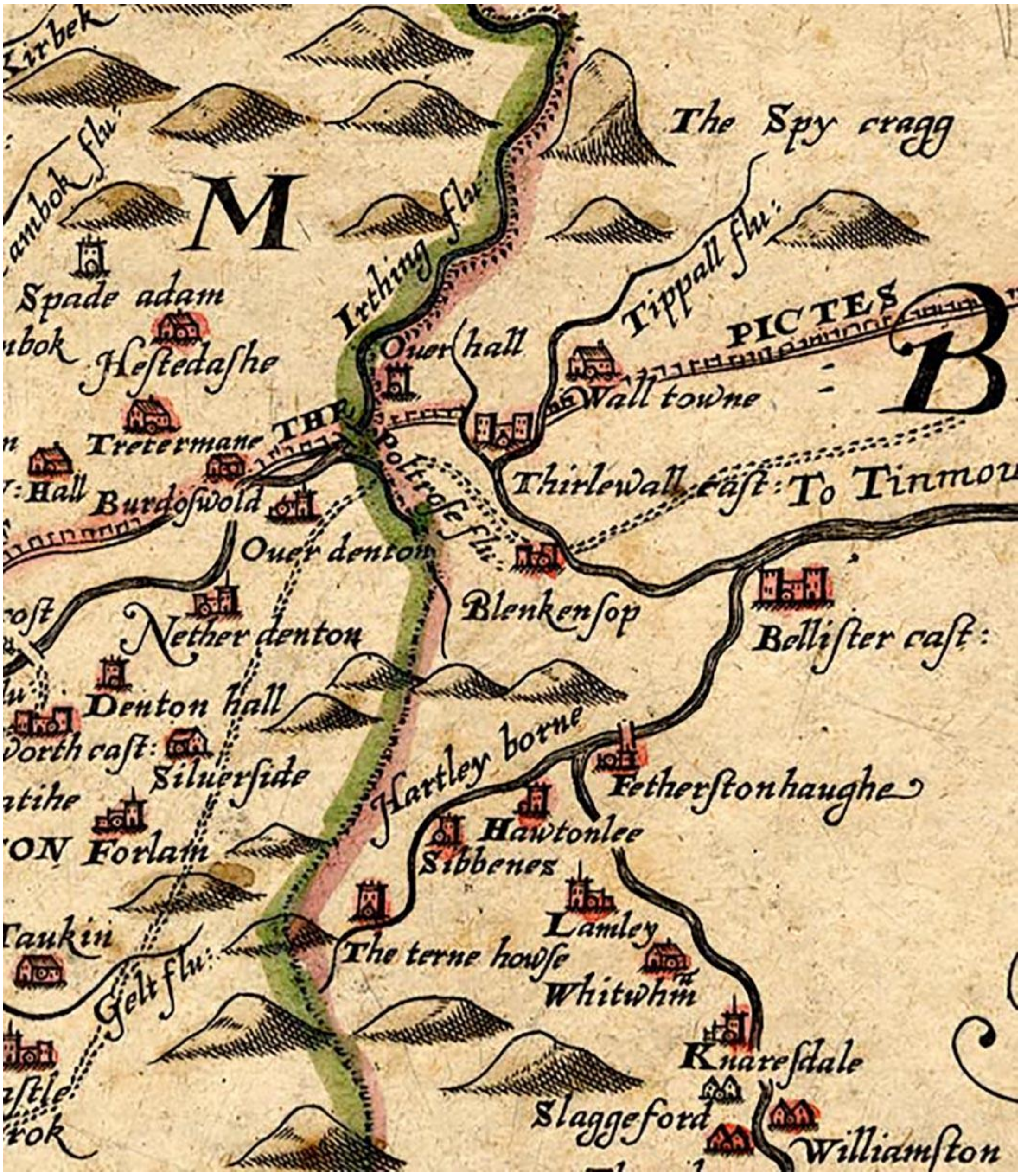
Geophysical and Laser Scanning Surveys at Thirlwall Castle, Northumberland 2019

Report by Alex Turner



Extract from Philip Lea's 1689 amendment of Christopher Saxton's map of England and Wales, 1579

Table of Contents

Table of Figures

<u>Author</u>
Alex Turner
Research Associate (Archaeology)
McCord Centre for Landscape
School of History, Classics and Archaeology
Newcastle University
Newcastle upon Tyne
NE1 7RU

Introduction

As part of the Hadrian's Wall Community Archaeology Project (WallCAP), gradiometer and electrical resistance surveys were undertaken in the field to the south-west of Thirlwall Castle. The surveys were accompanied by a program of topographic survey using a high-definition terrestrial laser scanner. The surveys, undertaken by WallCAP volunteers, were supervised by Alex Turner, Nicky Garland, Paul Frodsham and Rob Collins. The logistics of managing the volunteer groups undertaken by Kerry Shaw and Marianne Spence.

Location

The survey area was located 0.8 km north of Greenhead and 2.25 km east of Gilsland (Figure 1). It lies between Milecastle 46 to the east and Milecastle 47 to the west and is 0.8 km north-west of the Roman fort of Carvoran (Magna).

