Carham

Geophysical Survey

2019

A Report

by the

Bernician Studies Group

for the

Battlefields Trust

in partnership with the

Carham 1018 Society

Supported by

The National Lottery®

through the Heritage Lottery Fund

heritage lottery fund

Contents

Information Sheet

Report Title	Carham Geophysical Survey 2019
Report by	Bernician Studies Group (BSG): UK Charity Reg. No. 1170897
Report for	Battlefields Trust in partnership with Carham 1018 Society (BT1018Soc)
Site Location	The Holme, Carham, Northumberland
NGR Grid Reference	NT 3707.6384
Height OD	20m - 25m above sea level (Ordnance Datum)
Geology at Site	Glacio-fluvial deposits over Tournaisian limestone with possible igneous erratics
Site period and type	Medieval settlement?
Purpose of Survey	To test possible remains of a Cuthbertian cell (7th C) and an Augustinian priory (12th C).
Funding	Heritage Lottery Fund
Site Landowner	David and Peter Straker-Smith
Project Director	Colm O'Brien (BSG)
Technical Director	Edward Pennie (BSG)
Site Project Manager	Clive Hallam-Baker (BT1018Soc)
Date of Survey	21-23 October 2019
Report Authors	Edward Pennie, Geoff Taylor (BSG) with Rannoch Daly (BT1018Soc)
Report Editors	Colm O'Brien and Max Adams (BSG)
Date of Report	12 February 2020
Access Archive	Available on request from Bernician Studies Group
Access Full Report	Published online at www.bernicianstudies.eu/ Fieldwork Reports

Summary

1 - Introduction
In 2019 the Battlefields Trust, in partnership with the Carham 1018 Society (BT1018Soc), asked the Bernician Studies Group (BSG) about possible medieval remains in The Holme, at Carham, a tiny hamlet in Northumberland on the Scottish Border on the south bank of the river Tweed. The project would be community based with local volunteers and the funding would be from the Heritage Lottery Fund. The BSG proposed magnetometry.

2 - Scope of the Project
King Ecgfrith of Northumbria (670-685 AD) granted Carham to the church of St Cuthbert at Lindisfarne. In 1126 AD Carham was granted to the monks of Kirkham priory by Walter Espec of Helmsley. A DEFRA LiDAR image of the village and 'The Holme', a large field of pasture by the river, showed ground markings which suggested possible medieval remains.

3 - Landscape Characteristics
The prime agricultural soils of the lower Tweed valley show signs of occupation in Mesolithic and Neolithic times. In the 9 sqkm around Carham the Historic Environment Record (HER) shows Bronze age, Iron age, Roman and Medieval remains.

4 - Site Geology
The Cheviot is an extinct volcano ten miles south but the magnetic anomalies of the igneous rocks do not extend to the Carham bedrock, which is magnetically neutral. The surface geology of the survey sites in The Holme is glacial and alluvial deposits, including from the most recent ice thaw about 12,000 years ago, with occasional rocky outcrops.

5 - Establishing the Grid
An E/W baseline was established in The Holme and grid squares of 20m*20m were set out to enable survey of the area immediately north of the church (West site) and of a large rectangular shape visible on LiDAR in the middle of the field (East site).

6 - Scanning Methodology
Using a Fluxgate 256 Gradiometer, 22 Grids (15W and 7E) were scanned in zig-zag passes at intervals of 0.5m. All grid scans were of good standard and all are included in the report.

7 - Summary of Results
The rectangular shape in the East site (HER N116) is too big for a building but it is clearly of some antiquity and may be connected with fish or animal husbandry. The West site has many shapes which appear to be the foundations of buildings or boundaries and which could include residences, farm buildings or a place of worship (HER N112 and N117): which are consistent with, but do not prove, an early ecclesiastical site.

8 - Carham conclusion and Next Steps
The BT1018Soc is very pleased with the project and findings and will consider options for further study with further community participation and skills transfer.

PART 1: BACKGROUND

1 INTRODUCTION

1.1 This Report is produced by the Bernician Studies Group (BSG) (Annex A) for the "Battlefields Trust in partnership with the Carham 1018 Society" (BT1018Soc). The BSG's project proposals set out their community-based approach (Annex B) and the rationale for investigations of Carham's medieval history (Annex C). Ownership of the report rests with the BSG.

1.2 The tiny hamlet of Carham (11 houses) is in Northumberland. Carham (NT 3797.6384) sits on the Anglo-Scottish border on the south bank of the River Tweed 25 kilometres upstream from Berwick-upon-Tweed and 10 kilometres downstream from Kelso (Fig 1.1).

Figure 1.1: Carham and other medieval ecclesiastical sites.
The red diamond at Carham indicates a minor Augustinian house of the period.
(Source: OS 1:625k Map of Monastic Britain 1978)

1.3 The name 'Carham' derives from Old English and means 'settlement at the rocks' (Watts.2004). As can be seen on the Bing satellite image below, the rocks are on the banks of the nearby river Tweed (Fig 1.2). Across the river is the village of Birgham which, according to the village website, means 'the bridge settlement'. No trace of a bridge has ever been found but the river is fordable nearby. A track from Birgham leads south towards Carham rocks.

1.4 The origin of this survey was the Battle of Carham 1018 AD and the one-thousand year commemoration and re-enactment organised by the BT1018Soc in 2018[1]. The BT1018Soc identified The Holme as a possible site for the battle (Fig 1.2). Research by a Society member for the book of the battle (Daly.2018) led to discussion with members of the BSG about a LiDAR image of Carham (Fig 1.3) which showed rigg and furrow markings in 'The Holme' and a rectangular shape in the middle of the field which appeared to feature:

- a 'track' towards the south;
- an opening northwards towards the ancient course of the river;
- a possible boundary curving to the west.

Figure 1.2: Carham village, churchyard, River Tweed and 'The Holme' (Source: Bing Satellite image)

Figure 1.3: LiDAR image of Carham (LiDAR = Light Detection And Ranging). (Source: Environment Agency).

1.5 An initial BSG site visit in April 2019 indicated that the site had potential for archaeological remains and geophysical investigation. The BT1018Soc engaged the BSG to provide training for members and associates to conduct a magnetometry survey of the site, to provide on-going advice and to analyse the results. In addition to the BSG, the survey participants were:

- the Carham 1018 Society (Clive Hallam-Baker, Rannoch Daly, David Welsh),
- the Till Valley Archaeological Society (Mary Stevens)
- the Lowick Heritage Group (Brian and Byrnice Reeds);
- the Battlefields Trust (Nigel Woods).

1.6 Access to the site was agreed with the landowners, David and Peter Straker-Smith.

1 The 1976 OS Map (Sheet 74: NT 833 387) shows a site for the battle of Carham but with the date AD 1016. Subsequent historical research has established that AD 1018 is the correct date (Duncan.1976) but the 2007 OS Map (Sheet 339) omits the site of the battle.

Funding was provided by the Heritage Lottery Fund within the terms of their grant to the BT1018Soc for re-enactment, commemoration and legacy projects for the battle of Carham 1018. The survey took place on 21-23 October 2019.

2 SCOPE OF THE PROJECT

2.1 The earliest known reference to Carham is in Chapter 7 of the *Historia De Sancto Cuthberto* (South.2002) which records that "Carham and everything pertaining thereto" was granted to the church of St Cuthbert (i.e. at Lindisfarne) by King Egcfrith of Northumbria (670-685 AD) following a victory over the Mercian leader Wulfhere (d. 675). This suggests that there was a community at Carham at the time (perhaps the 'deserted village' of HER N117?). A charter of Henry I in 1126 connects Carham with the Augustinians (the 'Augustininan cell' of HER N112?) and an 'Abbey (site of)' appears on the Ordnance Survey map of 1900 (Fig. 3.1).

2.2 As a preliminary, BSG Research Directors Colm O'Brien and Max Adams and Technical Director Edward Pennie walked 'The Holme' on 30 April 2019 with BT1018Soc members. The site is fairly flat, sloping slightly upwards away from the river towards the B6350 on the south side. The flora is lush grass suitable for its present purpose; pasture for sheep and cattle. The rigg and furrow pattern is visible on the ground, as is the rectangular shape on the LiDAR image. All appear to be consistent with medieval remains (Annex D): hence the project objective.

Project Objective
"to test by geophysical survey the hypothesis that the present Church of St Cuthbert at Carham is positioned within an ecclesiastical precinct founded in the seventh century, part of the boundary of which can be detected in pasture land north and east of the church."

Geophysics

2.3 Magnetometry relies on three linked phenomena:

- that soils contain minute particles of iron;
- that these align themselves with the earth's magnetic field at the time of deposition;
- that subsequent human disturbance of soils changes the alignment of the iron particles.

The survey instrument, a gradiometer, records numerical values (nano-Tesla[2]) reflecting the intensity of the magnetic field. Any variations above or below a background norm across the survey area indicate places where the ground has been disturbed. Patterns are revealed and the raw data are then processed by a computer programme which transforms the numbers into areas of tone in a graphic display (see Section 7 below).

2 'Magnetic anomaly is expressed in nano-Tesla (nT) which represents about one 50,000th part of the earth's magnetic field.' (British Geological Survey Map of Magnetic Anomaly: UK North, 2007)

3 LANDSCAPE CHARACTERISTICS

3.1 The river Tweed meanders across its wide flood plain of alluvial soils which produce rich agricultural land with both pasture and arable crops. The steep banking across the river from 'The Holme' on the north side of the Tweed and the flat shingle on the south side indicate that the river channel has been moving northwards at that point. The LiDAR image (Fig. 1.3) seems to show a series of old river banks in the north of 'The Holme' which suggests that this movement has been proceeding for many years. Medieval paleo-channels have been mapped a couple of miles down the Tweed between Carham and Coldstream (Passmore and Waddington.2009. page 68).

3.2 The Carham district seems to have been inhabited for many centuries. Two miles downstream from Carham, field-walking surveys near Wark have found numerous Mesolithic and Neolithic stone implements, in some instances more than 20 lithics per hectare (Passmore and Waddington 2009: Vol 1: 102-3). They conclude 'The regular clusters of Meso-lithic material identified during this survey of the lower Tweed valley clearly identify this river as a major route-way for Mesolithic groups as well as an attractive area for settlement in its own right.' (Vol 2: 130-1)

3.3 Two miles upstream from Carham, detailed analysis of aerial photographs of crop marks at Sprouston show evidence of three phases of occupation:

- Phase 1 – Mesolithic, Neolithic and Bronze Age activity
- Phase 2 – Romano-British
- Phase 3 – 'a British estate adopted for use by the incoming English sometime in the late 6th or early 7th century' (Smith.1991. P 288)

Historic Environment Record

3.4 A search of the Historic Environment Record (HER) for archaeological sites in the 9 sqkm surrounding Carham (NGR 78,79,80.37,38,39) necessarily involved two sets of records:

- Northumberland *(http://www.keystothepast[3])*
- Scotland (*https://canmore.org.uk/*[4]).

3.5 The search identified 18 sites in Northumberland and 48 in Scotland. Although many of these are undoubtedly ancient, several have not yet been examined in detail and are not yet assigned to any particular historic period. Others are assigned to the Post-Medieval (after 1540 AD) which is more recent than the focus of this study. The twelve sites listed below (with their ID or Reference number) and marked on the map (Fig 3.1) include all eleven sites dated Medieval or earlier (before 1540 AD) and the undated rectangular shape already identified as a survey target (Item F). Table E1 (Northumberland) and Table E2 (Scotland) give further information from the HER about these twelve sites (Annex E).

3 Entries in "Keys to the Past" are extracts from the Historic Environment Record (HER). For access to the full HER contact NCC Conservation Team, County Hall, Morpeth, NE61 2EF. *(archaeology@northumberland.gov.uk)*

4 The website of the National Record of the Historic Environment Scotland

Sites in Northumberland

A – N115 - A bronze dagger of the Bronze Age found in the Tweed near Carham in 1853
B – N121 - A temporary Roman Camp at Carham
C – N117 - The Deserted Medieval Village of Carham
D – N112 - An Augustinian cell at Carham founded in 1131
E – N685 - The site of a C.13 tower at Carham Hall
F – N116 - A rectangular cropmark in The Holme of uncertain date

Sites in Scotland

1 – ID 58336 - A bronze scabbard of the Bronze Age found in the Tweed near Carham
2 – ID 58330 - A Pre-Historic fort and enclosure at Redden
3 – ID 58322 - An Iron Age fort and Pre-Historic enclosure at Birgham Haugh
4 – ID 58310 - An Early Medieval cross-slab found in Birgham
5 – ID 58325 - A Medieval chapel and burial ground in Birgham
6 – ID 343379 - The Medieval village of Birgham across the Tweed from Carham

3.6 Of particular note in Northumberland are the medieval village of Carham (Item C) and the Augustinian cell (Item D) which contribute towards the raison d'etre of the survey and the rectangular cropmark (Item F), so prominent in the LiDAR image (Fig. 1.3).

