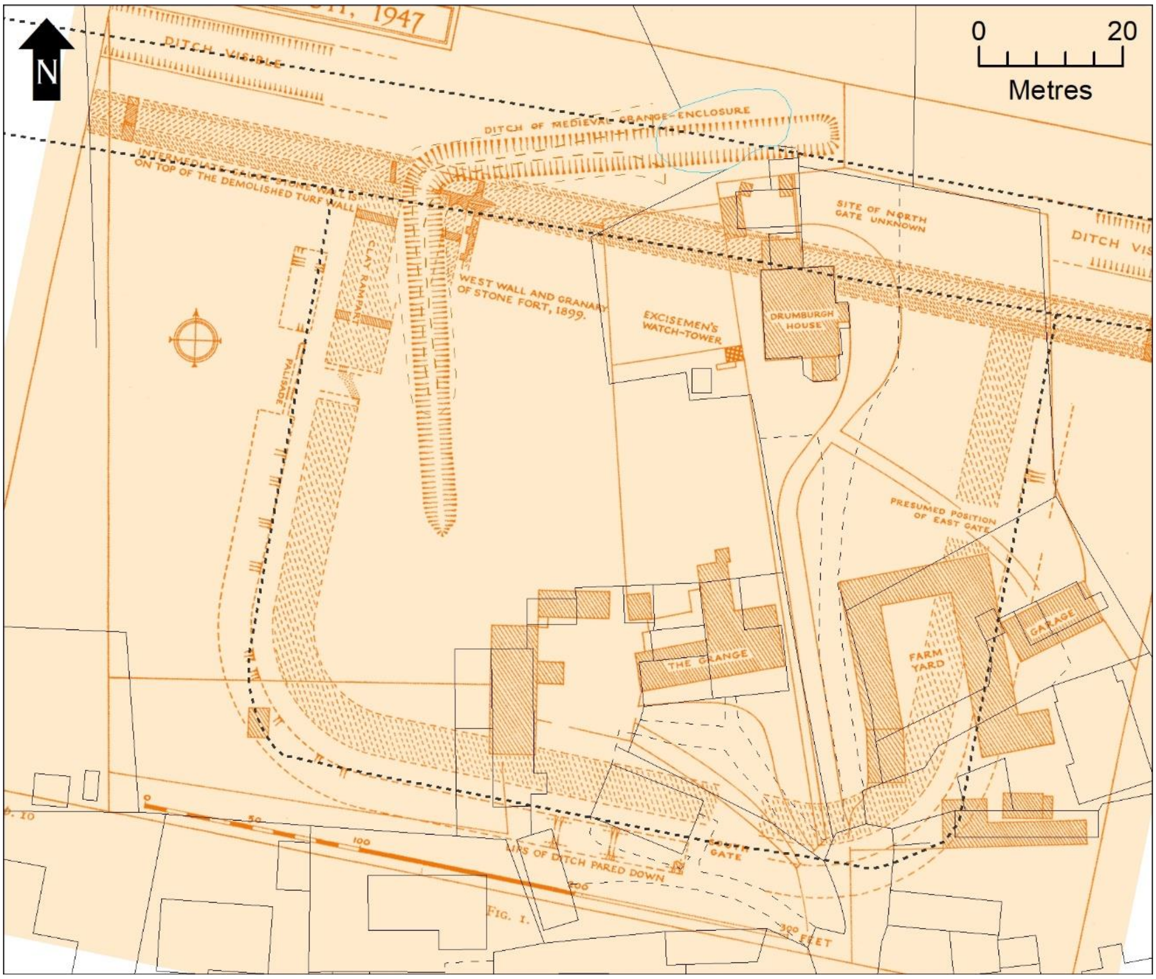

Figure 2 – Richmond's 1947 plan of Drumburgh overlain by modern Mastermap polyline data

Topography and Geology

Topography

Examination of the Lidar data shows that Drumburgh lies on a distinctive knoll raising it above the surrounding low-lying landscape (Figures 3 and 4). The southern part of the survey area was largely flat but dropped away significantly to the north and east. In the survey area to the east of Drumburgh House the change in slope was 8.5 metres from west to east and two metres from south to north. In the fields to the west of Drumburgh House the slope in the areas to the south of the enclosure ditch is two metres from south to north but beyond the ditch to the northern end of the field the slope greatly increases and is in excess of 10 metres. The enclosure ditch has a maximum depth of 1.5 metres on the eastern side and presented a challenge for consistent survey with a gradiometer. In addition, the central field undulated considerably due to the survival of medieval ridge and furrow (Figure 5).

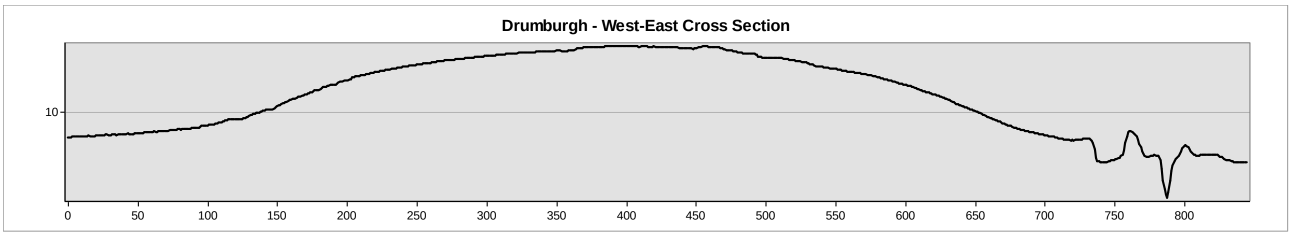

Figure 3 - West-East profile derived from the Lidar data. Z axis is logarithmic for greater clarity