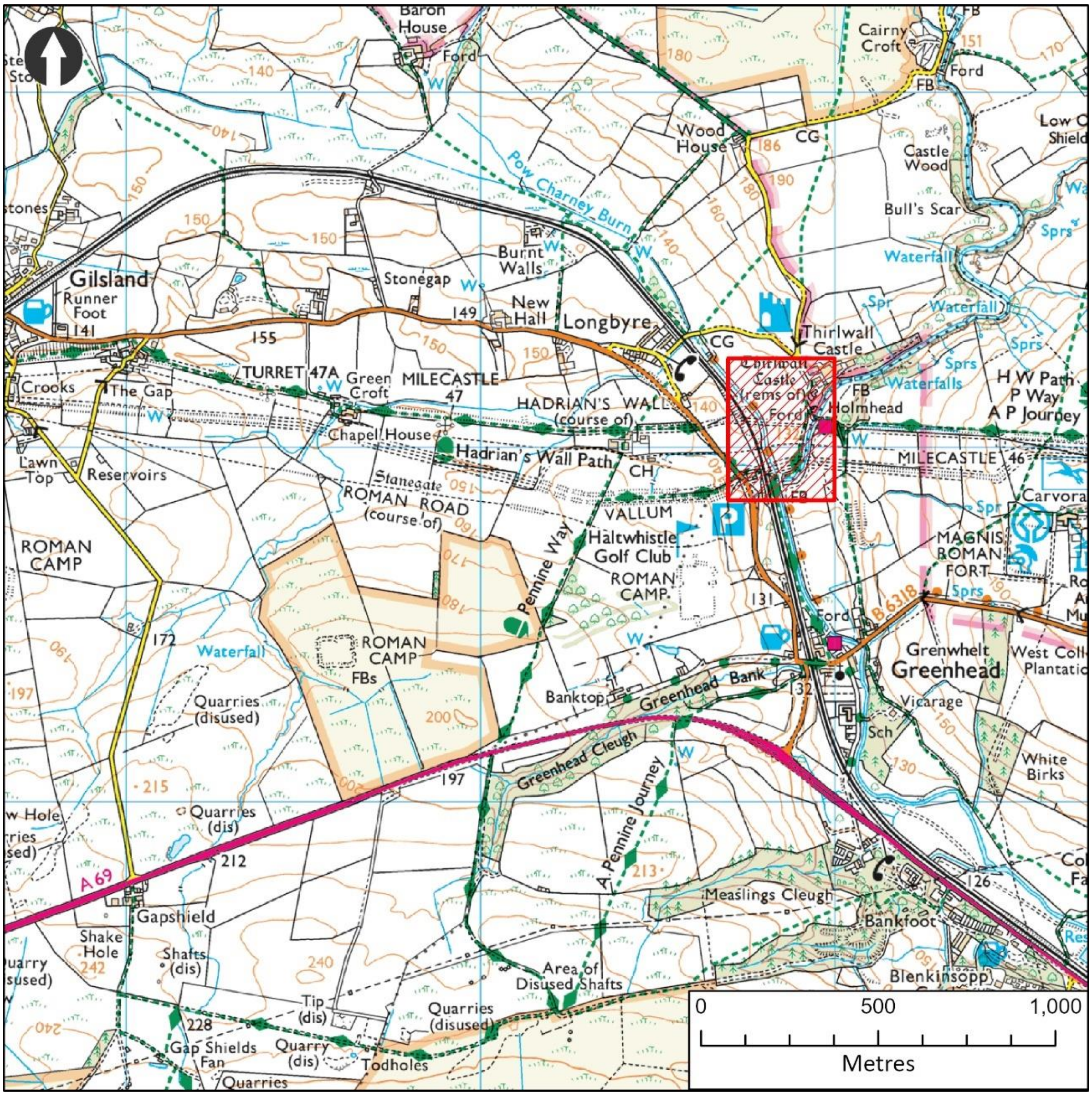


Figure 1 - Location of the survey area on the 1:2500 Ordnance Survey 2021

The survey areas were laid to pasture and bounded by hedges and fences to the east and south. Large metal gateways were present but the survey areas were sited to avoid ferrous interference with the gradiometer survey. The survey area was also sited to avoid the patch of land to the west of the survey that formed a bog with thick grass and reeds that was unsuitable for both resistivity and gradiometer survey (Figure 2). This area can be seen as significant depression on the digital terrain model (DTM) derived from the one metre resolution lidar data (Figure 3).

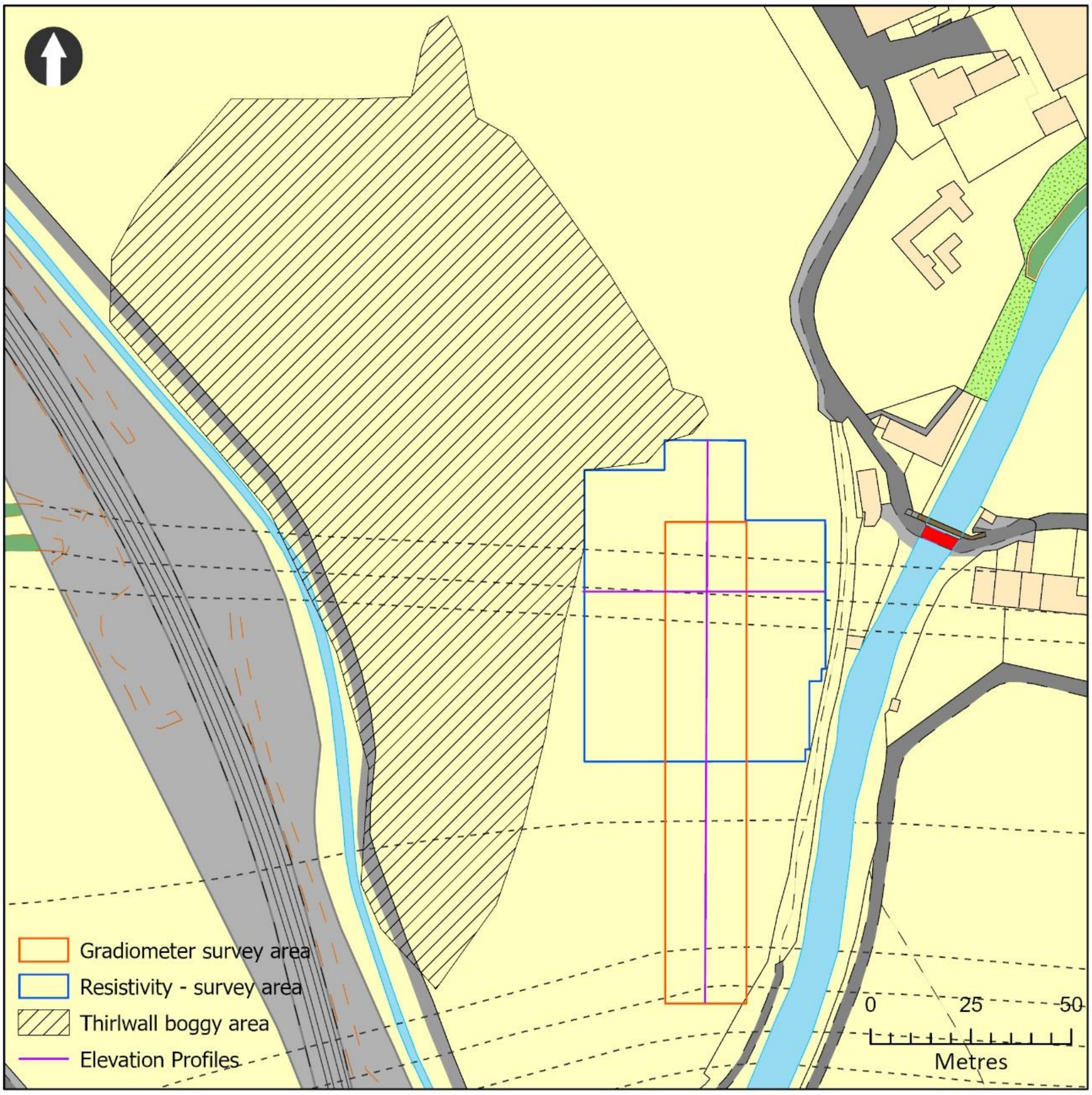


Figure 2 - Location of the resistivity and gradiometer survey areas showing boggy area to the west - Ordnance Survey Mastermap 2022