3.7 Of particular note in Scotland is the medieval village of Birgham (Items 4, 5 and 6) and the two Pre-Historic/ Iron Age forts and enclosures (Items 2 and 3). These sit a few feet above the flood plain on opposite banks of the Tweed just upriver from Carham where it is fordable between Birgham and Redden. It is tempting to speculate whether they may be connected to the bronze scabbard (Item 1) and dagger (Item A).

3.8 The Holme lies between the contours of 20m and 25 m OD above sea level. It is tiered with a lower part flood plain, an intermediate level which shows signs of broad rigg and furrow ploughing, and a higher area to the south-west sitting upon an outcrop of metamorphic limestone rock on which the present-day Church stands. The Holme contains the two sites surveyed:

- the Carham West site is immediately north of the church;
- the Carham East site is away from the river towards the centre of the field.

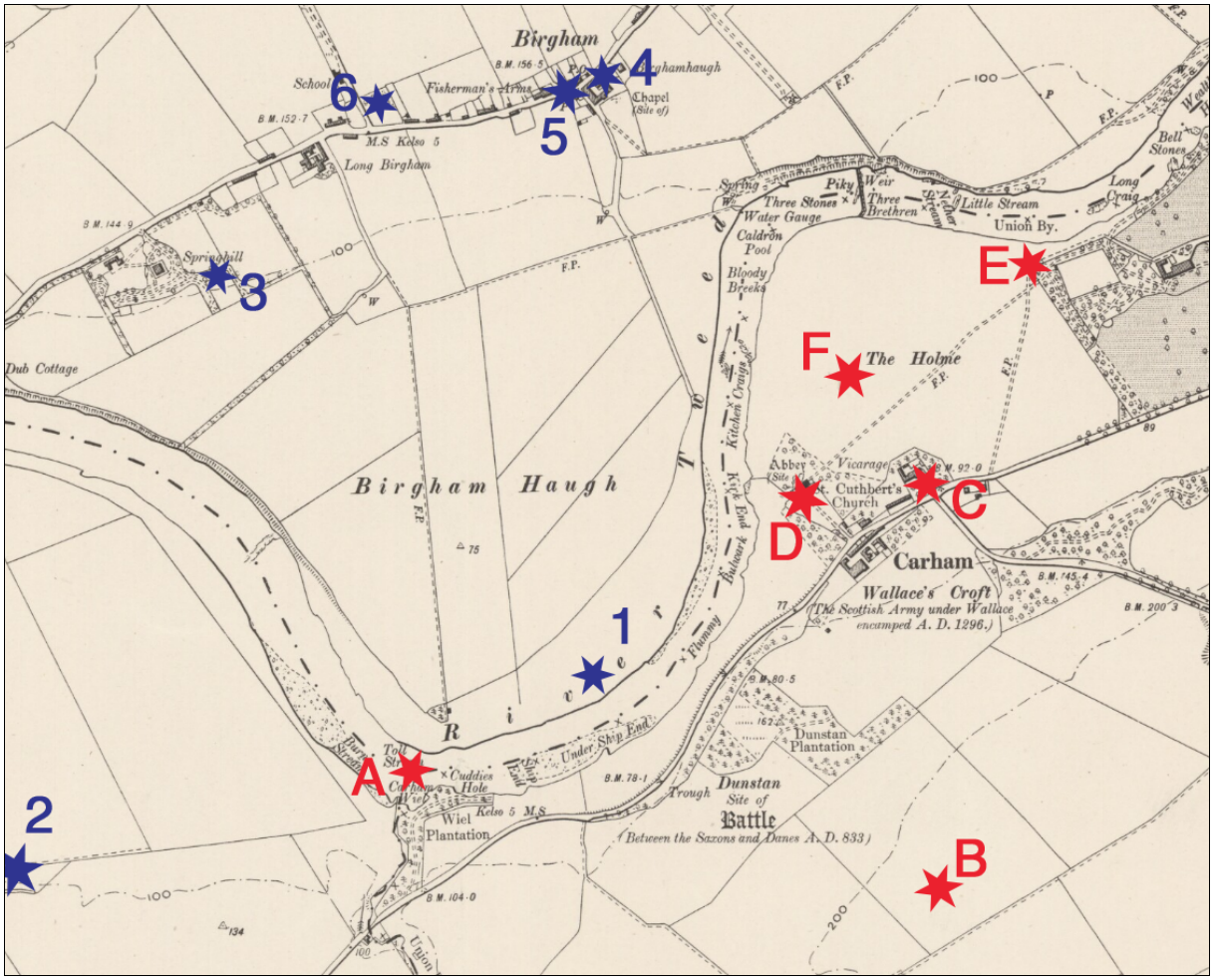

Figure 3.1: Carham and surrounds on the river Tweed in 1900 AD.
Items 1-6 and A-F are archaeological sites from the Historic Environment Record
(Source: OS Second Edition at 6 Inches to 1 Mile (1900)
Reproduced with the permission of the National Library of Scotland)

4 SITE GEOLOGY

4.1 In north Northumberland the obvious, dominant geological feature is the Cheviot Hill (Figs 4.1 and 4.2). 'The Holme' at Carham sits below the Cheviot on the flat plain of the river Tweed (point arrowed at C1 in Fig 4.1: marked with a star on Fig 4.2).

- The massive volcanic pluton of the Cheviot; an igneous blob of granitic and syenitic rocks (coloured RED in Fig 4.1) sits like an iceberg rising to a summit of 815 metres but extending underground to a depth of at least 8,000 metres.
- The Cheviot is surrounded for miles on all four slopes, but particularly on the West and North-West, by deposits of andesitic and basaltic lava and tuff (coloured Pale PINK) of the Silurian/Devonian era, about 400 million years old.
- This is further surrounded on the almost flat plains of the rivers Tweed and Till by a bedrock of Tournaisian sandstone, cement-stone and limestone of the Inverclyde Group (coloured Dark BLUE), about 350 million years old.

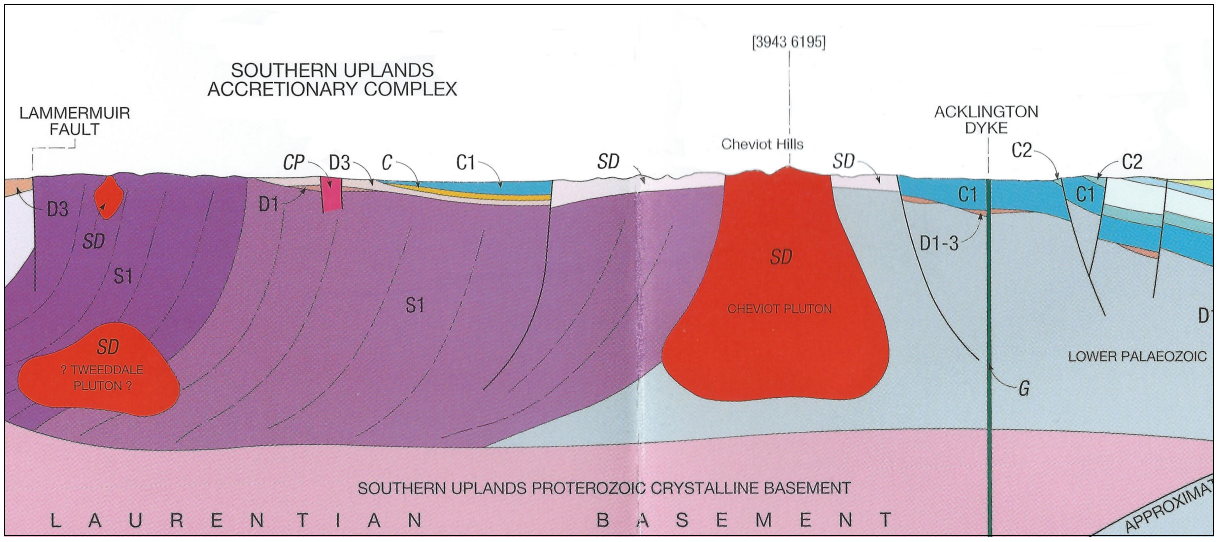

Figure 4.1: Cross-section of Bedrock Geology. (NNW on the left: SSE on the right)
The big red blob is the Cheviot volcanic pluton. The arrow C1 is pointing directly at Carham.
(Source: British Geological Survey. Bedrock Geology UK North 5th Edition, 2007)

4.2 The surface soil at Carham is typical of the Tweed valley bottom. Near the village there are glacio-fluvial deposits of sand and gravel of the Devensian ice age (126,000 to 11,700 years ago). On 'The Holme', nearer the river, there are deposits of river terrace and alluvial gravel, sand, silt and clay of the Holocene epoch (from 11,700 years ago to the present)[5].

Earth's Magnetic Field

4.3 The strength of the earth's magnetic field varies slightly from place to place across the globe, being at its strongest above igneous rock, which has a high iron content. Accordingly, the most prominent local magnetic anomaly is a reading in excess of +1,000 nT around the extinct caldera at the top of the Cheviot Hill (about 2% stronger than at the bottom). This

5 Source: http//mapapps.bgs.ac.uk/geologyofbritain/home.html accessed 27 Nov 2019

anomaly reduces significantly as one moves away from the Cheviot summit. 'The Holme' at Carham (marked with a star) lies ten miles NNW of the Cheviot between the magnetic field contours for -10nT and -20 nT (Fig 4.2).

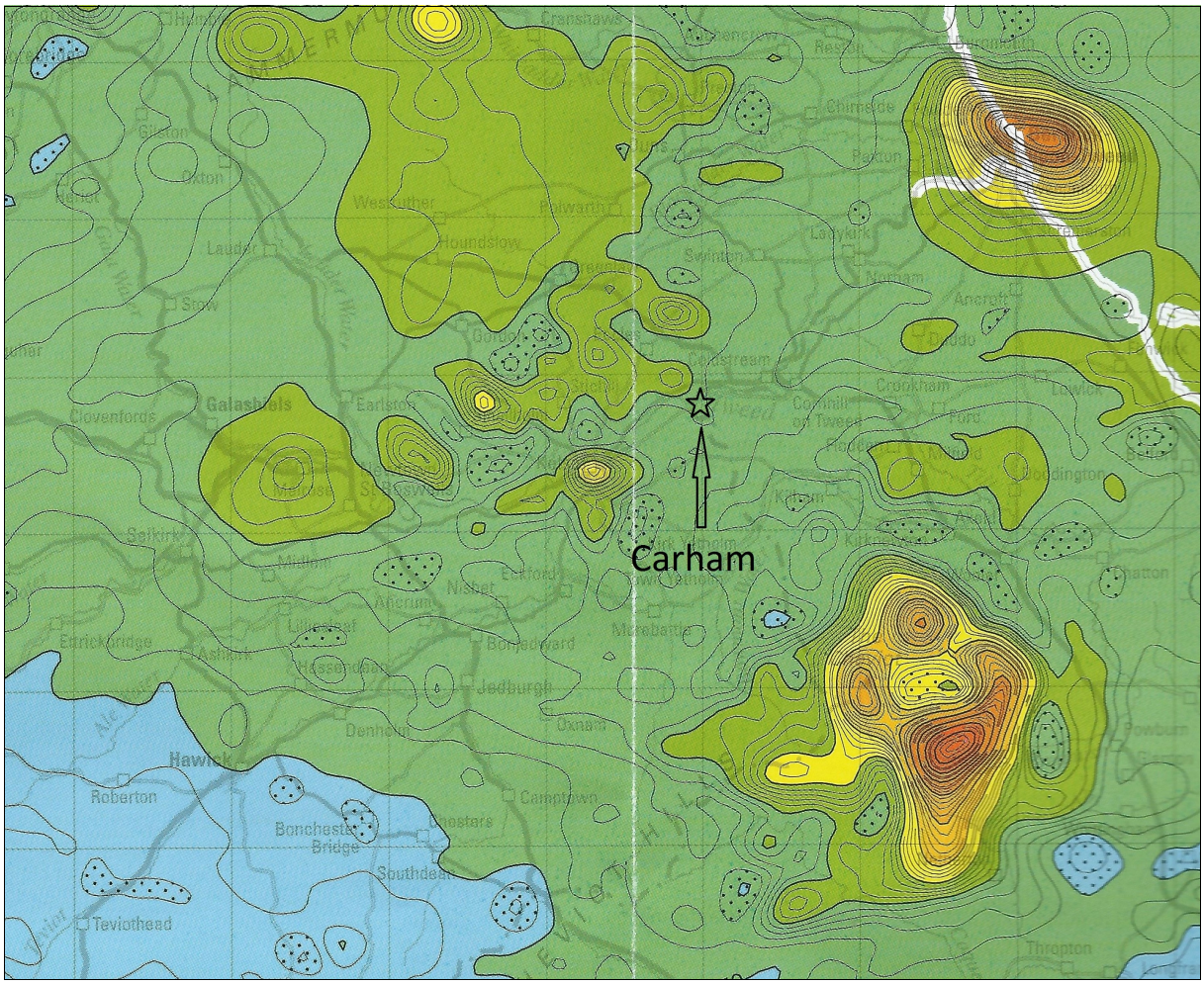

Figure 4.2: Magnetic Anomaly of Carham and surrounds.
At bottom right, the extinct caldera of the Cheviot is clearly visible in brown and red (up to +1,000 nT) with the central crater in yellow (up to +100 nT)
The greens of the surrounding areas indicate minor magnetic anomalies between +50 and -50 nT. The contour between the two shades of green, which runs very close to Carham (marked with a star) represents no anomaly, Zero nT.
(NB: The brown patch near Berwick is an extinct volcano now mostly under the sea.)
(Source: British Geological Survey Magnetic Anomaly UK North 2nd Edition, 2007)

PART 2 BSG REPORT OF THE GEOPHYSICS SURVEY

5 ESTABLISHING THE GRID

5.1 It is BSG normal practice to undertake a survey beginning at a base line along one of the ordinal compass points and then gradually progressing across the site (Annex F).