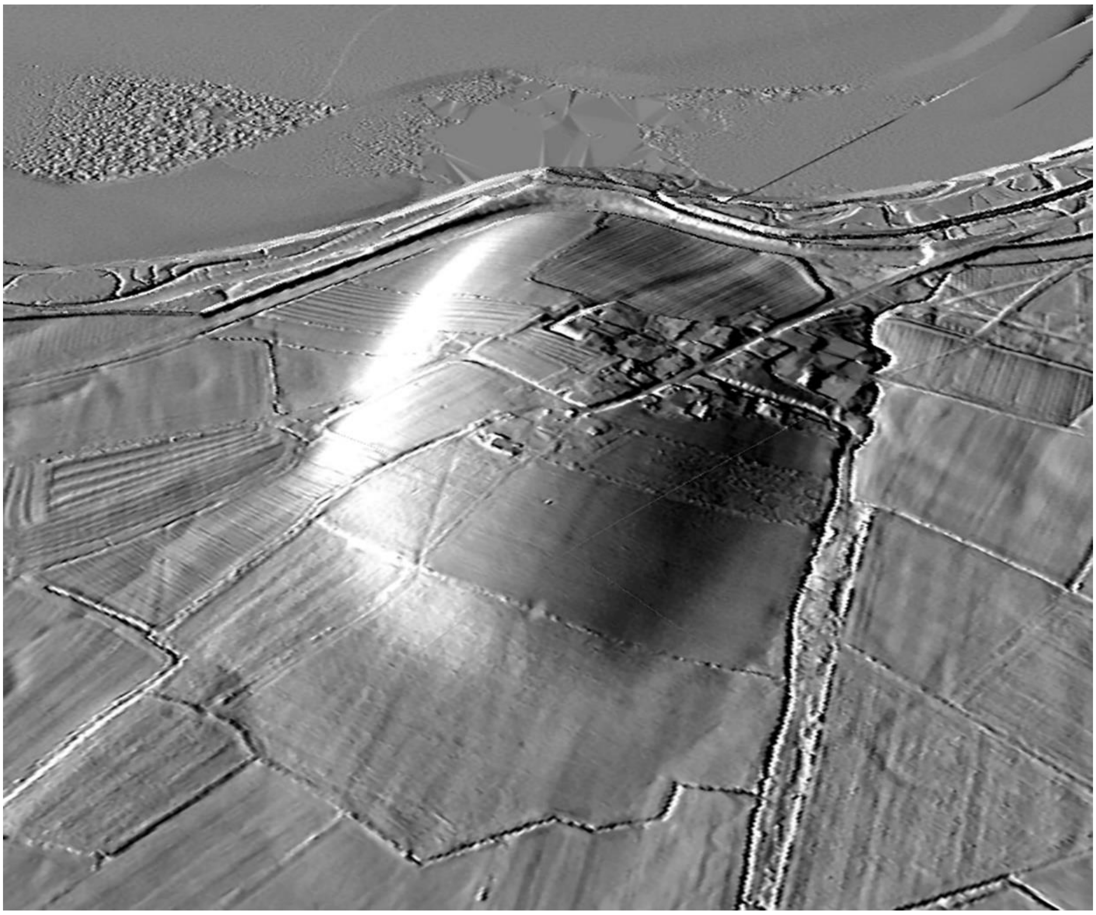

Figure 4 – 3D image of Lidar data show Drumburgh's location at the top of a knoll.

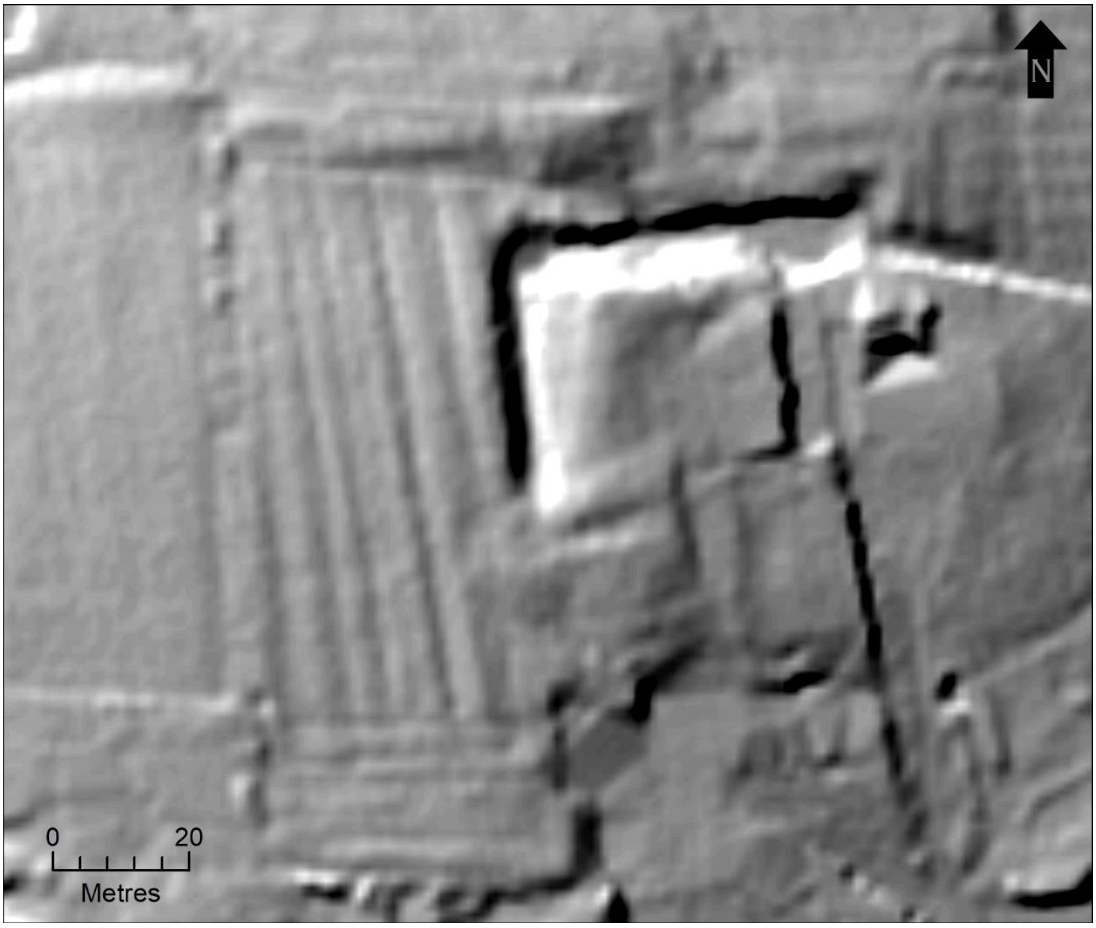

Figure 5 - medieval ridge and furrow survival at Drumburgh

Geology

The underlying bedrock geology was part of the Mercia mudstone group consisting of mudstone with gypsum-stone and/or anhydrite-stone. These stones are diamagnetic and therefore have no effect on magnetic survey techniques. The superficial geology consisted of a mixture of Gretna Till formation - Diamicton, saltmarsh deposits – clay and silt and intertidal sandflat depots – silt and clay (Figure 6). The soil map showed that the majority of the survey was covered with a loam soil with only the eastern edge having a mixing of sand, clay and loam (Figure 7). This geological combination, when not waterlogged, enabled good survey results to be obtained using either gradiometry or resistivity survey.