Topography

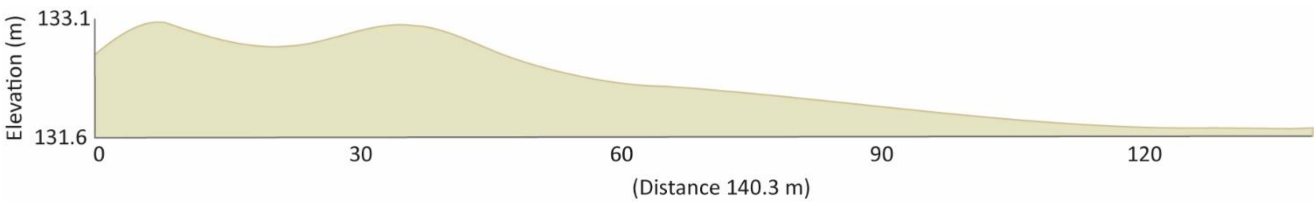


Figure 3 - north-south elevation profile across the survey area

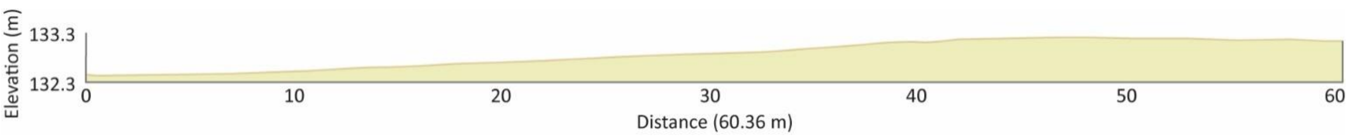


Figure 4 - west-east elevation profile across survey area

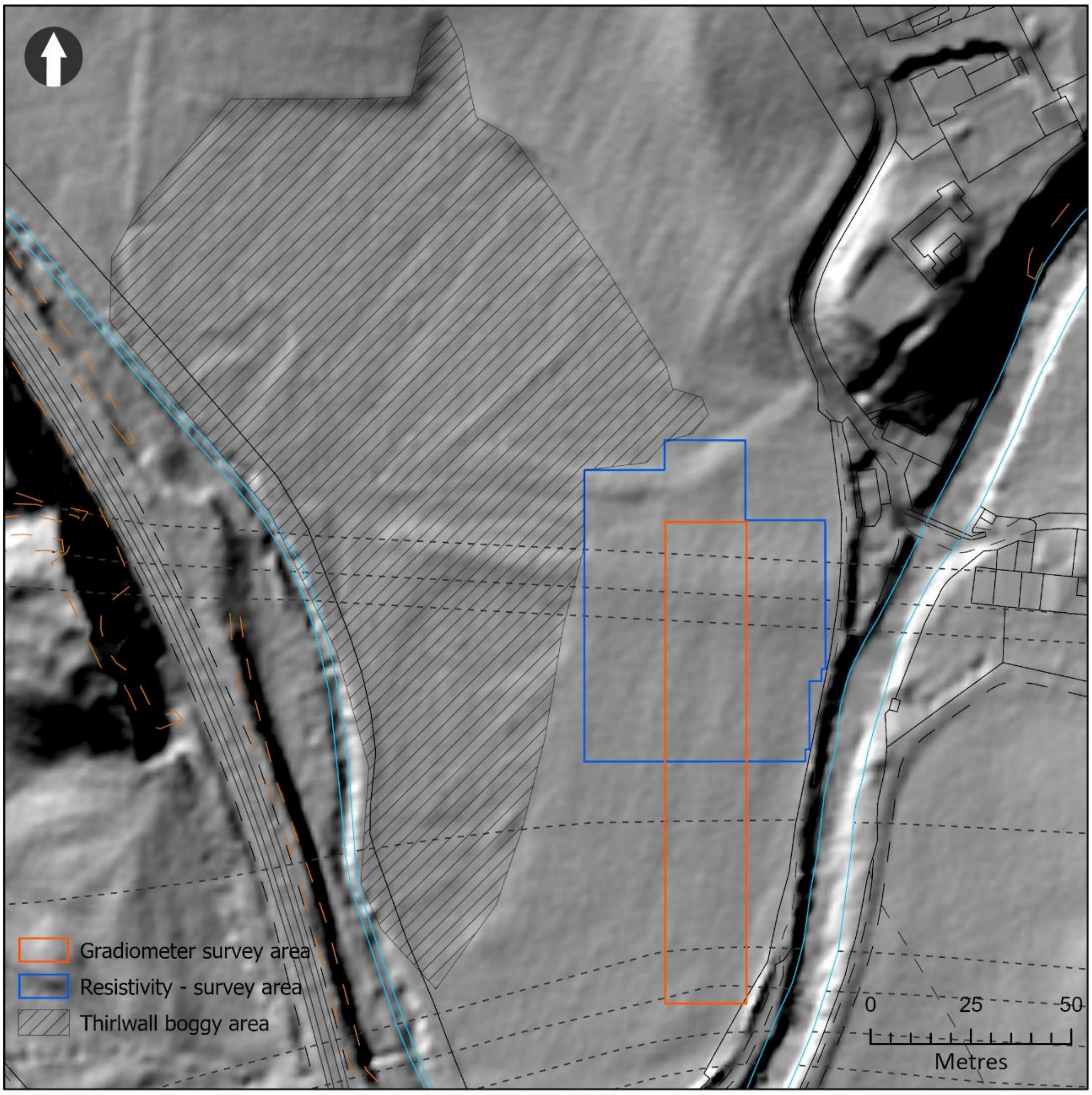


Figure 5 - Lidar digital terrain model (DTM) of the survey areas. The remnant line of the wall is clearly visible in the northern half of the survey areas

Examination of the Ordnance Survey contour data and the Environment Agency lidar data (Figure 5) shows a 1.5 metre slope from north to south across the survey area. The elevation profile (Figure 3) clearly shows the remnant earthwork of the wall. The slope in the west to east direction is less pronounced and is 1m at its maximum (Figure 4). At its western edge, the surveys border the boggy area that can be seen as a distinctive depression on the lidar. The sharp edges that mark the limits of much of this area would suggest that it is either an artificial construct or a natural feature that has been managed. The lower topography either side of the line of the wall, as it crosses this feature, might be a good indication that some of the remains of the wall are still in situ. Observation of field conditions at the wettest part of the year showed that much of this area is under water for significant parts of the Autumn/Winter. Fortunately, adequate drainage within this field enabled the collection of some excellent results from the resistivity survey. Waterlogged areas can cause amorphous positive and negative anomalies that, when classified, are often seen as natural. This may explain some of the lack of results in the southern half of the gradiometer survey.