5.2 The potential total survey area being about 200 grid squares of 20m*20m (315m*245m) and the likely survey capacity of the group in two days being no more than twenty such grid squares, as part of the training exercise the group had been asked to identify their priority areas. First priority was given to the area north of the Church (Carham West) as the firm ground was ideal for construction purposes and had not been ploughed. This was a possible location for a 'deserted medieval village' (HER N117) and/or an 'Augustinian cell' (HER N112). A second area (Carham East) would be included if time permitted as this showed an outline of a large rectangular feature in the LiDAR which appeared to correspond to the cropmark (HER N116). The grid pattern was therefore established to encompass these two areas and to link them together for continuity purposes (Fig 6.1).

5.3 After a morning briefing on 21 Oct 2019, the whole group moved on site in the afternoon to set out the baseline and the first four grid squares on the West site. An East-West base line was set out running from 1m North of the old tennis court (Point A on Fig 6.1) west for 180m to the edge of the Holme overlooking the Tweed (Point B). A South-North base line was set out to run for 100m north from the telegraph pole near the junction of the Churchyard and the first house's garden (Point R). The Grid centre was established at the intersection of these two base lines (Point C). Team A then surveyed the first four squares with the gradiometer whilst Team B set out further grid squares.

5.4 All grids were set out using compass, surveying poles, tapes and using the basic geometry of Pythagoras' theorem. Consequently, the grids are aligned by compass to an approximated magnetic north which is 2.5 – 3 degrees West of grid North.

5.5 A BSG grid-planning sheet showing the grid positions with marked out squares was used in the field, with data being written in as work progressed. The sheet was updated each evening with additional grid numbers and dates as they were set out and surveyed. The geometric method is a better training model for setting out, but a Geode GNSS system was used for logging the grid points. Full location details are given in Table 1 (Grid Marker Points) and Table 2 (Local Landscape Features) (Annex F).

6 SCANNING METHODOLOGY

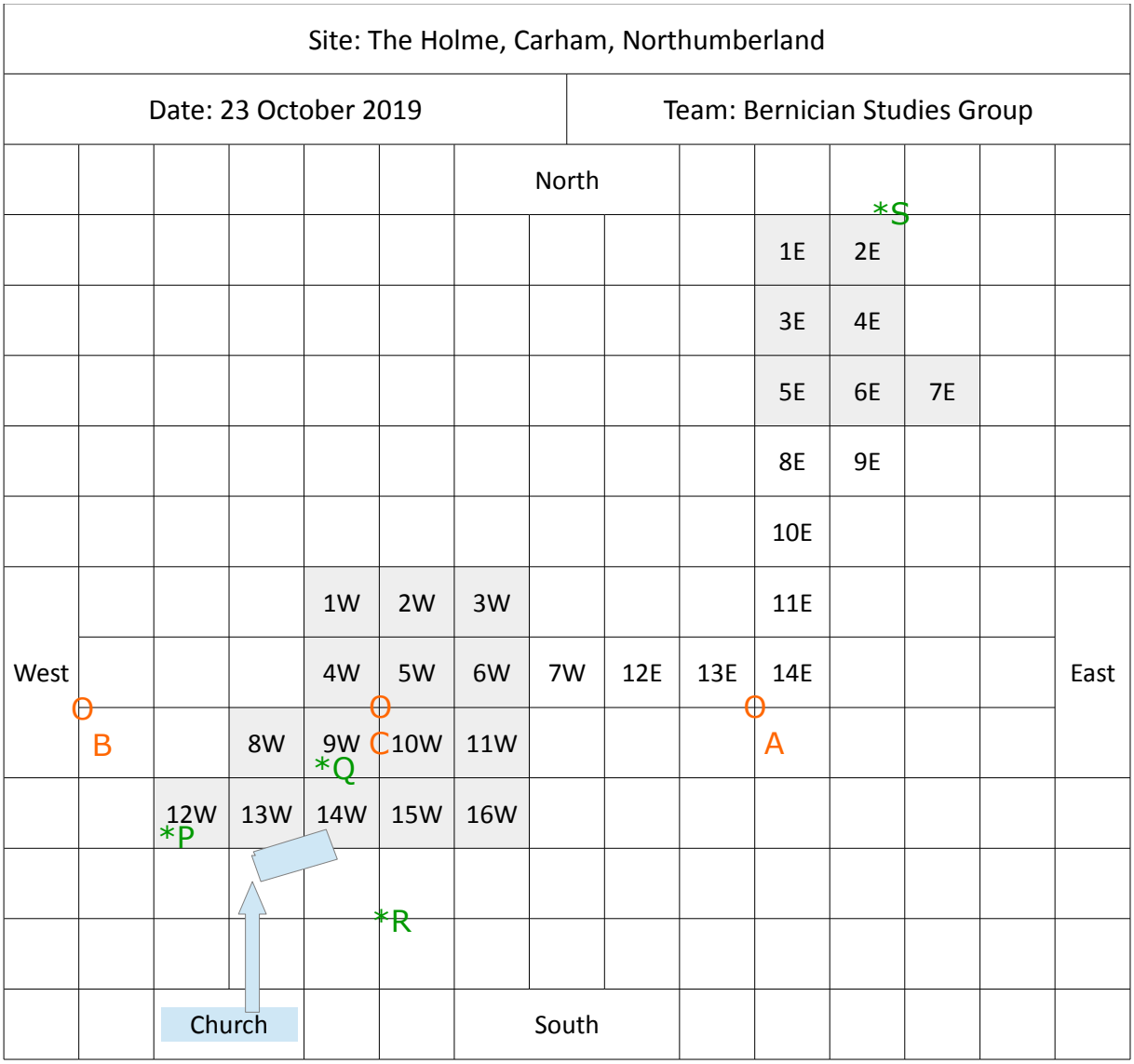

Figure 6.1: Final Grid at Carham: A-B = Baseline; C = Intersection
*The pegged squares (20m*20m) north of the church were labelled 1W-16W (West site) and those in the middle of the field were labelled 1E-14E (East site).*
In the SW, Carham church intruded upon grid squares 13W and 14W.
Topographical features: P=Lime Tree; Q=Silver Birch; R=Telegraph pole; S=Drainage chamber

6.1 Geophysical surveying using a Geoplot FM256 Fluxgate Gradiometer set at a sensitivity of 0.01nT began on 21 October 2019 at the intersection of the two base lines (Point C). Surveying was at intervals of 0.5m in W-E aligned zig-zag passes with a 50cm separation and at a sample rate of 8 readings per metre, giving 6,400 (8x2x20x20) readings per 20m square. The same methodology was used for all of the surveyed areas. Data was downloaded twice daily to ensure that any errors could be identified to the teams promptly and corrected, and that the quality of survey results was adequate. Initial analysis of the data was undertaken by

the BSG after each download. The total area surveyed was 8,800 sq m.

6.2 Starting from the base line intersection, the survey commenced in the West site with Grid Squares 5W and 10W together with the two adjacent grids further east (6W and 11W). These four squares showed strong linear features with right-angled corners suggesting archaeological features. Accordingly, the West survey was extended with two squares to the south (Grids 15 W and 16W), two to the north (Grids 2W and 3W) and a further two grids (1W and 4W) to the west of Grids 2W and 5W. With more features now visible in the data, the survey was further extended with two more grids to the south and west of the intersection (Grids 9W and 14W) plus three more grids further west (Grids 8W, 12W and 13W). The team had the experience of working around two large trees: Point P (a lime in Grid 12W) and Point Q (a silver birch in Grid 9W). Grids 13W and 14W were partial grids where the team had to work around the church.

6.3 These fifteen grids provided good coverage of the rocky platform area immediately north of the church, overlooking the river terrace. In the meantime, Team B had set out linking 20m*20m grid squares to the east and north (7W, 8E-14E) and had set out the East site so that Team A were able to use the remaining daylight of 23 October to survey grid squares 1E-7E. The overlay map below shows Carham village, the riverside setting on The Holme, the grid and landscape marker points and the scans from the West and East survey sites (Fig 6.2).

6.4 Surveying has potential difficulties, at least three of which were relevant to Carham:

- During the survey period, the weather altered from cold and dry to cool and windy and these weather variations can lead to inconsistency in readings.
- The West site is closer to rocky outcrops which, being potentially igneous, might have presented issues for magnetometry; but the survey results do not suggest that findings have been skewed.
- As this project was a teaching exercise for new operators, the quality of results to be expected was uncertain at the outset.

6.5 There was some exchange of membership between local Teams A and B to widen individuals' experience but most squares were surveyed by a select group of BT1018Soc members with each person surveying several squares in sequence to aid consistency in the quality of data. Despite the potential hindrances the actual variation in the quality of the data was very minor, as evidenced by the fact that there was very little need for data processing. Scanning was so good that even in the more difficult partial squares, no squares needed a repeat scan. In total, the BT1018Soc surveyed 19 full 20m x 20m squares and 3 partial squares, all of which have been included for analysis.

6.6 All of the final survey data has been included in the results below (Section 7). Each site's plots have been processed in one batch. Zero Mean Traverse with no threshold was applied to eliminate some stripes and then a Zero Mean Grid with Threshold 0.25 SD was used. This process smooths the edge match and creates a more cohesive image. Carham West had more spiky data, which bleached some of the detail from the image. The background in this area has a low base reading with little variation so any modern metallic object within range

of the survey such as fencing had a higher than normal interference and masked any small differences from non-metallic archaeology. Accordingly, this data was also clipped to +- 1SD. In addition, all squares were initially processed individually to ensure no features were missed by applying a universal setting. However, only original data was used in the batch processing. Pre- and post-processing screenshots are included for both sites (Annex F).

6.7 The underlying bedrock and surface geology was favourable to good survey results. The only site issues were the need to work around two large individual trees (a lime in 12 W and a silver birch in 9W) and to survey two partial grids adjacent to the Church (13W and 14 W). Weather conditions on the three days were favourable.

Figure 6.2: Overlay Map showing Carham, grid marker pegs, topographical features and the East and West survey sites

7 **RESULTS**

CARHAM EAST: Summary

7.1 One objective was to examine whether the rectangular feature clearly visible in the LiDAR image (HER N116) was an early archaeological feature. The outline of the West side of the feature is clearly, although not strongly, visible running through East grids 1, 3, 5 & 6. The Eastern side runs parallel but was only surveyed in grid 2. The rectangular feature is highly unlikely to have been a building as it is 60m long by 40m wide and such a structure would have required massive foundations, which were not evident. In addition, there is no historical record of such a grand building. However, three external features indicate that it is probably very old:

- The causeway connecting it through modern gardens and buildings to the south;
- The funnel shape to the North where the land slopes down in a crescent and then again to the flood plain of the river towards the ford;
- The rigg and furrow around the feature.

CARHAM EAST: Detailed Findings

7.2 The black border in the centre of the LIDAR image below (Fig 7.1) is the approximate coverage of the East survey (Fig 7.2). This is probably a little under half of the required area for a full survey. However, there is little further to understand from this site using the tools at our disposal. Several herring-bone type features running approximately N-S in grids 2E, 4E and 6E are probably drainage pipes. They all lead towards a large brick chamber with a cast iron cap (circa 20th century) just north of grid 2E. What appears to be a partial drain collapse can be seen on the surface mid way through grid 6E.