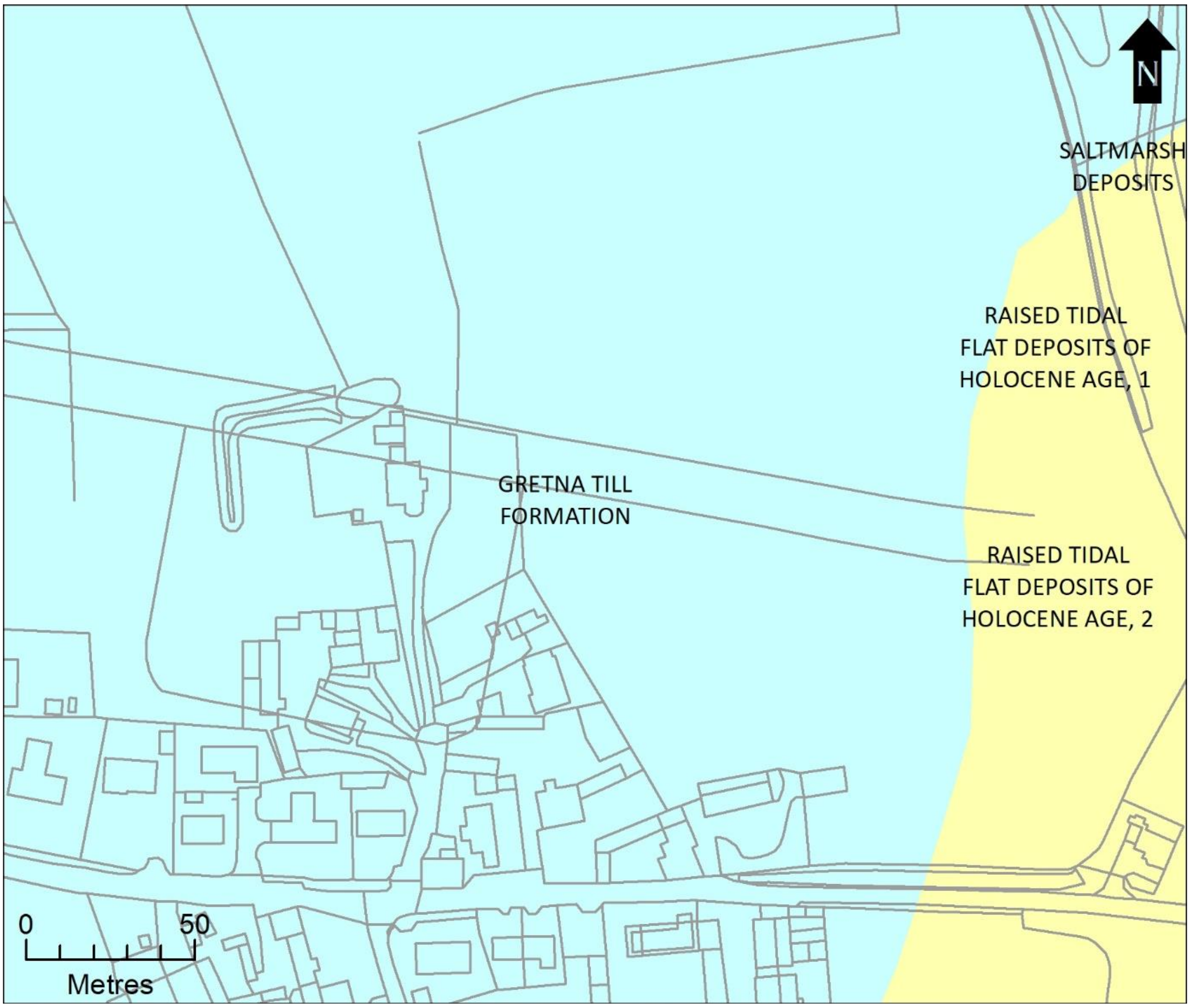

Figure 6 - Superficial geology – BGS 1:50,000 digital mapping

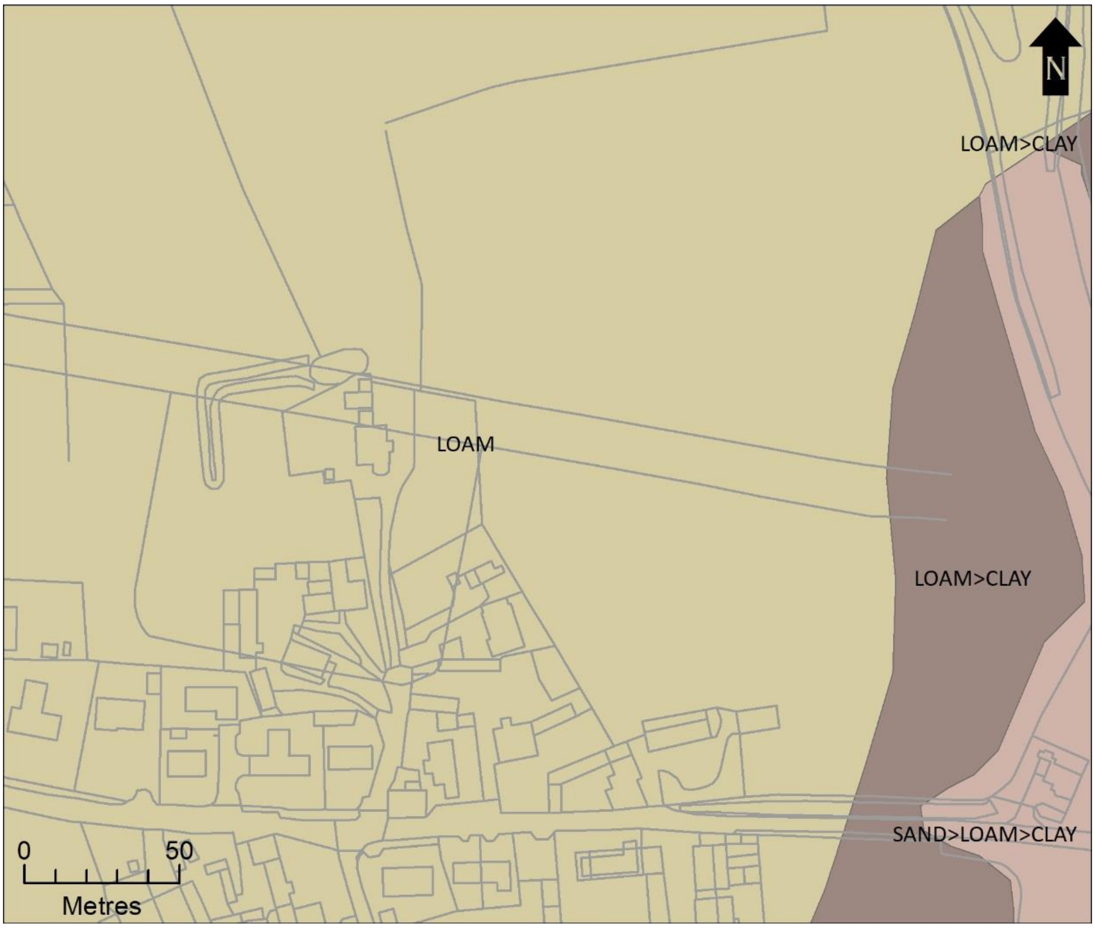

Figure 7 – Parent soil types for the survey area. BGS 1:50,000 digital geology data

Survey Methodology

Methods - Survey Grids and Markers

The gradiometer survey grid consisted of 30 30m x 30m squares laid out using a Leica GNSS differential survey grade GPS connected to the Leica RTK Smartnet network. Temporary grid pegs were used to mark out the grid but the livestock in the fields meant these had to be removed overnight and relocated the following day. In practice this had very little impact on survey speed. The survey grid coordinates were derived from Mastermap digital data and stored as a feature class within the survey ArcGIS geodatabase. Grids were numbered sequentially in a south-north series of west-east columns (Figure 8). Due to the restricted size of some of the fields in the survey area a number of the grids were partial. These were laid out as simple rectangles. The grid layout, where possible, was chosen to avoid close proximity to the ferrous intrusions within the field but in order to survey the area in close proximity to the feeding troughs and gates some ferrous disturbance was unavoidable. The area covered by a resistivity survey was unaffected by ferrous intrusions.

Methods - Fluxgate gradiometer survey

The survey was carried out using a Bartington Grad 601/2 fluxgate gradiometer with two vertical sensors spaced one metre apart. Following an initial scan of the survey site, a magnetically sterile area was identified for the creation of the survey control point. This was used to calibrate the gradiometer before each day of survey and after any significant stoppages. In accordance with accepted practice (Schmidt et al 2016, 12) data was collected along a series of zig-zag traverses spaced one meter apart with sample readings being taken every 25 centimetres. This gave an effective resolution of 3600 readings for each 30m x 30m survey grid.