Geology

The underlying bedrock geology was largely sandstone in the northern half of the survey and limestone, sandstone, siltstone and mudstone in the lower lying southern half of the survey. The castle at Thirlwall is built on a sandstone outcrop and this extends westward into the field along its eastern boundary. Above this the superficial geology is largely a mixture of clay, silt sand and gravel with an area of Till (diamicton) at the northern edge. The soil is a clay to sandy loam with an area of clayey to silty loam mimicking the same area as the Till (diamicton). None of the geological elements present on the site represent a problem for either resistivity or gradiometer survey.

Figure 6 - Bedrock geology for the survey area. BGS 1:50,000 digital geology data.

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

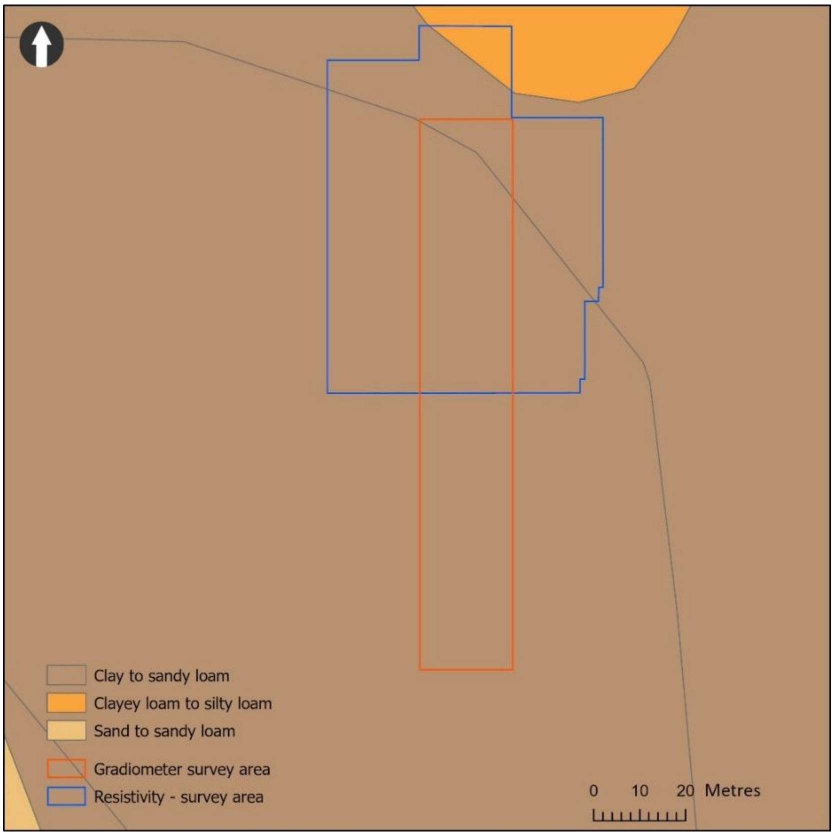


Figure 8 – Soil data (Parent material) for the survey area. BGS 1:50,000 digital geology data

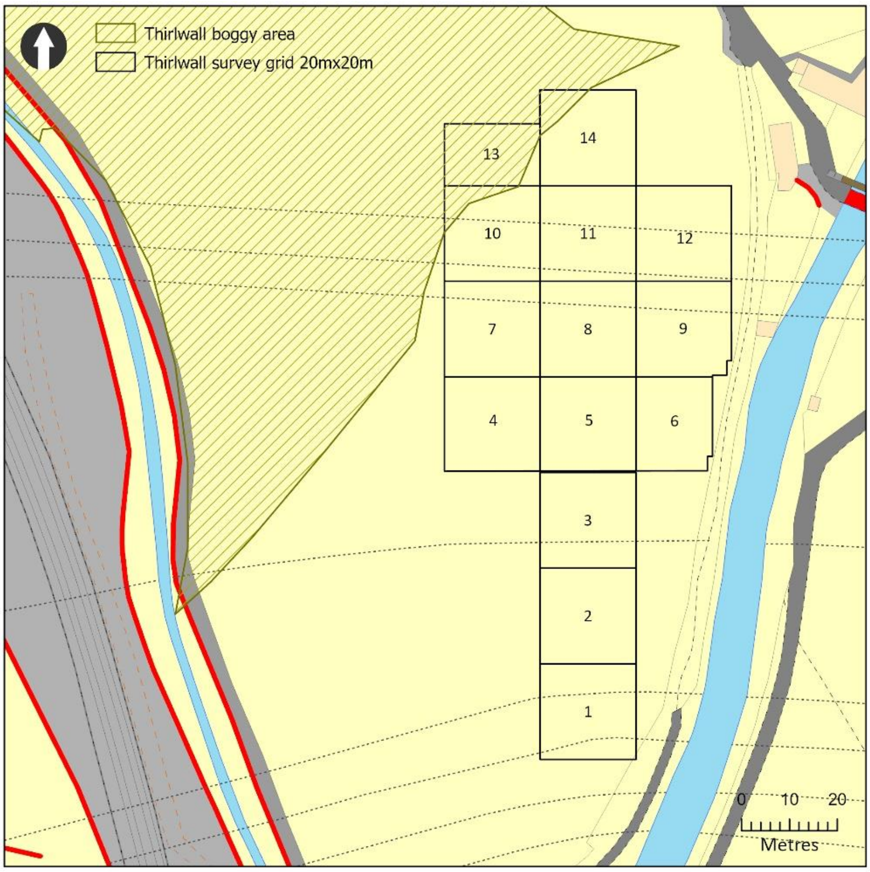


Figure 9 - Location and numbering of the 20mx20m survey grids

Survey Methodology

Methods - Survey Grids and Markers

Fourteen 20m x 20m full and partial survey grids grid were laid out using a Leica GNSS differential survey grade GPS connected to the Leica RTK Smartnet network. Grids 5, 8 and 11 were common to both the resistivity and gradiometer surveys. Given the time constraints and numbers of volunteers involved, the two survey areas were kept largely separate to enable both types of survey to be undertaken concurrently. In addition to the geophysical survey a topographic model of the survey field was created using a Faro Focus X330 phased-based laser scanner. A total of 71 scans of the survey area and its surrounds were made and this was used to create a detailed model of the survey areas in relation to the surrounded structures, including the castle.