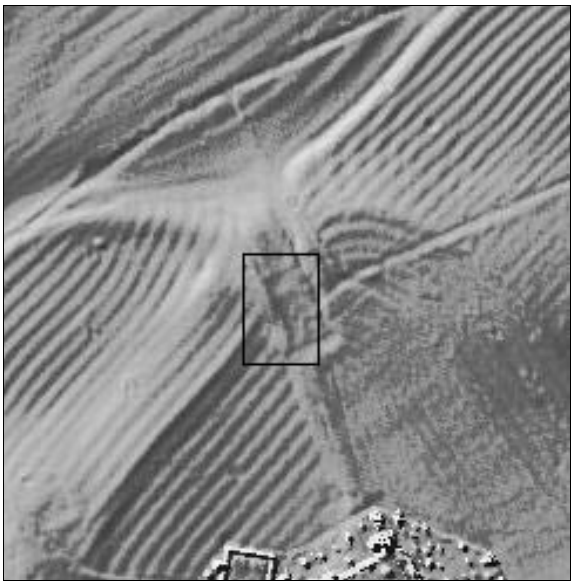

Fig 7.1: East, LiDAR

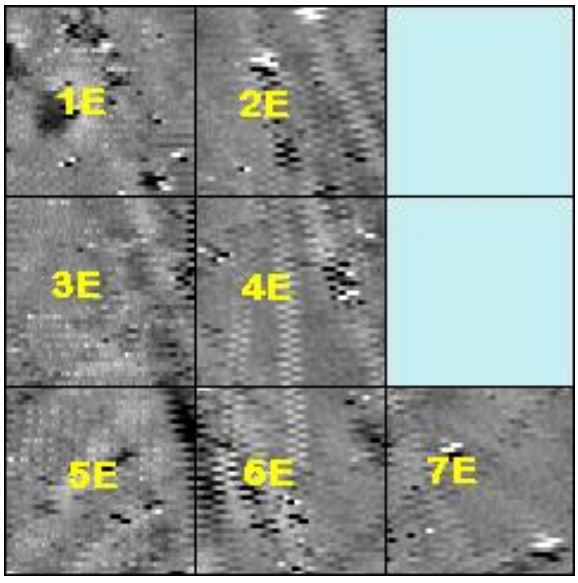

Fig 7.2: East, Survey Grid

N. B. In Fig 7.2 the grid square numbers are arbitrary and for ease of reference only.

7.3 The western edge of the rectangular feature is clearly visible in grids 1E, 3E, 5E and 6E

with the eastern edge showing in grid 2E. This is highlighted in Fig 7.6. The relationship of this feature to the surrounding rigg and furrow may be problematic as the feature could be:

- earlier, with the rigg and furrow constructed around;
- contemporaneous, with the rigg and furrow constructed around;
- later, with the previous rigg and furrow dug out and the spoil left on the embankments on the landward sides of the feature.

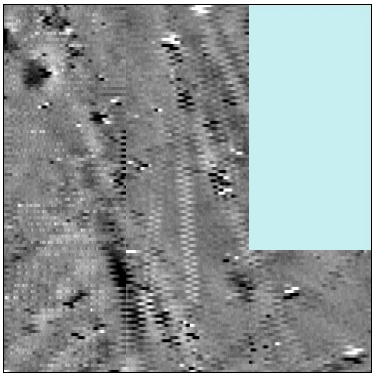

Fig 7.3: East, raw data.

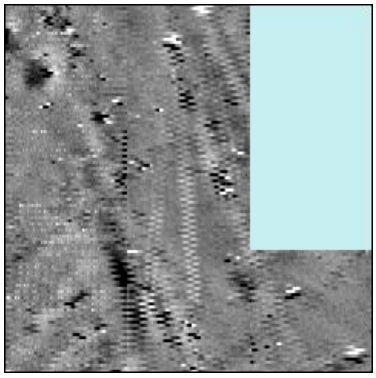

Fig 7.4: East, processed

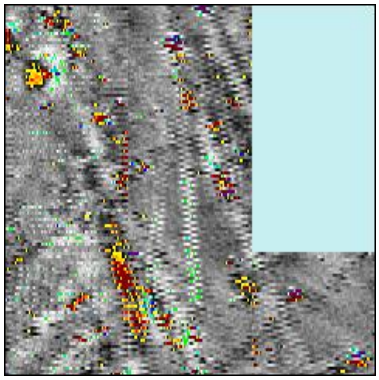

Fig 7.5: East, Greyscale 31

As can be seen, the processing and the Greyscale 31 added very little to the images.

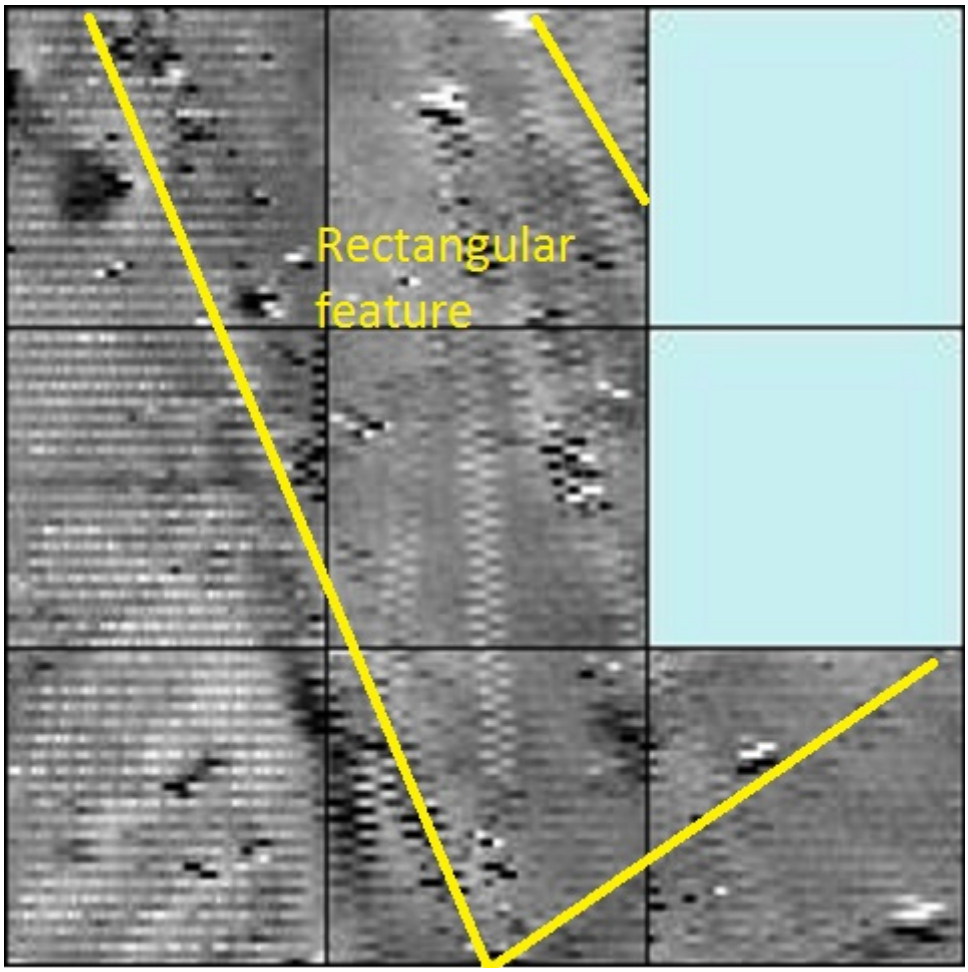

Figure 7.6: An annotated version of Fig 7.3 highlighting the rectangular feature.

7.4 The edges of the rectangular feature are visible to the naked eye on the ground. At 40m wide by 60m long (and in the past it may have been longer to the north) it is extremely large for a building: there are no indications of substantial foundations or large post-holes to carry a roof. Therefore, we must consider that its purpose was not for habitation or worship but probably an open air function. Possibilities include:

- fish rearing/ processing;
- a compound for animal husbandry (perhaps connected with rieving?);
- a small riverside harbour was considered (rocks just above Carham make the river almost unnavigable beyond this point) but this part of the field is slightly higher ground and possibly too far above river level.

CARHAM WEST: Summary

7.5 To test the hypothesis that the present Church of St Cuthbert at Carham is positioned within an ecclesiastical precinct founded in the 7th century, the most appropriate starting point was the higher, firm ground north of the church overlooking the sweep of the River Tweed. This is a typical site chosen by those early founding fathers. Even a modest monastic site (an 'Augustinian cell' HER N112?) would contain a series of buildings both for religious purposes and normal living, within a bounded precinct. Within those boundaries, early sites were less regular in layout than those founded post-conquest (a 'deserted medieval village' HER N117?). The geophysics reveals rectangular features beneath the surface that are likely to be the stone foundations of buildings of various sizes (Fig 7.11: Items 1-4). In addition, closer examination reveals that there may be structures from an earlier period showing up as fainter outlines either buried deeper in the subsoil or constructed of more ephemeral material (Fig 7.11: Items A and B).

7.6 The West site would benefit from wider scanning of adjacent grids to gain a fuller picture of the foundations and any precinct boundaries and perhaps from deeper examination to more clearly establish their age and methods of construction.

CARHAM WEST: Detailed Findings

7.7 In contrast with the East grids, the raw data of the West grids (Fig 7.7) reveal much more detail after processing (Fig 7.8) and in Greyscale 31[6] (Fig 7.10). Almost every grid (Fig.7.9) appears to contain the foundations of complex structures. The main features observed in the West site have been outlined and labelled in Fig 7.11 and can be compared with the Greyscale 31 image in Fig 7.10:

1 is a pair of similar small structures about 3m square.
2 is either a series of joining structures or one large structure with interior walls.
3 is a very large structure close to 40m*20m.
4 is a narrower structure but it may be just as long, with a more complex interior, and it may extend into adjacent unsurveyed areas beyond grids 8W and 12W.

6 In Greyscale 31 all readings within 2 SD (2 Standard Deviations from the Mean) are shown in greyscale with only the remaining 5% of readings shown in colour. The colours are in rainbow order from RED, the readings highest above the mean, to VIOLET, the readings furthest below the mean.

Items A and B are more subtle features which may indicate earlier phases of construction or perhaps use of more ephemeral materials.

7.9 Carham West is therefore a very important site and could well contain the remains of early ecclesiastical buildings. The strong readings indicate that these are probably stone structures which are likely to be late medieval, perhaps from the early 12th century era of King Henry I and Queen Matilda, but there are tantalising ghosts of possible earlier buildings (see Annex C) that would require more intensive study.