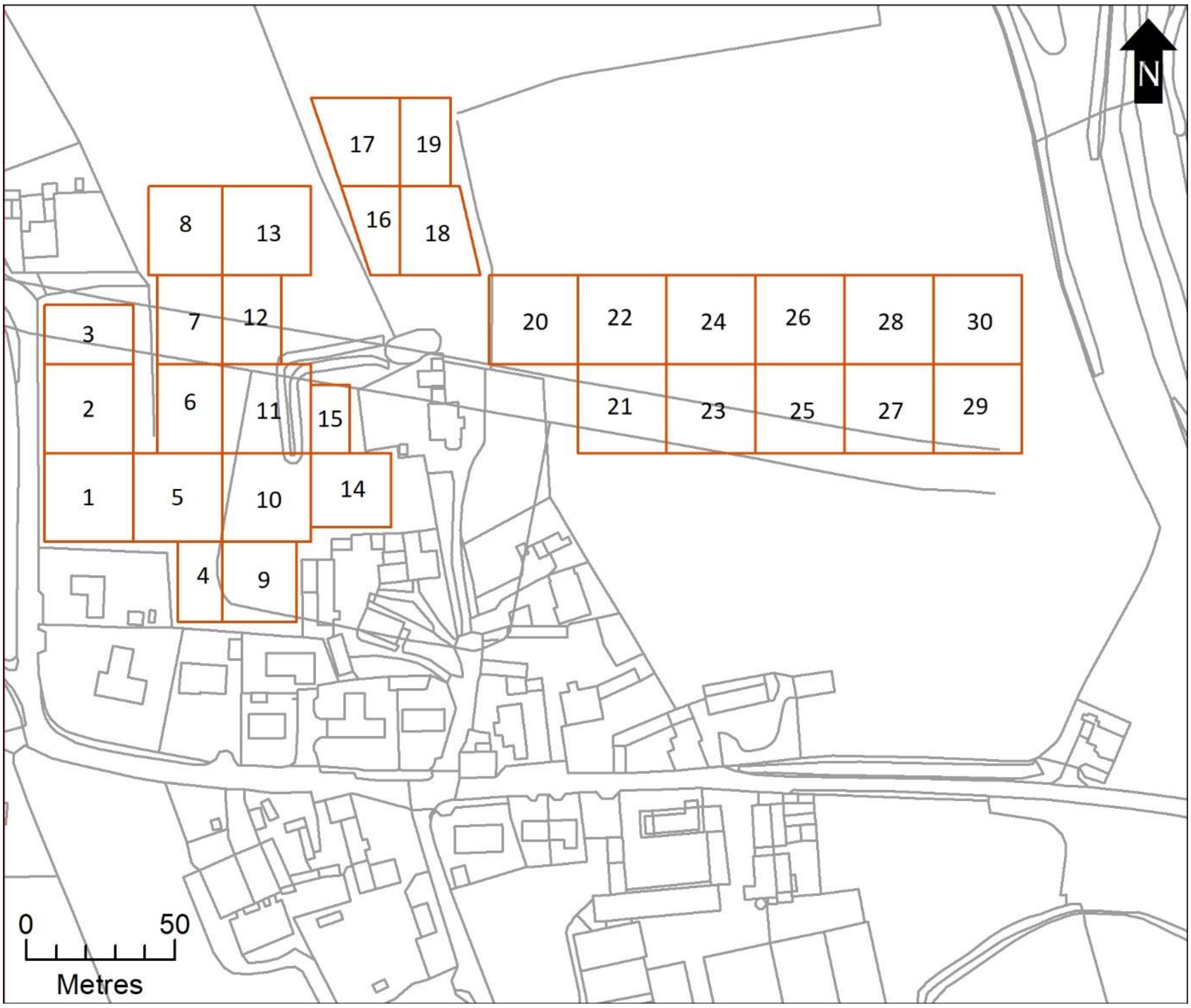

Figure 8 - Location and numbering of the gradiometer survey grids.

Methods – Electrical resistance survey

Electrical resistance survey was carried out using a Geoscan RM15D Advanced equipped with a MPX15 multiplexer collecting data in parallel twin configuration. The data was collected using a 0.5 metre traverse and 0.5 metre sample to provide a four times greater resolution of survey than a standard 1 metre x 1 metre survey. This gave a resolution for each survey grid of 1600 readings. The enhance survey resolution significantly impacted on survey speed and it was to counterbalance this that a restricted are of four grids in key positions, to the north and south of the proposed excavation, was chosen.

Data processing and presentation

The data from both the resistivity and gradiometer surveys were processed using Geoplot 4.0. The resulting plots were exported as raster images to ArcGIS 7.1 where they were scaled and georeferenced using the latest vectored Mastermap data. This enabled comparison with a combination of modern and historic Ordnance Survey mapping data, Environment Agency Lidar data and aerial photographs downloaded from Digimap. The integration of digital output from the geophysical survey with the Digital Terrain Model (DTM) obtained from the Environment Agency Lidar data also enabled detailed topographic examination of the survey terrain. Digital overlays were created for features identified within the survey output and formed the basis of the final interpretation of the data.

Reference to Historic Ordnance Survey

As part of the interpretation process, an examination of all the editions of the Ordnance Survey at 1:2500, was carried out. Historic Google Earth images were also consulted for the first decade of this century but provided no additional information of significance. The study of the historic maps showed that the arrangement of the survey field boundaries to the east was the same as it is today but there has been

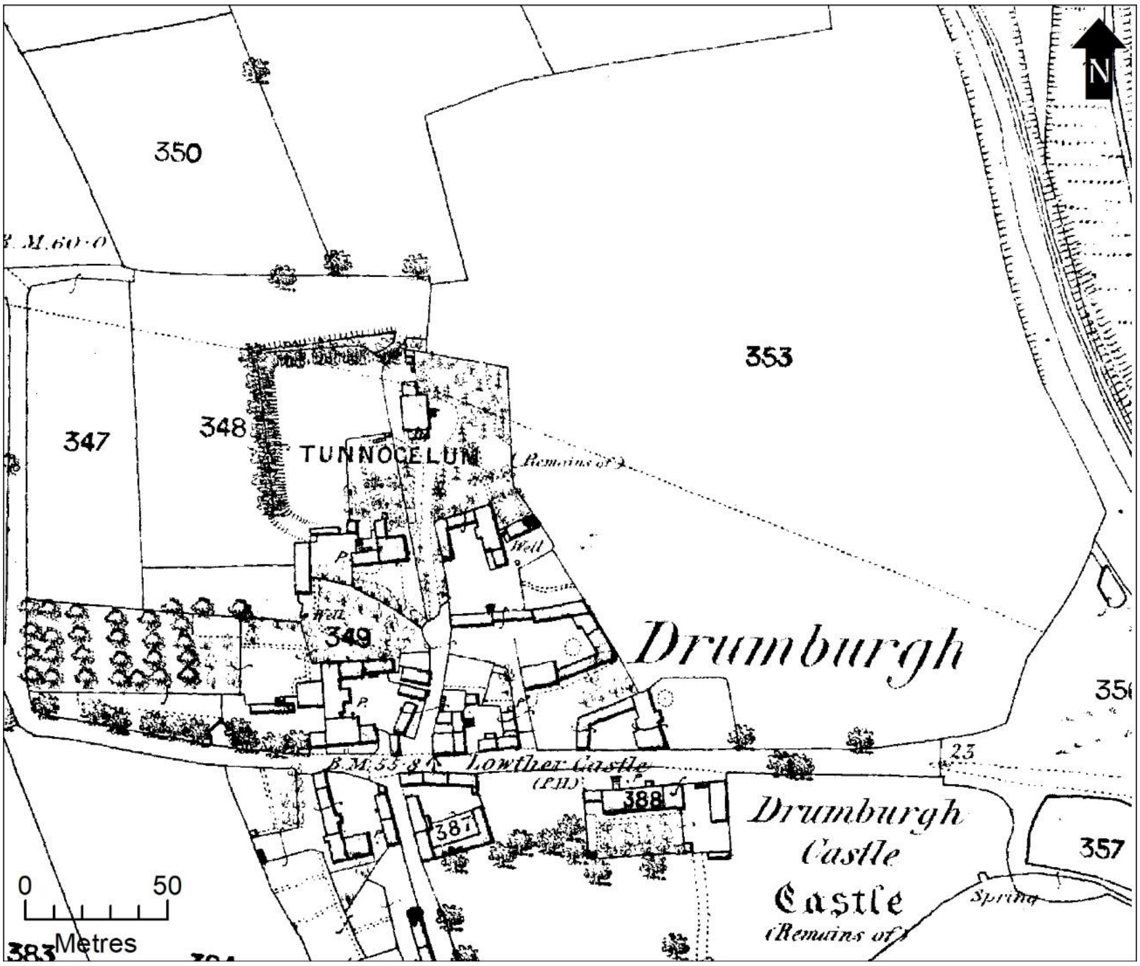

Figure 9 - Field boundary layout shown on the Ordnance Survey 1:2500 County Series 1895