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 1600 readings for each 20m x 20m survey grid.

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 area of grids located either size of the line of the wall 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 was much the same as it is today (Figure 10). Even the railway was in existence at the time of the Fist Edition County Series map as The Newcastle & Carlisle Railway had been opened as a through route on 18th June 1838. The line of the wall is marked but it only on the second revision of the 1:2500 County Series published in 1921 that the Military Way and the Vallum are added (Figure 11).

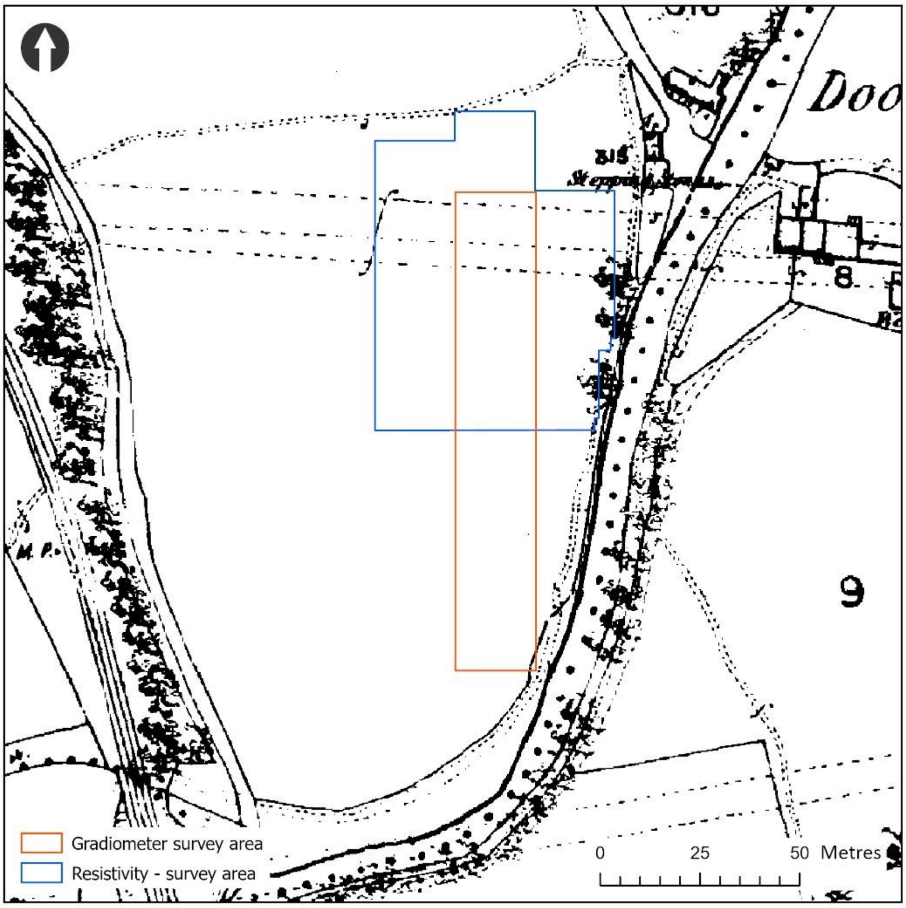


Figure 10 - Location of the survey areas on the County Series 1:2500 map published in 1895

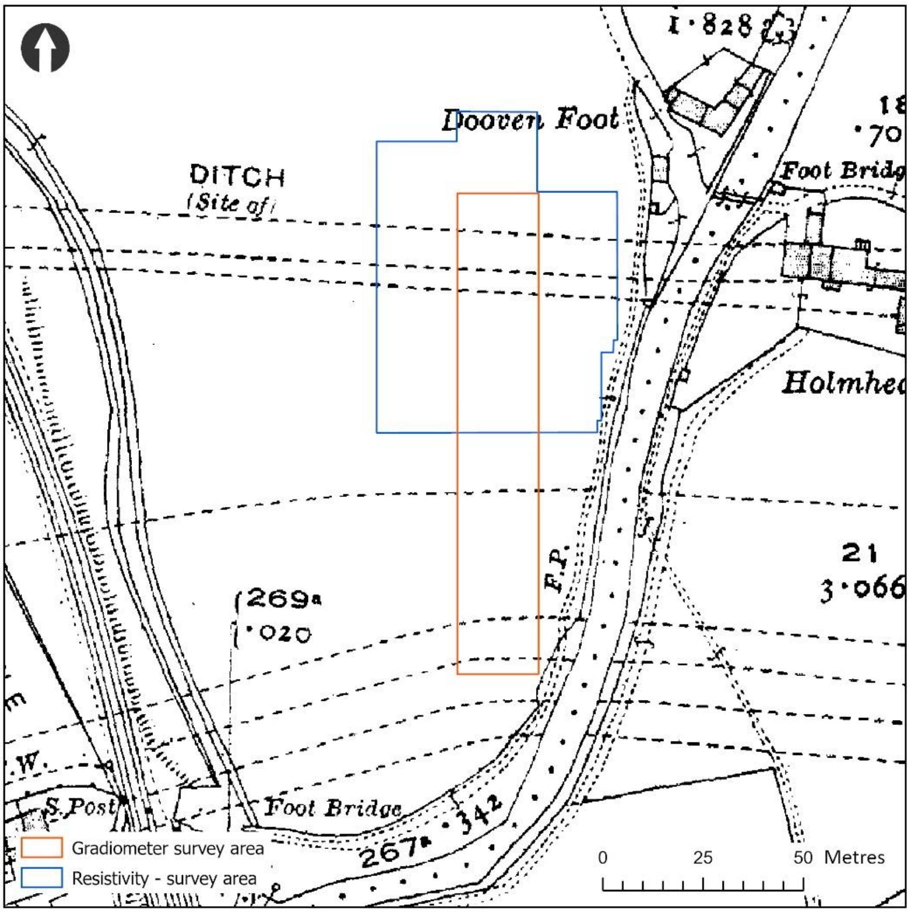


Figure 11 - Location of the survey areas on the County Series 1:2500 map published in 1921

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 (Figure 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.