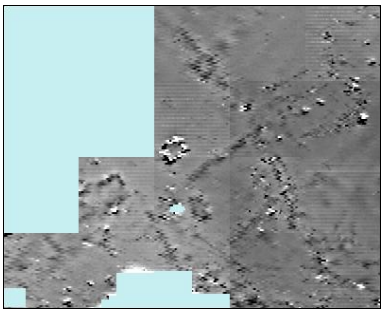

Fig 7.7: West, raw data

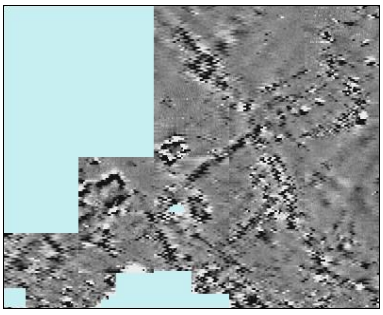

Fig 7.8: West, processed

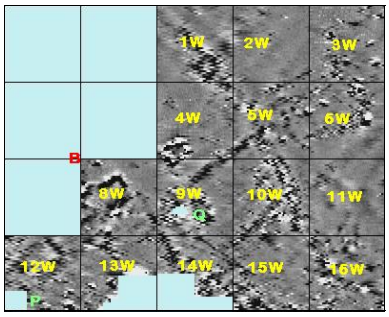

Fig 7.9: West, Survey Grid

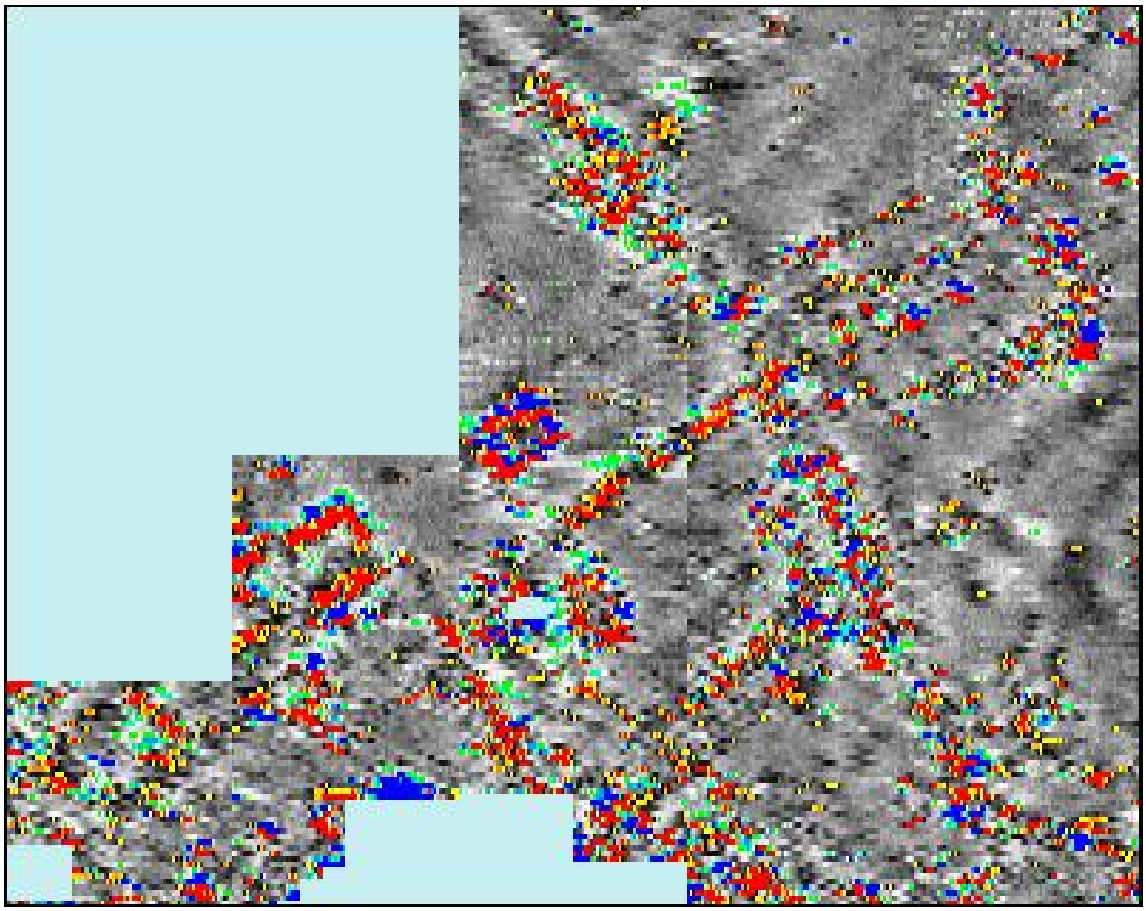

Fig 7.10: West, Greyscale 31

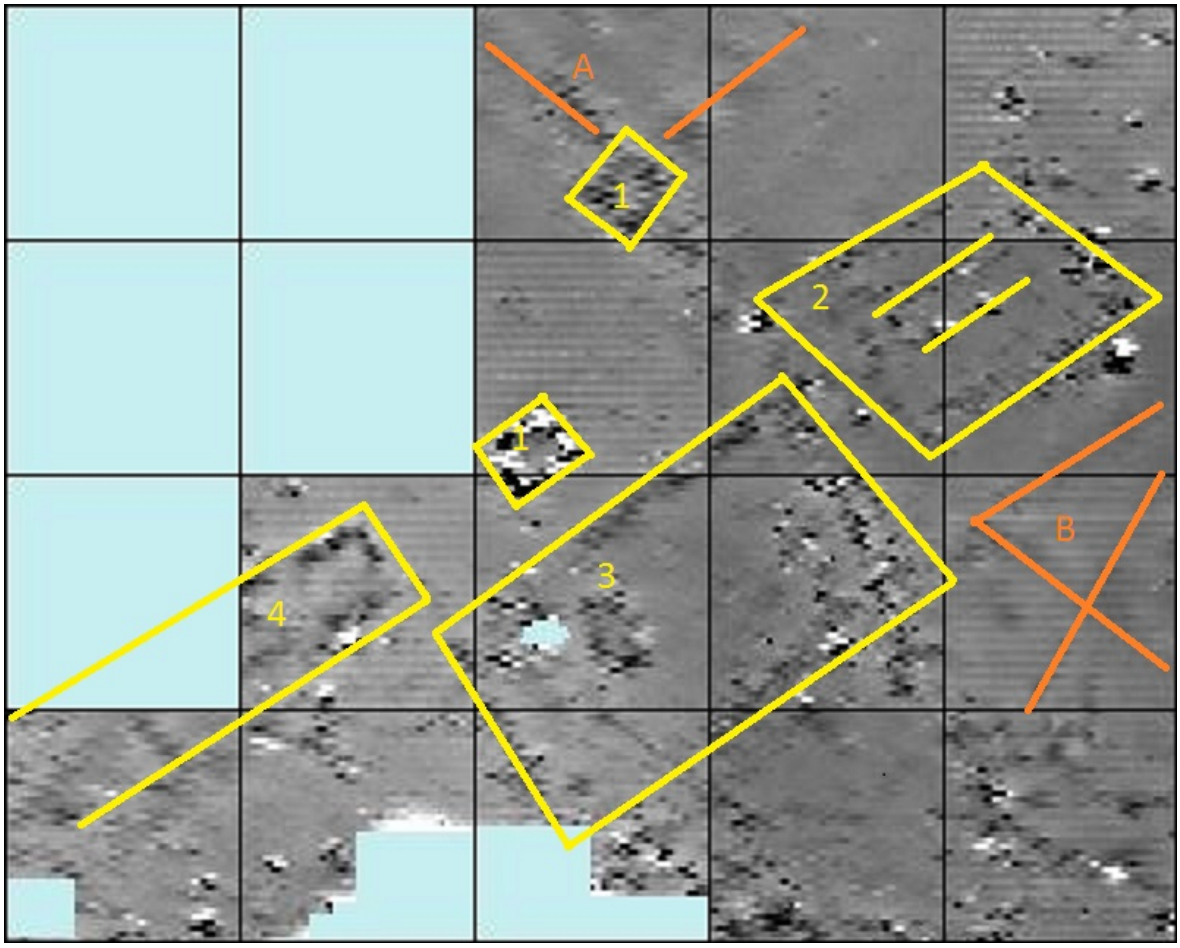

Figure 7.11: An annotated version of Fig 7.7 highlighting Items 1-4 and Items A, B.

8 CONCLUSION of BT1018Soc

8.1 The BT1018Soc are extremely pleased with the outcome of the survey. The training and support provided by the BSG in their Demonstration/ Participation model allowed local teamwork not only amongst members of the BT1018Soc but also with members of the Till Valley Archaeological Society and the Lowick Heritage Group. The briefings, demonstrations and project leadership on site allowed a far greater area to be surveyed than originally expected and to a higher standard: no repeat work was necessary. The BSG and all participants would like to express our appreciation to the landowners, David and Peter Straker-Smith for their assistance in providing access to The Holme and to the sheep who allowed us to share their grazing for a few days.

8.2 The findings in the West site suggest that there are remains north of the present church which are consistent with the buildings and precinct of a medieval community (HER N112 and N117) and which appear to have extended beyond the 15 grid squares in the present survey. The rectangular feature in the 7 grid squares of the East site (HER N116) appears to have been connected to an ancient trackway to the south and perhaps a river crossing to the north and may have been connected on the west side to the precinct boundaries of the medieval community.

8.3 In addition to these results, the BT1018Soc and their local associates have gained valuable knowledge and experience about the practical application of Geophysics and one member, Rannoch Daly, has gained the experience of drafting this report to the required archival standard.

9 NEXT STEPS

9.1 After this report is published the BT1018Soc and the BSG will organise a local public meeting to publicise the findings. Both will then consider whether further archaeological exploration is likely to be fruitful, its nature and funding.

9.2 There appears to be a strong case for extending the magnetometry survey from the present 22 grid squares to about 120 grid squares (about 240m E/W by about 200m N/S) around the West site up to and including the East site (see Fig 6.2).

9.3 An extended survey would not only offer the prospect of Carham revealing more details about medieval life on the Anglo-Scottish border but also further skills transfer for local community participants.

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Annex A

Bernician Studies Group

1. The Bernician Studies Group (BSG) is an educational charity in Newcastle upon Tyne (No. 1170897) associated with the lifelong learning programme Explore. Through archaeological and historic landscape studies, the BSG investigates the early historic kingdoms of north-east England, Bernicia and Northumberland, and their wider chronological and geographical settings. The BSG is engaged in archaeological fieldwork in north-west Ireland through its partner organisation, the Inishowen Studies Group.

2. The BSG's studies, scholarly activities, fieldwork standards and practices are conducted under the guidance of three Research Directors: Max Adams, Colm O'Brien and Diana Whaley.

Geophysics

3. The group have carried out geophysics surveys at Beamish (2014), Heavenfield (2015), Causey Park (2016), Brinkburn (2017) and, in partnership with the Lowick Heritage Group, at Hunting Hall in Lowick (2018). The reports of these five investigations are published on the BSG website at: http://www.bernicianstudies.eu/ Fieldwork Reports

Lands of St Cuthbert

4. Building on the accounts recorded in Sections 8 and 11 of the *Historia de Sancto Cuthberto* (South.2002), BSG directors have recently published research into the lands of St Cuthbert in modern Northumberland (O'Brien, et al.2018).

Inishowen

5. Under licence from the Department of Arts, Heritage and the Gaeltacht of the Republic of Ireland, the BSG has initiated a project in Donegal; The Inishowen Early Christian Landscapes Project. The BSG has conducted seven fieldwork seasons (2012 – 2018) in Donegal including full magnetometry surveys at the early ecclesiastical centres of Carrowmore, Clonca and Cooley, Co. Donegal.

<u>Publications arising from the Inishowen Project</u>:

O'Brien, C. and Adams, M. 2016a 'Early Ecclesiastical Precincts and Landscapes of Inishowen, Co. Donegal' 160-174 in T. Ó Carragáin and S. Turner (eds) Making Christian Landscapes in Atlantic Europe. University of Cork Press.

O'Brien, C., Adams, M., Haycock, D., O'Meara, D. and Pennie, E. 2014 'The Early Ecclesiastical Complexes of Carrowmore and Clonca and their Landscape Context in Inishowen, Co. Donegal.' Ulster Archaeological Journal, 72, 142-160.

Early Christian Landscape of Inishowen: Results of Fieldwork 2012 and 2013 and several other reports are available at: http://www.bernicianstudies.eu/?page_id=257

Annex B

Bernician Studies Group
Project Proposal: Magnetometry with Community Participation

1 In association with the local heritage organisation, BSG personnel will give a presentation to the local community on:

- the historical evidence which lies behind the investigation;
- archaeological survey methods;
- the results of the present survey.

Archaeological Method

2 The survey method is magnetometry survey conducted in the field with a Fluxgate Gradiometer and with post-survey processing and reporting. The BSG offer two models of community engagement which can be adapted to suit local requirements.

The Demonstration-Participation Model

3 This is a non-intensive model of engagement where it is not expected that those participating will then be undertaking geophysical survey independently. This model demonstrates and engages people in the how-to of geophysical survey. The BSG provides:

- an explanation of the features of the Fluxgate Gradiometer and demonstrations of its use in a survey area;
- an opportunity to handle the instrument and take measurements in sample survey transects;
- an explanation and demonstration of how the survey data are captured and processed in specialist software;
- an explanatory discussion of the graphic representation of the results of the survey in which they have participated.

The Training Model

4 The training model is an intensive course, designed to enable members of a community archaeology or other heritage group to undertake geophysical survey independently with help-desk support, if needed, from the BSG.

5 The training course in the use of the FM256 will be delivered at the proposed survey site over three days. Participants will be organised into teams of three. The lead trainer will be Jack Pennie, the Bernician Studies Group's project geophysicist. Jack will be assisted by other BSG members as necessary.

6 The aim of the course is to equip independent archaeologists:

- to be able to use the FM256 Fluxgate Gradiometer in their own project fieldwork;
- to download and process their own data;
- to interpret data at a basic level;
- to publish their findings in an appropriate professional format and to archival standard.

7 The course will cover all basic aspects of gradiometer survey, from grid layout and surveying, to the practical use of the machine in the field, safe downloading, data-processing and interpretation. The course will be supported by bespoke handouts and simple user-friendly aides-memoire.

Specifications

- Instrument make and type: Geoscan FM256.
- Instrument sensitivity setting: 0.1nT.
- Software: GeoPlot 4.

Field Method

8 In 10m x 10m or 20m x 20m survey squares, survey is in parallel zig-zag traverses, with traverse separations of 0.5m and reading intervals of 0.125m. The FM256 is balanced, aligned and zeroed against drift.