significant change in the field boundaries to the west of Drumburgh House. In the southwest corner of the area the orchard has now been replaced by a bungalow and the east-west boundary to their north no longer exists.(Figure 9). On this map the fort is marked incorrectly as Tunnocelum (Ravenglass) rather than Congavata. The probably derives from Collingwood-Bruce’s 1867 publication of MacLauchlan's survey of Drumburgh (Figure 10). Unlike this publication the Ordnance Survey omit the question mark after the attribution. When the 1:2500 Ordnance survey first revision was published in 1900, Tunnocelum has been replace by the simple word fort. The Ordnance Survey National Grid edition for 1970 shows some of the current changed field boundaries and the bungalow in the southwest corner is present at this point. The other noticeable change is the expansion to the north of the garden of the Grange enclosing more of the remains of the fort (Figure 11)

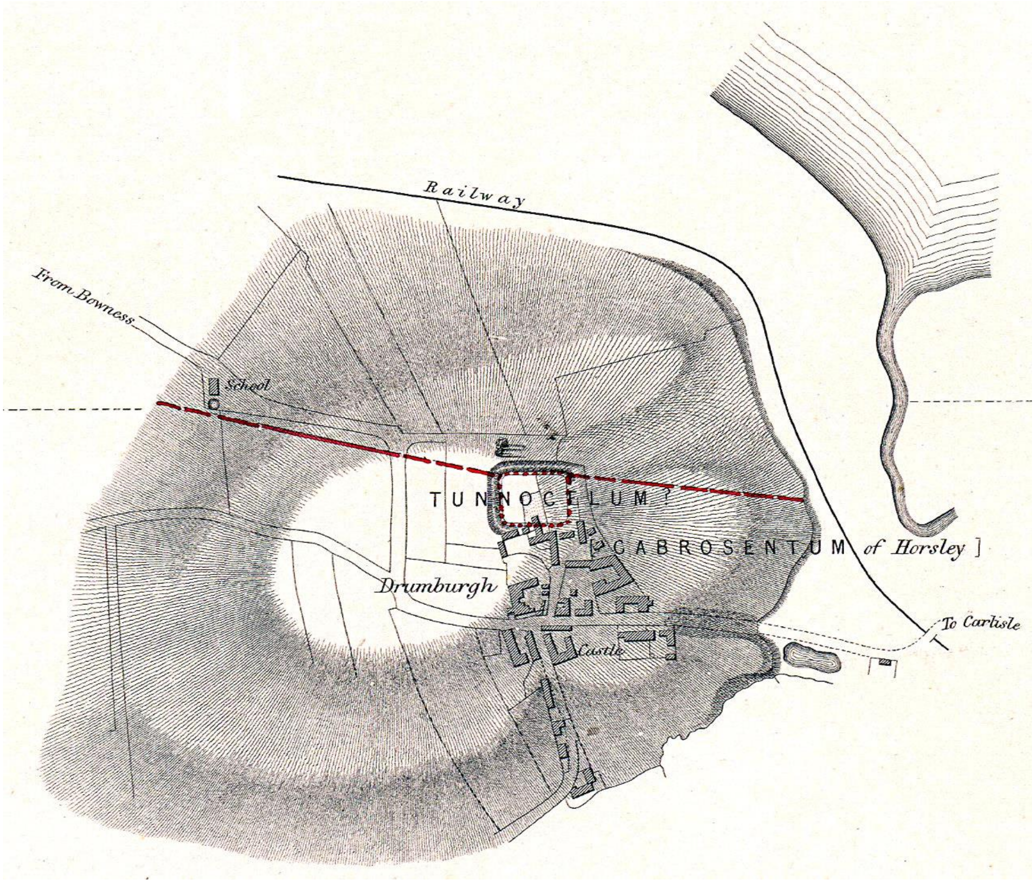

Figure 11 - MacLauchlan's survey of Drumburgh reproduced in Collingwood Bruce's The Roman Wall (1867)