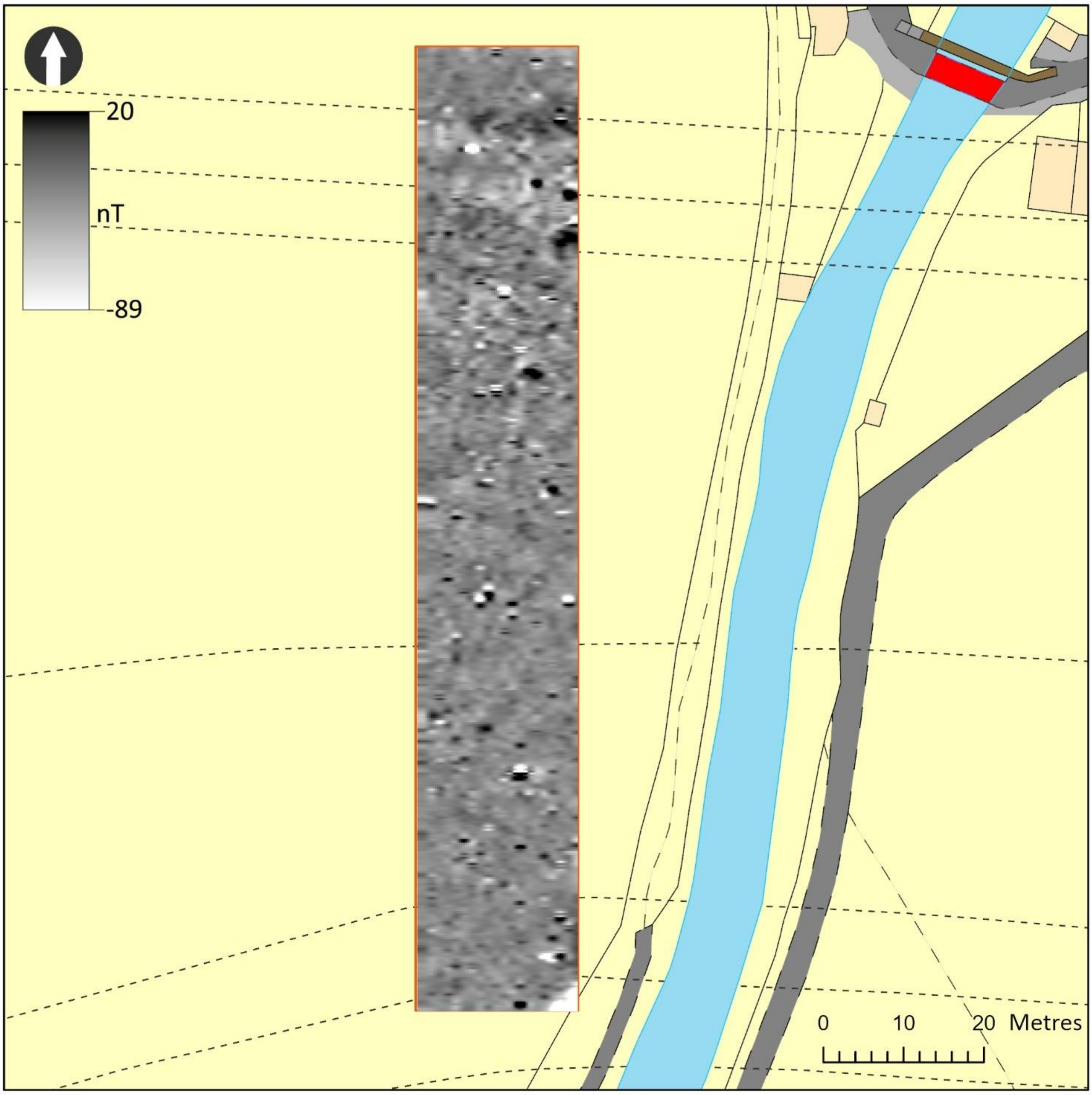


Figure 12 - Thirlwall gradiometer survey results

Gradiometer Results – Interpretation

The scaled and georeferenced geophysics plots were used to produce an interpretive overlay within ArcGIS. Each of the drawn polygons or polylines was given a unique reference number that is used within the interpretive discussion (Figure 13).

37: Stronger negative response coinciding with the line of the wall.
38: A very weak negative response that mirrors the sub-circular feature on the resistivity survey. If this feature were complete, it would be c.30m in diameter. Early enclosure?