Data Processing

9 The BSG processing protocol limits post-survey processing to the minimum necessary (*EAC Guidelines for the Use of Geophysics in Archaeology (GUGA),* 2016, Section 4). It is normally only Despiking, Clipping, Edge Matching and X & Y Extrapolation.

Graphic Output

10 Greyscale plots of minimally enhanced data. (Meets *EAC GUGA,* 2016, Section 6.2).

Gradiometer

11 The FM256 is a remote-sensing device, linked to a data-logger which measures and records small changes in magnetic response from buried features. Along with the resistivity meter it is the industry-standard tool for locating, identifying and interpreting the remains of settlement and boundary features on susceptible soils. Magnetometry relies on the three linked phenomena that:

- all soils contain minute particles of iron;
- these align themselves with the earth's magnetic field at the time of deposition;
- human disturbance of soils changes the alignment of the iron particles.

12 The gradiometer is particularly useful in the detection of ditches and banks, enclosures and other features cut into subsoil such as graves, pits and sunken-featured buildings. It can also be used to detect hearths, kilns and ferrous-metalworking sites. It is not normally as effective in the detection of buried wall and other masonry features that are limestone based, but it is effective on features with high iron sandstones and volcanic basalt stone walls.

Annex C

Bernician Studies Group
Project Proposal: Carham and St Cuthbert: The Historical Evidence

1. The present parish church at Carham, dedicated to St Cuthbert, may be the successor to a church established here on an endowment of King Egfrith of Northumbria (670–685).

Historia de Sancto Cuthberto

2. The evidence is in the text known as the *Historia de Sancto Cuthberto* (hereafter, for convenience, referred to as the *HSC*). This was compiled, possibly in stages, at some time between the mid-10th and the mid-11th centuries within the Community of St Cuthbert. This is the ecclesiastical community who tended the body of their saint, who had died in 687,:

- after he was taken to Norham from the monastery of Lindisfarne (830-845);
- during the time at Chester-le-Street (883–995); and
- on to the eventual resting place in Durham from 995 (E. Cambridge.1989)

3. Despite its title, the HSC is not a biography of the saint. In the main, it is a set of claims made as to churches established and lands held in the name of St Cuthbert: the churches and lands of the monastery of Lindisfarne and its successor establishments post 885.

4. Section 7 of the *Historia* reads:

'Ea tempestate pugnauit Ecgfrid rex contra regem Merciorum Wulfhere filium Pendici, et ceso exercitu illius ipsum uicit in fugam uno tantum comitante puerulo conuertit. Et hoc obtinuit per auxilium sancti Wylfridi, qui cum eo fuit, maxime vero per orationes sancti Cuthberti qui absens erat. Post hoc bellum dedit Ecgfrith rex sancto Cuthberto Carrum et quicquid ad eam pertinet, et habuit eum in summa ueneratione quam diu uixit, ipse at tota sua cognatio, donec eo defuncto uenerunt Scaldingi et Eburacum ciuitatem fregerunt et terram uastauerunt.'

'In that time King Ecgfrith fought against the king of the Mercians, Wulfhere [died AD 675[7]] son of Penda, and having cut down his army he vanquished him and put him to flight with only one small boy accompanying him. And he [i.e. Ecgfrith] obtained this through the aid of St Wilfrid, who was with him, but especially through the prayers of St Cuthbert, who was absent. After this battle King Ecgfrith gave Carham and whatever pertains to it to St Cuthbert and held him in highest veneration as long as he lived, himself and all his kindred, until after his death the Scaldings [i.e. the Danes] came and crushed York and devastated the land.'

[Text and translation from the edition by T. Johnson South, 2002.]

5. Four points of interest arise here concerning Carham estate and church.

Carham Estate

6. The key phrase here is *Carrum et quicquid ad eam pertinent* – "Carham and whatever pertains to it". This is a grant of a landed estate, of which the estate centre is at Carham, with

7 Garmonsway.1972. p. 35

dependent places pertaining to it. This is a typical unit of land of the pre-Conquest period, the unit known as the small shire (or perhaps, in this case, a half shire). It is likely that the townships which came to form the ecclesiastical parish of Carham, and which formed the core holdings of the barony granted in the 1120s by Henry I to Walter Espec of Helmsley and centred at Wark-on-Tweed constituted this land unit, that is: Carham itself, along with Wark, Learmouth, Mindrum, Downham, Moneylaws and Pressen.

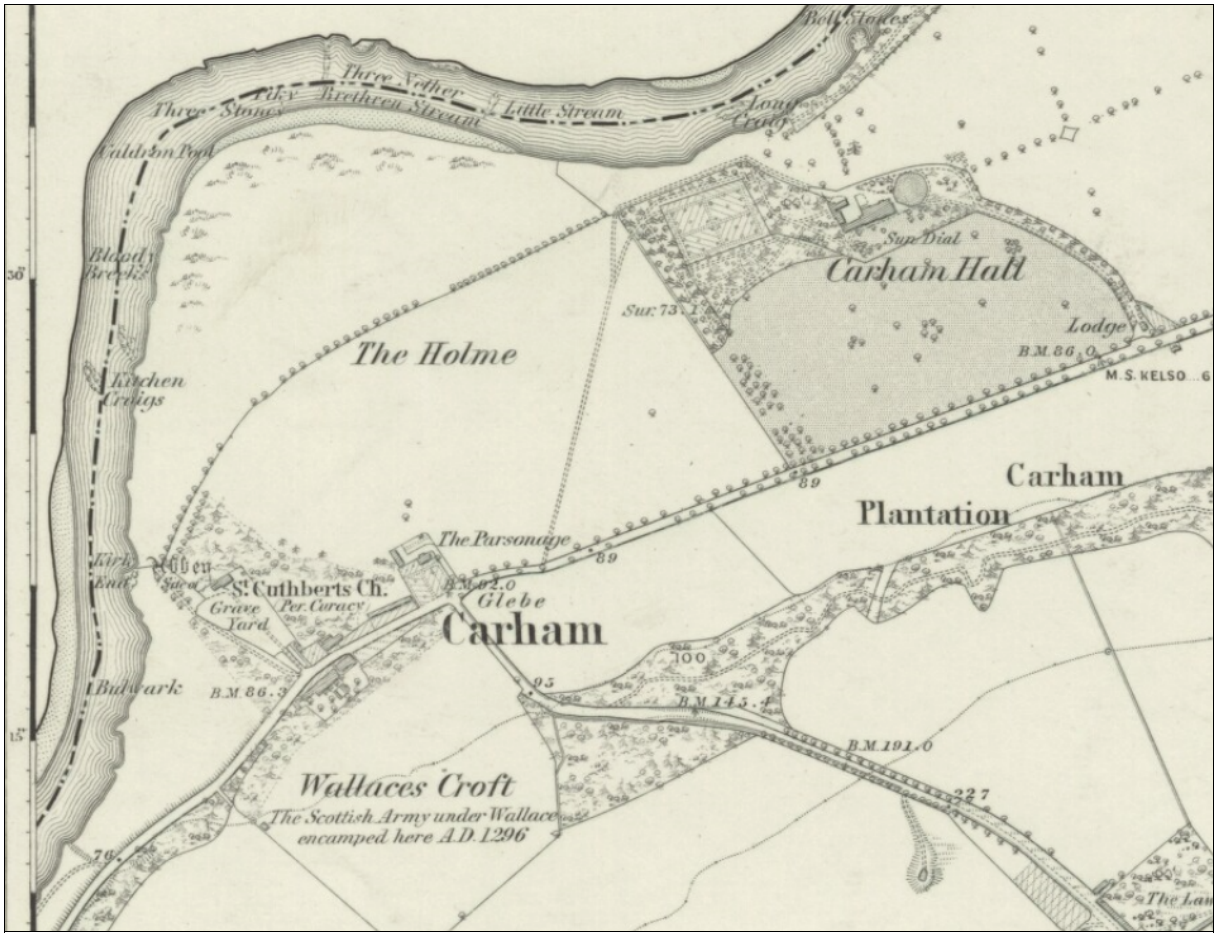


Figure C1: Carham in 1860.
The note west of the church reads 'Abbey (site of)'.
The equivalent note on the current OS 6 Inch map (not reproduced here) is more specific: it reads 'Priory Cell Augustinian'.
(Source: OS First Edition at 6 Inches to 1 Mile Northumberland IX (Inset VIIIA) Surveyed 1860 Pub. 1865. Reproduced with the permission of the National Library of Scotland)

Carham Church

7. Though the text does not make this explicit, it is likely that the Lindisfarne brethren, on receipt of this grant, established a church and a religious community at the estate centre in Carham. The evidence on this point is indirect. A precept of Queen Matilda (1100-1116), wife of Henry I, granting to 'God and St Cuthbert and the monks serving him the church of Carham and whatever pertains to it' (*ecclesiam de Carram et quicquid ad eam pertinent*), (Johnson.1956: Calendar 1143) using precisely the same form of words as given in the

Historia, is a strong indication that a church centre had survived the Anglo-Scandinavian era and come through into the post-Conquest period (HER N117?). Fragments of a cross shaft of late 10th/ early 11th century date found at Carham (HER N114) are consistent with such survival[8].

Ulchill the Clerk

8. In a subsequent notification in 1126, Henry I confirmed Walter Espec's gift of several lands to the church of Kirkham including: 'the church of Carham, the church of Kirknewton (*Niwetona in Glendala)*, the church in Ilderton, the vill of Titlington [in Eglingham], the houses of Ulchill the clerk in Carham and all his land, with the services which he rendered to Walter Espec (c. Northumb.)' (Johnson.1956: Calendar 1459).

Augustinians

9. One consequence of this action by Henry I in 1126 was that a house of Augustinian Canons came to carry out parochial functions here (see Fig C1), making Carham another case in Northumberland, along with Brinkburn and Hexham, of the Augustinians picking up and taking forward an already existing church (HER N112?). Carham and Brinkburn both derive from the 7th century monastery at Lindisfarne. At Hexham the Augustinians took over the already existing monastery, also founded in the 7th century.

8 The Carham cross is in the Great North Museum, Hancock, Barras Bridge, Newcastle-upon-Tyne, NE2 4PT

Annex D

Bernician Studies Group
Project Proposal: Carham and St Cuthbert: Walking the Site

Description

1. The church of St Cuthbert at Carham and the wedge-shaped churchyard are immediately west of a row of houses and gardens on the north side of the Cornhill to Kelso road (B6350), between the road and the river Tweed. The present-day church of St Cuthbert, which was built in 1790 (with later additions) to replace a former medieval building, is sited at the north end of the churchyard. North and east of the churchyard and gardens is 'The Holme', a field under permanent pasture, with the river looping around its north and west sides. Broad riggs of medieval plough cultivation cover the surface of the field as far as the edge of the terrace above the river flood plain. The LiDAR survey (Fig 1.3 on page 6) has been annotated below to highlight the features described (Fig D1).

2. Features on Fig D1 are marked A – F.

A = A block of rigg immediately north of the gardens is aligned SW to NE.
B = Eight of these riggs curve left at their NE ends over the embankment of E.
C = The embankment curves south-westwards, following the terrace edge towards the north-west corner of the churchyard at (C).
D = The west boundary of the churchyard is itself along the terrace edge as it curves in south-eastwards, coming close to the line of the road at (D).
E = A large rectangular feature, about the size of a tennis court.
F = An embankment which might be a precinct boundary.

3. The curve south and west through points B, C and D describe nearly half of the perimeter boundary of an oval. The way that the riggs of Block A override this embankment at point B is stratigraphic evidence suggesting that the embankment is of earlier date than the cultivation represented by the riggs.

Interpretation

4. These observations give rise to the hypothesis that the embankment, as traced between points B, C and D, is the remains of a boundary of an early medieval ecclesiastical precinct; the precinct established from King Ecgfrith's grant to the Lindisfarne monastery.

5. If this hypothesis is correct, the continuation of the boundary south-east from point B is not so clear. A rectangular feature (E), seemingly later than the riggs, and with a trackway extending south from here, breaks the alignment. It might be that an embankment (F) dividing two blocks of riggs marks the continuation of the precinct boundary, but on the evidence of the LiDAR survey alone this is uncertain.

6. If the alignment between points B and D represented half of a regularly-shaped precinct boundary, then the whole would have formed a rounded square of about 6 or 7 hectares.