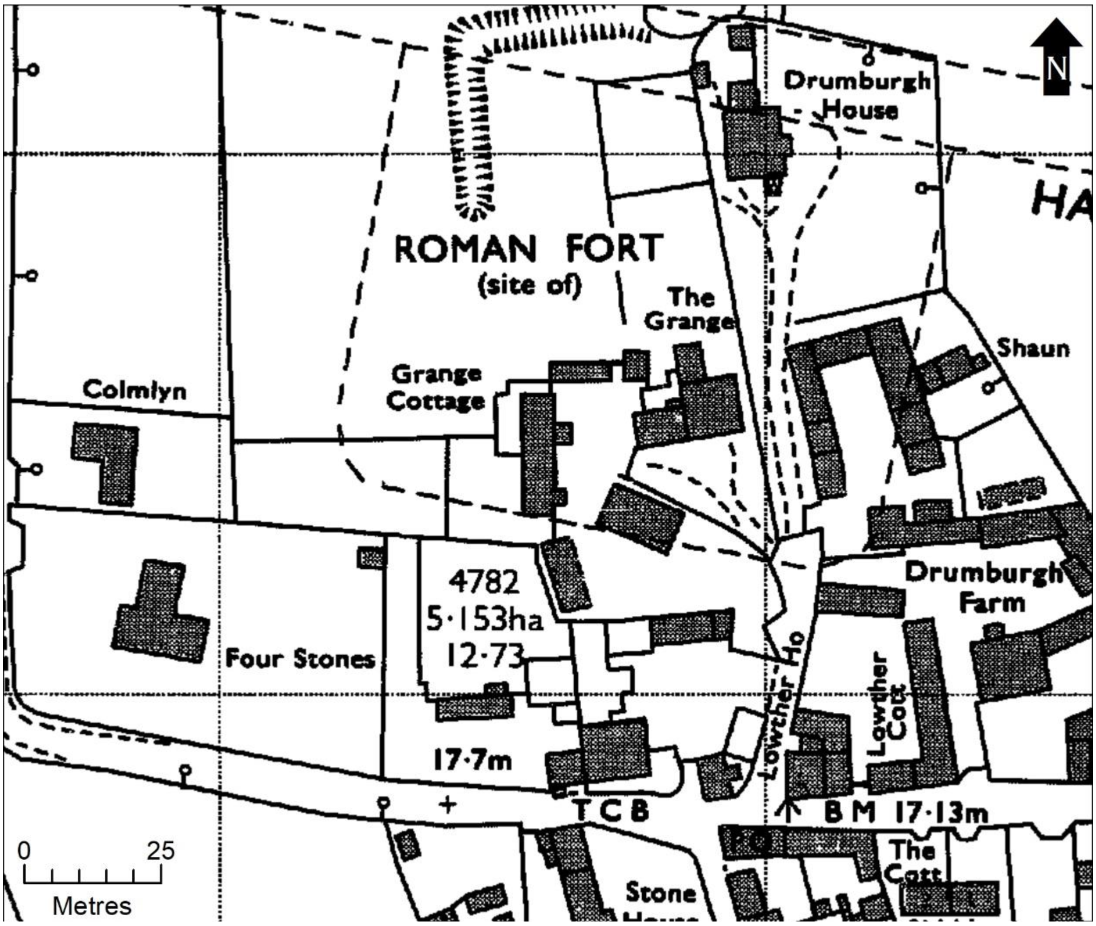

Figure 10 - Ordnance Survey 1:2500 map for 1970 showing new buildings and boundary changes

Survey Results and Interpretation

Gradiometer Results – process summary

The data was processed using Geoplot 4 and exported as a raster image to the ArcGIS 7.1 project for the survey (Figures 11 and 12). Only basic processing was necessary within Geoplot 4. The grids were despiked with a threshold of +/- 3SD and the Zero Mean Traverse filter was applied to reduce any striping as a result of changes in the orientation of the gradiometer during zig-zag survey. A uniform High Pass Filter, to filter any changes in the geological background, was applied with a window of 10 readings in both the X and Y direction. Interpolation was carried out between traverses so that the final data had an X and Y resolution of 0.25 metres. The plots were then scaled and georeferenced to the British National Grid in ArcGIS using coordinates derived from the differential GNSS. The results from the gradiometer survey (Figures 12-14) clearly show the line of the ditch in the field to the east but are also badly affected by a drainage pipe and a large pit filled with ferrous material in the fields to the west of Drumburgh House.