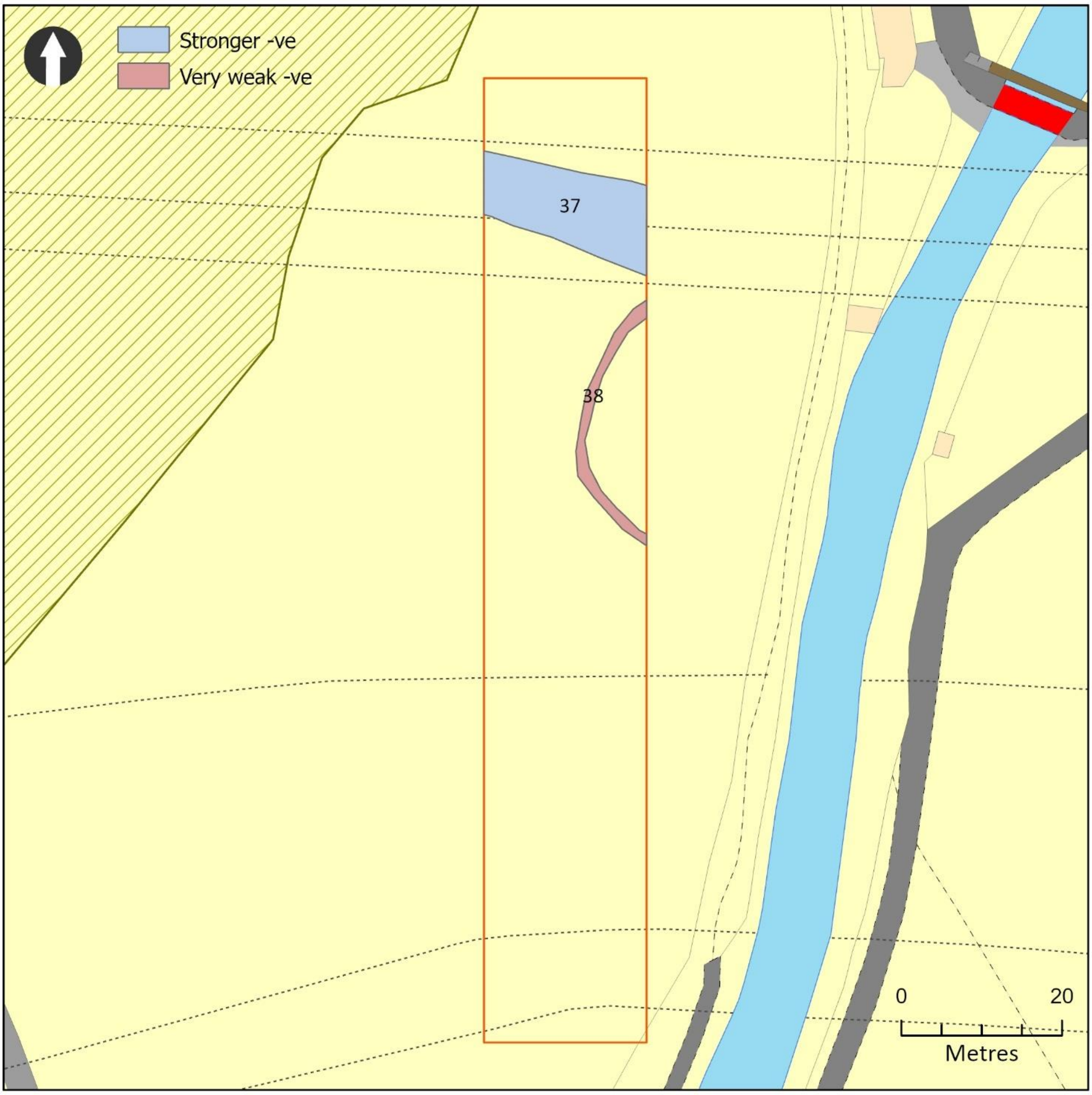


Figure 13 - Interpretation of the gradiometer survey results

Resistivity Survey - Results

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. The results, shown in Figure 12 revealed few archaeological anomalies, consistent with the results from the gradiometer survey.

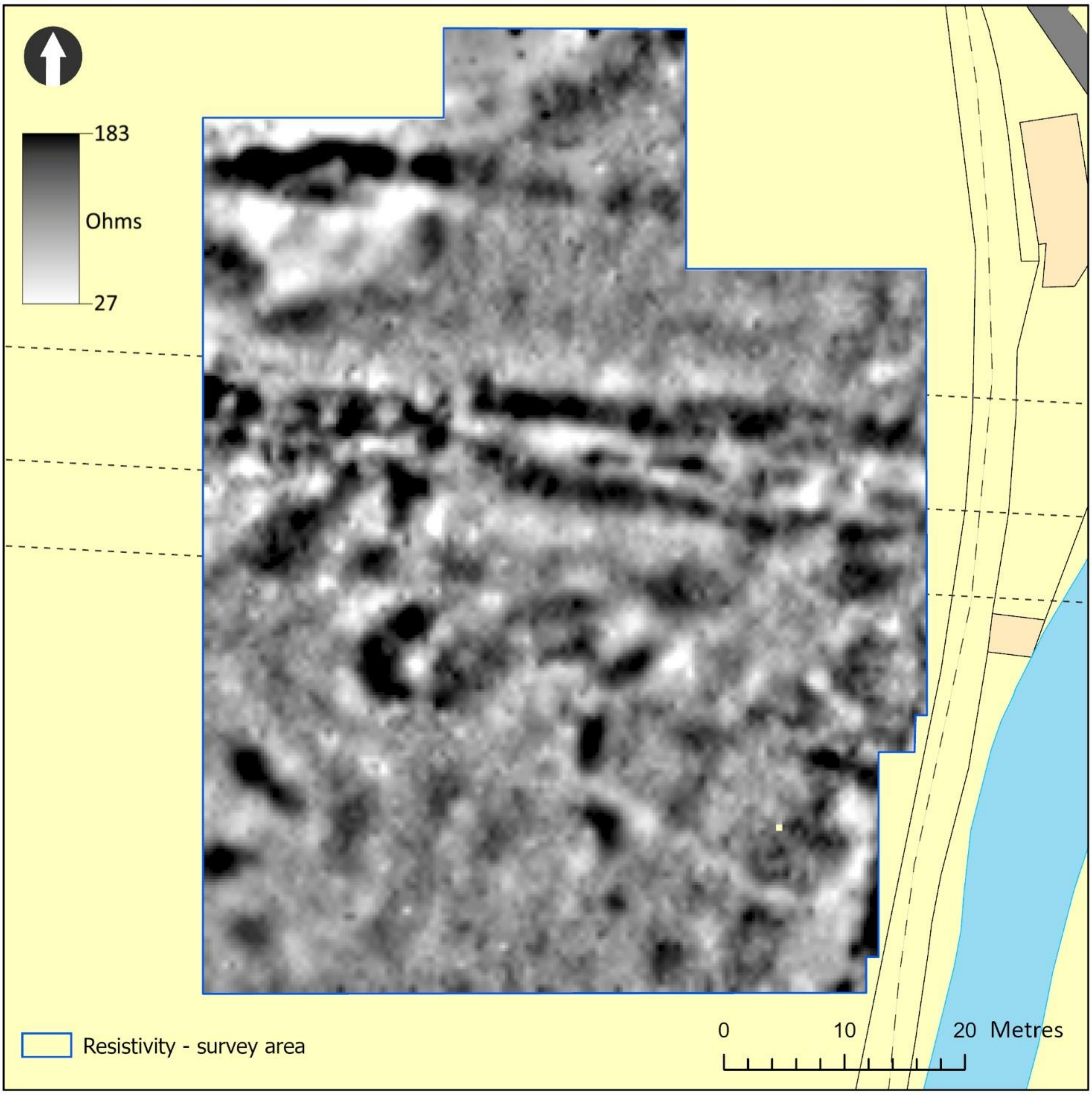


Figure 14 - Resistivity survey results

Resistivity Survey - Interpretation

1: Linear feature consisting of a series of high resistance responses running roughly parallel to the wall. It seems to have a relationship with [2] and may possibly be the remains of a trackway associated with a route across the boggy area.