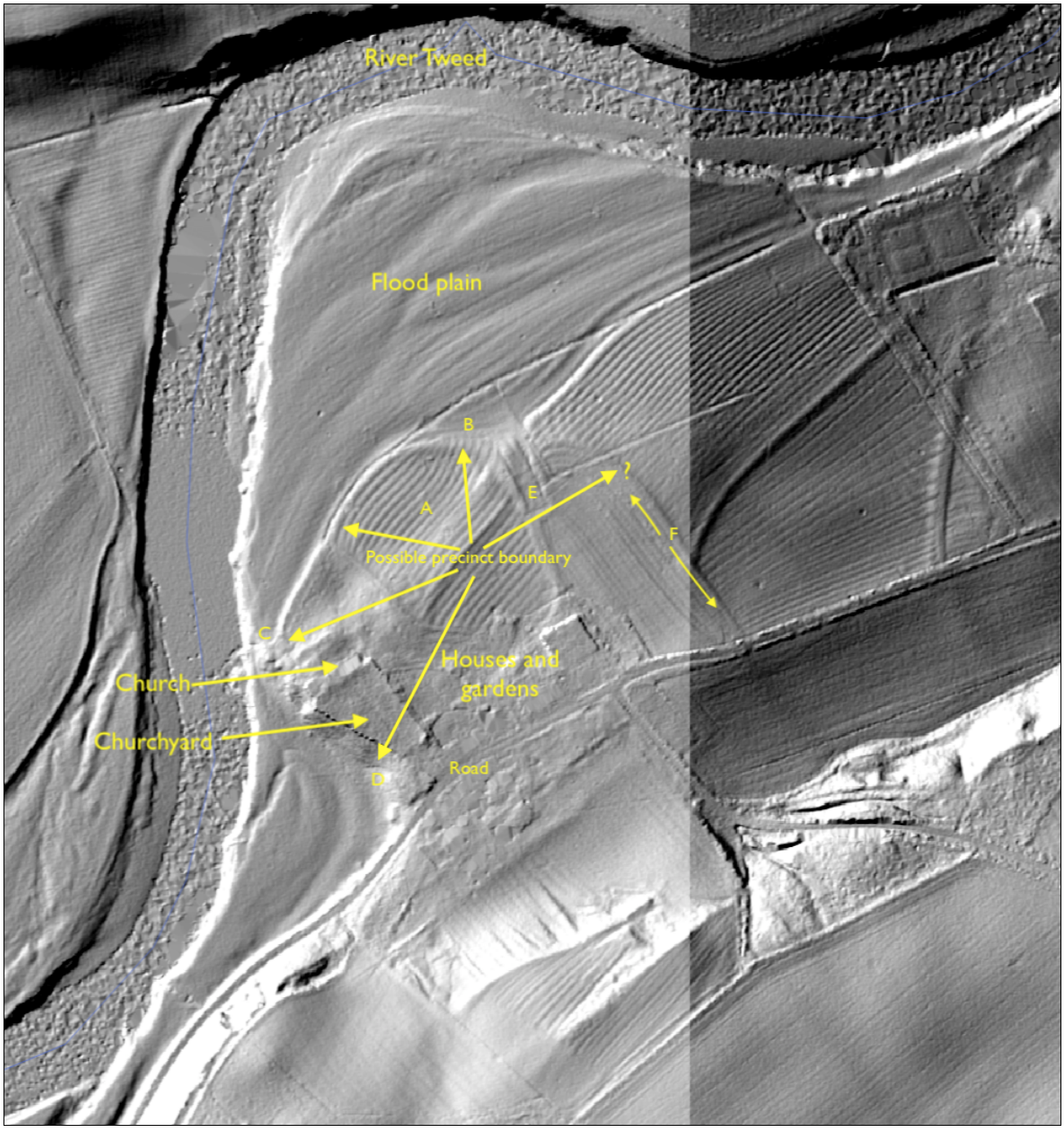


Fig D1: Carham LiDAR survey: annotated to show possible early settlement precinct (Source: Environment Agency)

Annex E

Bernician Studies Group
Historic Environment Record (HER) of Archaeological sites around Carham

Tables E1 and E2 give details of the eleven sites of the Medieval period or earlier (before 1540) found in the HER for the 9sq km around Carham (NGR 78,79,80.37,38,39) and marked on the OS map in section 3 (Fig 3.2)

Table E1: Six Archaeological sites in Northumberland within the 9sqkm around Carham. Source: http://www.keystothepast.info *(accessed 17 Jan 2020)*[9]

Ref. No.	Item	Period	NGR	Map
N115	Dagger	Bronze Age (2600BC-700BC)	3790.6380	A
A bronze dagger was found in Carham in 1853. It is probably of Bronze Age date. This object is now in the Museum of Antiquities in Newcastle (Acc No. 1853, 5)				
N121	Roman Camp	Roman (43-410)	3799.6377	B
This is the site of a Roman military camp. It can be seen on an aerial photograph of this site. It was probably a temporary camp, built to house an army on the march.				
N117	Carham Deserted Village	Medieval (1066-1540)	3798.6384	C
The Deserted Medieval Village of Carham was first recorded in a document dating to 1296. It still had at least twenty houses in the early 18th century, and a map of 1769 shows two rows of houses with the churchyard at the west end. In the 19th century the village shrunk to a single farm, though earthwork remains can still be seen in nearby fields.				
N112	Augustinian Cell	Medieval (1066-1540)	3797.6384	D
This is the site of a small Augustinian abbey founded in 1131. It continued in existence until the Dissolution of the Monasteries in 1539. No buildings survive today, though they probably lay to the west of the church. Vickers, K.H. 1922. A History of Northumberland, vol.11 (Newcastle upon Tyne), 12-17, 20-1				
N685	Carham Hall Tower	Medieval (1066-1540)	3804.6388	E
Carham Hall was built on the site of a 13th century tower. In 1541 it was called a `little tower without barmkin or gate'.				
N116	*Crop-mark	Uncertain	3799.6387	F
An aerial photograph of this site near to Carham Hall shows the cropmarks of a rectangular enclosure. It is not possible to say more about the date or purpose of this site without further exploration.				

* This crop-mark is undated but it seems to correspond with the rectangular mark on the LiDAR image which is a focus of this study (Fig. 1.3).

9 Entries in "Keys to the Past" are extracts from the Historic Environment Record (HER). For access to the full HER contact NCC Conservation Team, County Hall, Morpeth, NE61 2EF. (archaeology@northumberland.gov.uk)

Table E2: Six Archaeological sites in Scotland within the 9 sqkm around Carham
Source: https://canmore.org.uk/ *(accessed 10 December 2019)*[10]

Ref. No.	Item	Period	NGR	Map
ID 58336	Scabbard	Bronze Age (2600 BC - 700BC)	3794.6381	1
A bronze sword-sheath, 1ft 9ins in length, of the Bugthorpe type (2nd century BC, surviving into the Christian era), was found by fishermen on the bed of the river Tweed on the Scottish bank above Carham. It is now in the British Museum (S Piggott 1950).				
ID 58330	Fort and Enclosure	Pre-Historic	3783.6377	2
Two enclosures have been identified at Redden from aerial photographs (RCAHMSAP 1994), in the NW corner of a field situated W of the Weil Plantation. The most northerly enclosure or fort is bordered by woodland to the N; the NE corner of the rectangular enclosure is visible to the S.				
ID 58322	Fort and Enclosure	Iron Age (700BC – 43 AD)	3788.6387	3
Cropmarks at Birgham Haugh reveal the triple ditches of a fort situated 200m SE of Springhill and measuring about 65m by 50m internally. Immediately NE of the fort there is what may be an associated ditch about 2m broad which runs from E to W over a distance of at least 70m. It cuts across a small enclosure measuring about 25m square within its ditch. G S Maxwell 1978; RCAHMS 1980. (CUCAP AP's and RCAHMS, flown 1976 and 1979)				
ID 58319	Cross-slab	Early Medieval (410 - 1066)	3794.6391	4
A carved stone was found in the burial-ground at Birgham in 1958. It possibly came from the chapel that stood at this site in the medieval period. It has been suggested that the thirteenth-century stone came from the grave of a nobleman, as it bore an engraving of a two-handed sword. No trace of this item has been recorded since about 1980.				
ID 56325	Chapel and Burial Ground	Medieval (1066 - 1540)	3794.6391	5
St Magdalene's chapel at Birgham is recorded in 1250; its probable site is indicated by a rectangular depression close to the N side of the burial ground. 'Several pieces of medieval pottery' have been found in a field immediately to the SE.				
ID 343379	Birgham Village	Medieval (1066 - 1540)	3789.6391	6
Evidence for this site, or the origins of this site, comes from documentary sources. In 1290 the Treaty of Birgham agreed a marriage between the infant Edward of England (later Edward II) and Margaret, the 'Maid of Norway' (very briefly Queen of Scotland), who died a few months later age six, before the marriage and before her enthronement.				

10 The website of the National Record of the Historic Environment Scotland: - https://canmore.org.uk/

Annex F

Bernician Studies Group
METHODS OF GEOPHYSICAL SURVEY

1. The BSG follows the European Archaeological Council (EAC) Guidelines 2016 which incorporate the English Heritage (EH) Guidelines on Geophysical Survey in Archaeological Field Evaluation 2008. In addition, the BSG has created its own guidelines, which are a practical application of those principles.

Establishing the Grid

2. The EH guidelines have this to say on the subject of grids:
"This is the network of control points used to locate the geophysical survey measurements relative to base mapping and/or absolute position on the Earth's surface, (see Part IV, 1.1). Whether physically marked on the ground or measured while surveying using a global positioning system (GPS), these must be located to survey-grade accuracy (±0.1m). The survey grid must be independently re-locatable on the ground by a third party, by measurement to local permanent features, and/or by the use of GPS coordinates. All vocational information must be geo-referenced. In certain cases (e.g. where permanent features are absent), and with appropriate permission, it may be acceptable to emplace permanent survey markers."

Re-Establishing the Grid

3. The BSG guidelines expand on this:
"It is important that when you have once set up a grid for a survey, you can set out the same grid again. This is so you know exactly where on your site the new features are, and can tell people where they should be excavating. The best way to do this is to set two baselines. Ideally in ordinal directions, one running North to South and the other East to West across your site. If you can, find a starting point for each baseline by referencing them to fixed points in the landscape that can be found again. Recording their position using GPS:- you lay out your base line using the GPS positioning device keeping your initial grid reference eg Westing for the Northern and Southern ends of one base line and then Northing for the East-West. As the Geode has accuracy; of (±0.2m), then baselines of greater than 200m will provide (±0.1m) at 100m. Once this is complete, measure and mark 20m intervals along each base line and then triangulate 20m*20m grids on both sides of each base line using Pythagoras theory with a 28.28m diagonal. Insert poles at each corner. Once this is complete, you will have 3 poles in line at 20m intervals by measuring 20m and using line of sight, you can complete the grid layout for the site. High visible ranging poles at 20m intervals out of alignment by more than (±0.04m) are easily corrected by line of sight. Now use the GPS to record all of the corners of your grids as well as any physical features on the site."
Full location details are included for the grid marker points (Table 1) and local topographical features (Table 2).

Baseline

4. Whilst it is desirable to have the length of the baseline equal to the length of the survey area, it is not always possible, so you must record how far along the baseline the survey area

begins and the end of the baseline.

5. The baseline itself can be positioned anywhere you wish, but there are certain constraints, such as the availability of fixed points to reference from. Also ensure that you are able to cover the survey area with the resources you have; it is pointless having perfect baselines 200m from the survey site.

6. Prior to the introduction of accurate GPS (BSG uses Geode GNSS which is accurate to 0.2m) the baseline may be aligned by compass. However, compasses are not aligned to grid North and are subject to greater error margins.

Phase 1 Geophysical Survey

7. If the Initial Evaluation indicates a need for a comprehensive Geophysical Survey then it is undertaken using the following BSG standard.

8. A grid pattern of 20m by 20m squares aligned N–S and E-W is set up over the area. If this survey indicates that there may be archaeology between the edges of the squares and the site boundary then these partial grids may be included within the overall survey area up to 1m from the boundary edge.

- The FM256 Fluxgate Gradiometer is set at 0.1(nT), the highest sensitivity.
- The FM256 is balanced, aligned and zeroed against drift as per English Heritage *Standards for Geophysical Survey*.
- A zig-zag survey is undertaken, with readings every 0.125m on a traverse of 0.5m.

Phase 2 Post Survey Processing

9. The BSG limit data processing to the minimum necessary (see Trace Images and Screenshots listed below). Within Historic England Standards, processing has been restricted to the following procedures:

- Zero Mean Traverse and Zero Mean Grid are applied and Data may be clipped (to ±1SD) if features are obscured.
- Graphics are limited to Greyscale and 1 other appropriate colour representation.

Trace Image 1:	Carham West:	Raw data
Trace Image 2:	Carham East :	Raw data
Screenshot 1:	Carham West:	Geoplot 4, Pre-processing image
Screenshot 2:	Carham West:	Geoplot 4, Post-processing image
Screenshot 3:	Carham East:	Geoplot 4, Pre-processing image
Screenshot 4:	Carham East:	Geoplot 4, Post-processing image

Archive

10. Raw data and any pre-processing is retained in archive for reference and is available on request from the Bernician Studies Group.