Figure 12 - Overview of the gradiometer survey results

Figure 13 - Detailed view of the western part of the gradiometer survey results

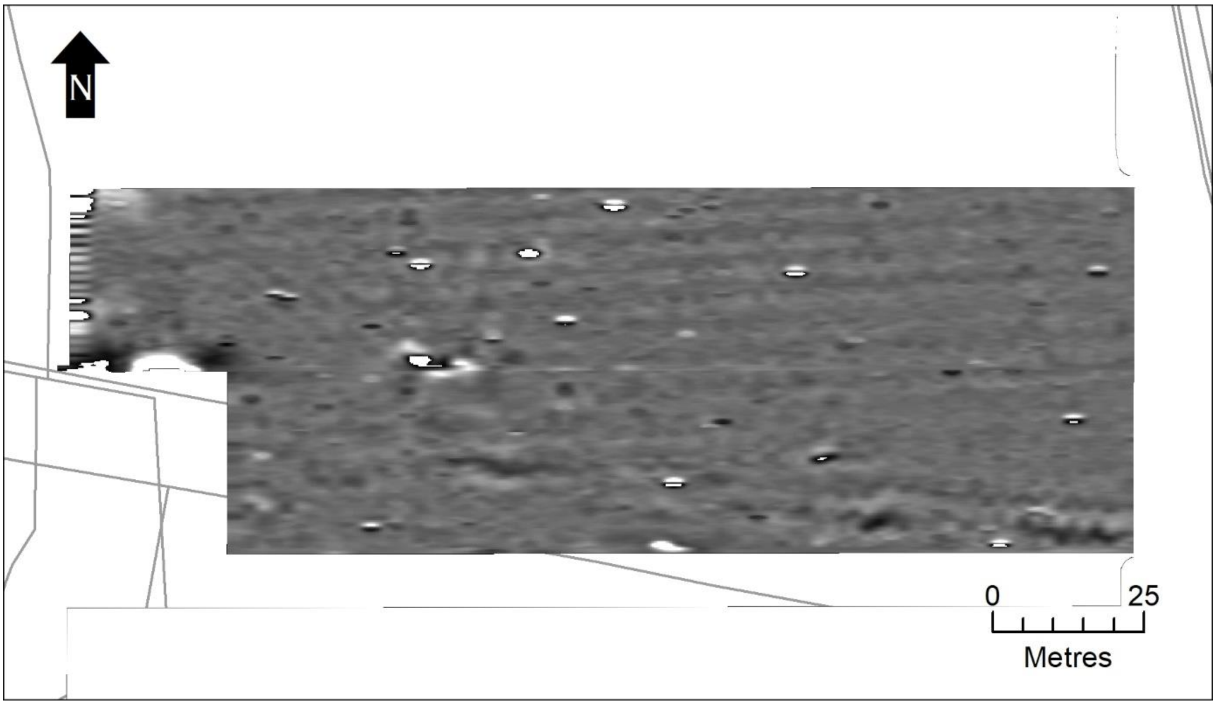

Figure 14 - Detailed view of the eastern part of the gradiometer survey results

Gradiometer Results – Interpretation

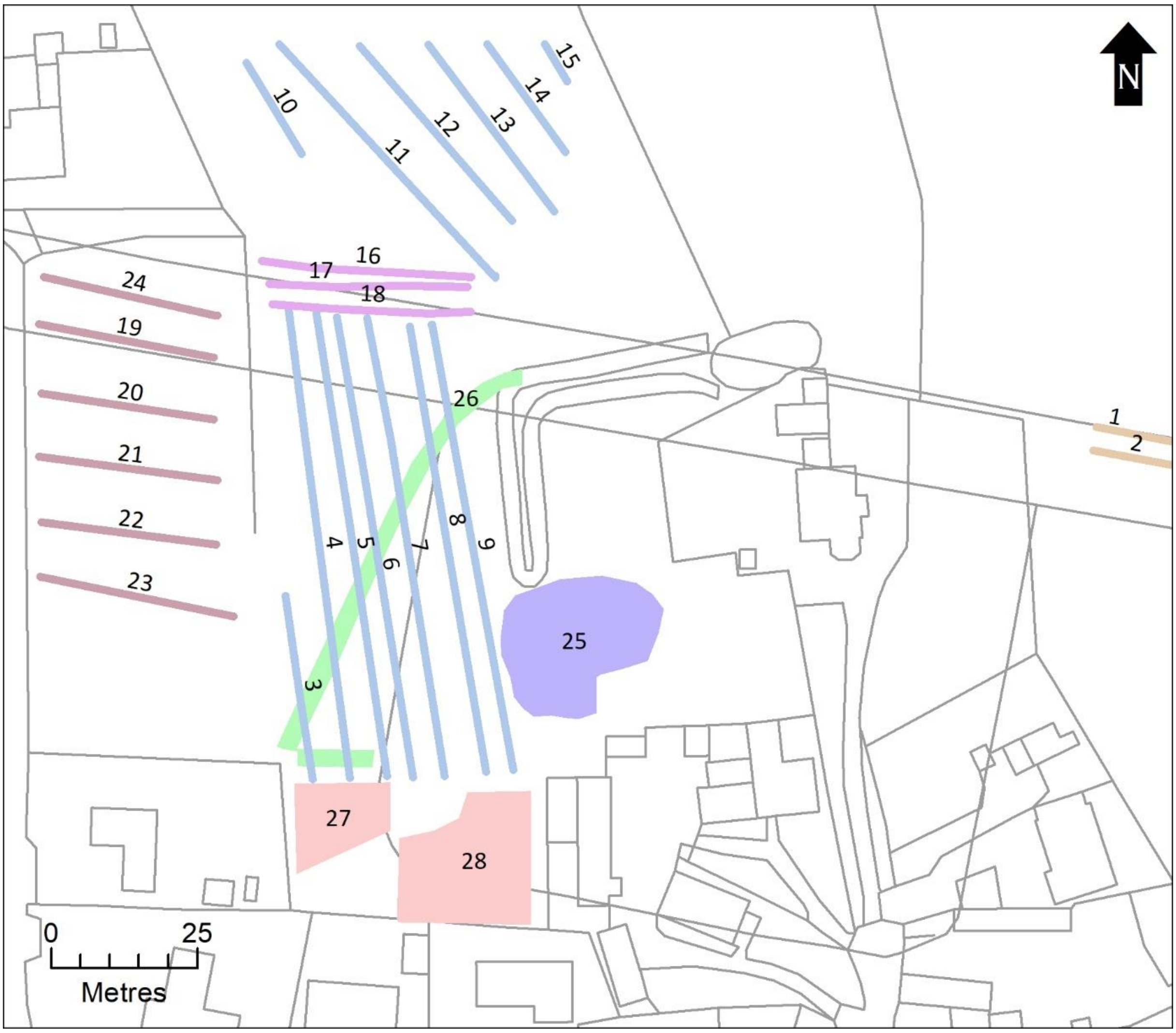

Figure 15 - Interpretation of the gradiometer survey results - western part

Figure 16 - Interpretation of the gradiometer survey results - eastern part

The scaled and georeferenced geophysics plots were used to produce interpretive overlays within ArcGIS. Each of the drawn polygons or polylines was given a unique reference number that is used within the interpretive discussion (Figures 15 and 16).

Figure 16 - 1-2: Two parallel linear bands with a positive response. The represent the edges of the ditch and can be traced back to the extension of Drumburgh House where the ditch was uncovered during building works. It is also clearly visible on the Lidar plot (Figures 4 and 5).
Figure 15 – 3-15 and 19-24: The remains of medieval ridge and furrow. This is most pronounced in the central field where it runs south to north. These features are also clearly visible on the Lidar plots (Figures 4 and 5)
Figure 15 – 16-18: The parallel linear features probably form part of a section of ditch visible as an earthwork at the western edge of the survey area.
Figure 15 - 25: A large area with a massive dipolar response indicating the present of substantial quantities of ferrous metal. Anecdotal evidence suggests that this is a pit that was later filled with rubbish.
Figure 15 - 26: This is a drainage pipe the empties into the northern section of the medieval enclosure ditch.
Figure 15 – 27-28: Two areas of highly disturbed ground that may be related to garden activity. It is shown as belonging to Grange Cottage, with what looks like an orchard, on the Ordnance Survey 1:2500 maps for 1900 and 1925.