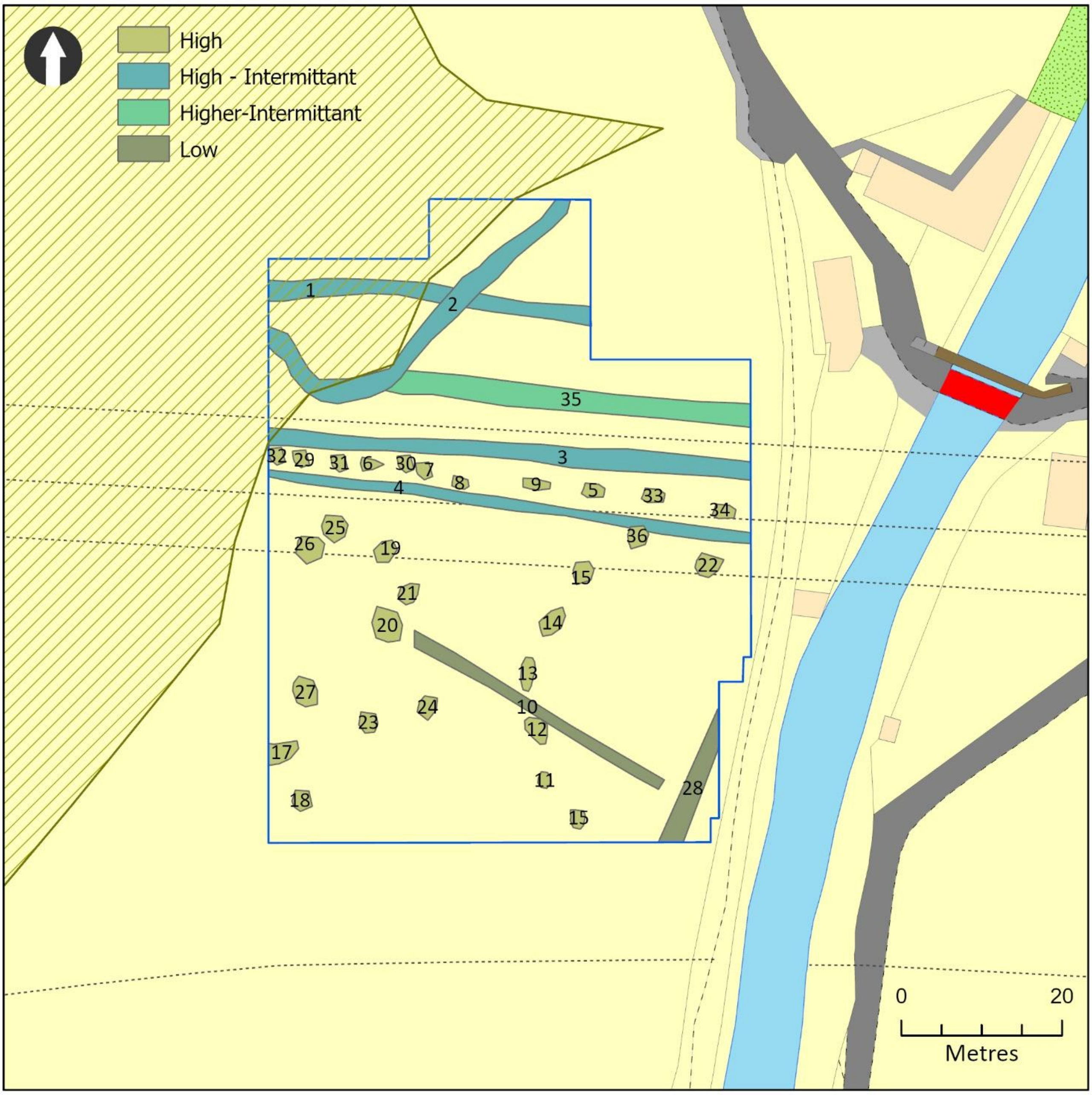
2: A curvilinear high resistance feature that follows the edge of part of the boggy area. It may be infill along the edge of this feature.

35: A linear feature with a higher response that runs parallel to the wall to the north. This could be a response from the edge of the ditch.

3 and 4: This high resistance linear feature is the line of the wall but is patchy at the west end. 5-9 and 29-34 are areas of high resistance that are part of the makeup of the wall. This patchy response may well reflect the systematic robbing of material from the wall to build Thirlwall Castle.

17-26: Areas of high resistance that appear unconnected. They could be rubble from the dismantling of the wall but could equally represent natural deposits within the subsoil.

11-15 and **36:** This series of high resistance responses form a semi-circular feature that may represent an early enclosure and is also seen within the gradiometer data [38]



Summary

There was limited success with the gradiometer survey, particularly at the southern and this could be due to changes in the level of waterlogging of the ground. The resistivity survey was far more successful in detecting sub-surface features including the remains of the wall and possibly the ditch. The vallum and the military way do not appear in the gradiometer survey even though their line, as shown on the post 1921 Ordnance Survey, should cross the survey area. A further resistance survey to the south of the one completed was unable to take place due to waterlogging and land access issues. Given the results from the northern survey this is something that would be worth considering in the future.

Sources and References

British Geological Survey (2011) - *Soil Parent Material Model [SHAPE geospatial data], Scale 1:50000, updated: 1 June 2011, BGS, using: EDINA Geology Digimap Service, <https://digimap.edina.ac.uk>, Downloaded: 2021-05-13 09:35:02.7*

British Geological Survey (2016) *DiGMapGB-50 [SHAPE geospatial data], Scale 1:50000, updated: 30 November 2016, BGS, using: EDINA Geology Digimap Service, <https://digimap.edina.ac.uk>, Downloaded: 2021-05-13 09:35:02.7*

Environment Agency (2016) *Lidar Composite Digital Terrain Model England 1m resolution [ASC geospatial data]. Scale 1:4000, Updated: 5 January 2016, Open Government Licence, using: EDINA LIDAR Digimap Service, <https://digimap.edina.ac.uk>, Downloaded: 2021-05-13 09:37:04.87*

Ordnance Survey (2021) *1:50,000 Scale Colour Raster [TIFF geospatial data], Scale 1:50,000, updated: 14 May 2021, Ordnance Survey (GB), Using: EDINA Digimap Ordnance Survey Service, <https://digimap.edina.ac.uk>, Downloaded: 2021-11-01 09:37:39.084*

Schmidt A, Linford P, Linford N, David A, Gaffney C, Sarris A and Fassbinder J (2016) *EAC Guidelines for the use of Geophysics in Archaeology*

Simpson F, Hodgson K and Richmond I (1934) New Turret-Sites on the Line of the Turf Wall and the Type of Stone Wall Later Associated with Them in *Transactions of the Cumberland and Westmorland Antiquarian and Archaeological Society Series 2 Volume 34*