Resistivity Results – process summary

The data was processed using the same software as the gradiometer survey. The data was despiked with a threshold of +/- 3SD and then a Gaussian high pass filter was applied with a window of 10 reading in the x and y directions to minimise the effect of background geology. A low pass filter with a window of 1 reading in the X and Y directions was used to smooth the data and enhance any large weak features. Interpolation of the data was carried out in the X and Y directions to give data plots with a final spatial resolution of 0.25m x 0.25m. This was an equivalent resolution to the gradiometer data.

Resistivity Results – Interpretation

Summary

The lack of real success with both gradiometry and resistivity surveys in detecting significant sub-surface features is surprising given the location of the survey area in relation to the line of the wall and ditch. There seems to be no evidence from the geophysics of even the slightest remains of a turf constructed wall. Simpson, Hodgson and Richmond's account of the discovery of turret 56b suggests that it is a turf turret on the southern edge of a five-metre berm (Simpson, Hodgson and Richmond, 1934, 132). If this were the case, it is possible that the resistivity survey didn't extend far enough south to catch any wall features. However, the gradiometer survey extended 25 metres south of the line of the ditch and also failed to reveal anything of great significance. Although not currently visible, the supposed line of the vallum is marked on earlier maps but this was significantly further south to that of the survey area. It is unfortunate that the Ground-penetrating Radar equipment was unavailable at the time of survey, as that could have been usefully employed across the line of the wall and ditch to give greater ground penetration.

Sources and References

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