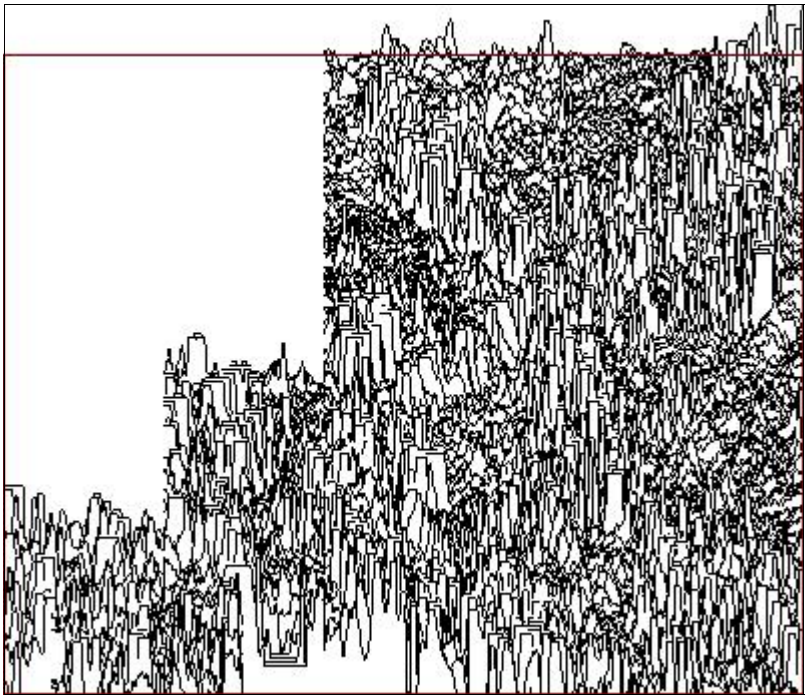
Table F1: Location details for 56 grid marker points at Carham

Object Id	Latitude North	Longitude West	Altitude Metres	CS British National Grid X	Y	Name Base	Description
743	55.6390	-2.3244	26.5	379679.8	638429.7	56	
742	55.6392	-2.3244	25.2	379679.1	638448.8	55	
741	55.6392	-2.3241	27.0	379699.0	638449.7	54	
740	55.6390	-2.3240	27.2	379700.0	638429.8	53	
739	55.6391	-2.3234	25.6	379739.9	638436.1	52	
738	55.6390	-2.3236	24.3	379730.2	638435.1	51	
737	55.6391	-2.3234	25.3	379739.8	638442.1	50	
736	55.6391	-2.3237	23.8	379719.5	638441.8	49	
680	55.6397	-2.3238	23.3	379716.4	638510.4	48	
679	55.6397	-2.3232	24.6	379756.4	638512.4	47	
678	55.6400	-2.3213	25.4	379875.0	638537.7	46	
677	55.6402	-2.3213	24.8	379874.1	638557.8	45	
676	55.6403	-2.3213	24.9	379873.0	638577.8	44	
675	55.6405	-2.3213	25.2	379872.1	638597.8	43	
674	55.6407	-2.3213	24.4	379871.1	638617.6	42	
673	55.6407	-2.3217	23.8	379851.2	638616.5	41	
672	55.6405	-2.3216	25.1	379852.2	638596.5	40	
671	55.6403	-2.3216	25.7	379853.1	638576.7	39	
670	55.6401	-2.3216	25.5	379854.1	638557.0	38	
669	55.6400	-2.3216	25.4	379854.9	638537.1	37	
668	55.6398	-2.3216	24.9	379855.9	638517.1	36	
667	55.6396	-2.3216	24.4	379857.1	638496.6	35	
666	55.6407	-2.3220	23.2	379831.5	638615.7	34	
665	55.6405	-2.3219	24.5	379832.6	638595.8	33	
664	55.6403	-2.3219	25.3	379833.5	638575.8	32	
663	55.6401	-2.3219	25.3	379834.4	638556.0	31	
662	55.6400	-2.3219	25.1	379835.5	638536.0	30	
661	55.6398	-2.3219	24.8	379836.3	638516.0	29	
660	55.6394	-2.3219	24.7	379838.1	638476.0	28	
659	55.6396	-2.3219	24.4	379837.1	638495.9	27	
658	55.6396	-2.3222	25.4	379817.3	638495.0	26	
657	55.6396	-2.3225	25.8	379797.2	638494.4	25	
656	55.6394	-2.3222	25.1	379818.0	638475.3	24	
655	55.6390	-2.3228	25.8	379779.9	638433.7	23	
654	55.6390	-2.3231	26.6	379760.0	638432.8	22	
653	55.6390	-2.3234	27.4	379739.9	638431.9	21	
652	55.6394	-2.3219	23.6	379834.2	638475.7	20	East
651	55.6394	-2.3225	24.0	379798.3	638474.2	19	
650	55.6392	-2.3228	24.1	379779.1	638453.2	18	
649	55.6394	-2.3228	25.1	379778.0	638473.2	17	
648	55.6396	-2.3228	24.6	379777.0	638493.0	16	
647	55.6397	-2.3228	22.8	379776.2	638513.3	15	
646	55.6397	-2.3231	35.9	379756.7	638504.5	14	
645	55.6396	-2.3231	25.4	379757.4	638493.0	13	
644	55.6394	-2.3231	26.4	379758.3	638473.0	12	
643	55.6392	-2.3231	26.4	379759.1	638452.8	11	
642	55.6392	-2.3234	25.2	379738.7	638451.7	10	
641	55.6394	-2.3234	24.1	379738.0	638471.3	9	
640	55.6395	-2.3235	23.9	379737.1	638491.2	8	
639	55.6397	-2.3235	22.1	379736.3	638511.1	7	
638	55.6395	-2.3238	22.0	379717.5	638490.4	6	
637	55.6394	-2.3238	23.7	379718.5	638470.4	5	
636	55.6392	-2.3237	25.8	379719.0	638451.7	4	
635	55.6393	-2.3244	23.8	379679.3	638468.9	3	
634	55.6393	-2.3248	22.7	379649.7	638467.3	2	west
633	55.6391	-2.3241	26.5	379695.2	638440.8	1	

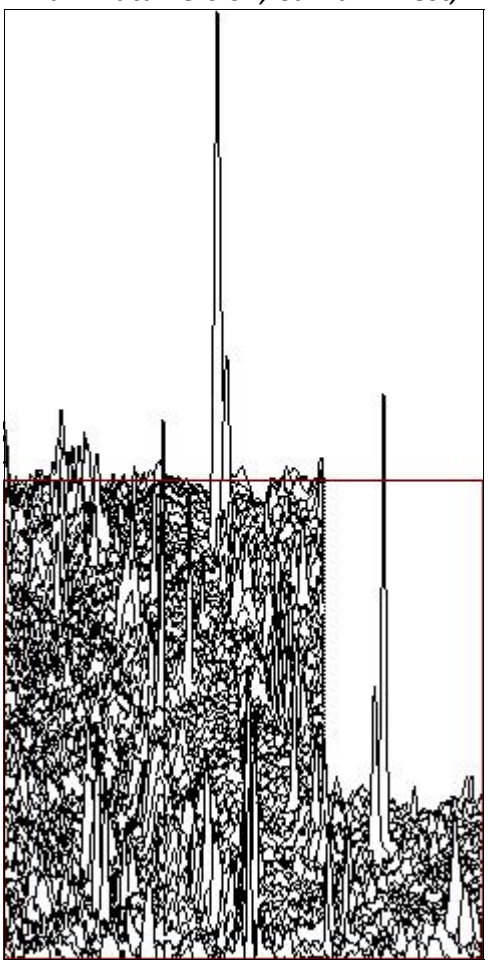
N.B. The height 35.9m for grid point 14 was an error when setting up which, unfortunately, was not corrected.

Table F2: Location details for 55 topographical features at Carham

Object Id	Latitude North	Longitude West	Altitude Metres	CS British National Grid X	Y	Name WPT	Description Edge Type
735	55.6395	-2.3209	25.0	379897.6	638488.3	55	Corner Post
734	55.6393	-2.3215	24.3	379861.3	638467.8	54	Corner Post
733	55.6394	-2.3219	23.8	379835.1	638473.5	53	Corner Post
732	55.6391	-2.3223	24.3	379811.2	638444.7	52	Barbed Wire Fence
731	55.6391	-2.3223	24.3	379811.2	638444.8	51	Gate Hinge Side
730	55.6391	-2.3223	24.6	379810.3	638444.0	50	Gate Opening Side
729	55.6391	-2.3223	24.4	379808.2	638441.9	49	Gate Hinge Side
728	55.6390	-2.3224	24.8	379801.2	638432.7	48	Barbed Wire Fence
727	55.6390	-2.3225	25.3	379793.9	638425.3	47	Corner Post
726	55.6390	-2.3228	25.6	379776.2	638428.1	46	Barbed Wire Fence
725	55.6389	-2.3234	26.5	379741.2	638421.6	45	Barbed Wire Fence
724	55.6389	-2.3234	27.2	379739.6	638422.2	44	Stone Wall
723	55.6390	-2.3236	25.6	379730.7	638433.4	43	Stone Wall
722	55.6404	-2.3220	22.6	379827.6	638587.3	42	Escarpment Edge
721	55.6406	-2.3217	22.3	379845.2	638611.9	41	Escarpment Edge
720	55.6408	-2.3215	21.4	379863.2	638625.6	40	Escarpment Edge
719	55.6409	-2.3213	21.3	379872.8	638638.0	39	Escarpment Edge
718	55.6418	-2.3248	19.5	379653.1	638743.8	38	Water Edge
717	55.6409	-2.3250	19.5	379639.8	638642.7	37	Water Edge
716	55.6402	-2.3252	20.1	379629.7	638565.0	36	Water Edge
715	55.6398	-2.3253	19.3	379622.4	638516.7	35	Water Edge
714	55.6394	-2.3253	19.8	379622.7	638479.1	34	Water Edge
713	55.6392	-2.3252	18.2	379624.7	638455.7	33	Water Edge
712	55.6391	-2.3252	19.4	379626.2	638441.8	32	Stone Wall
711	55.6391	-2.3251	20.3	379633.1	638442.6	31	Style
710	55.6391	-2.3249	22.4	379643.4	638442.9	30	Stone Wall
709	55.6391	-2.3249	22.5	379644.5	638443.3	29	Barbed Wire Fence
708	55.6392	-2.3248	23.1	379653.6	638455.3	28	Barbed Wire Fence
707	55.6391	-2.3246	24.3	379663.9	638446.3	27	Barbed Wire Fence
706	55.6391	-2.3247	23.8	379656.8	638438.2	26	Barbed Wire Fence
705	55.6391	-2.3247	24.3	379657.8	638439.5	25	Barbed Wire Fence
704	55.6392	-2.3240	25.0	379702.1	638452.3	24	Escarpment Edge
703	55.6392	-2.3241	25.1	379697.6	638453.4	23	Escarpment Edge
702	55.6392	-2.3242	25.0	379692.6	638451.1	22	Escarpment Edge
701	55.6391	-2.3243	25.6	379685.7	638447.1	21	Escarpment Edge
700	55.6391	-2.3244	25.2	379678.3	638442.9	20	Escarpment Edge
699	55.6391	-2.3245	25.3	379671.7	638438.9	19	Escarpment Edge
698	55.6390	-2.3246	24.9	379666.9	638431.9	18	Escarpment Edge
697	55.6391	-2.3247	24.1	379656.7	638438.3	17	Gate Hinge Side
696	55.6390	-2.3247	24.3	379659.8	638436.0	16	Gate Opening Side
695	55.6389	-2.3245	26.8	379673.2	638423.8	15	Stone Wall
694	55.6391	-2.3237	26.5	379722.8	638437.6	14	Gate Hinge Side
693	55.6391	-2.3237	27.9	379721.4	638437.9	13	Gate Opening Side
692	55.6391	-2.3237	27.0	379719.3	638436.0	12	Stone Wall
691	55.6389	-2.3240	26.1	379701.5	638424.8	11	Stone Wall
690	55.6389	-2.3243	27.9	379684.5	638413.9	10	Corner Post
689	55.6389	-2.3243	27.4	379682.5	638415.4	9	Gate Hinge Side
688	55.6389	-2.3243	28.3	379683.2	638414.8	8	Gate Hinge Side
687	55.6389	-2.3243	29.7	379683.8	638415.6	7	Gate Hinge Side
686	55.6389	-2.3243	29.0	379681.5	638417.8	6	Wooden Fence
685	55.6389	-2.3242	26.9	379692.8	638422.9	5	Gate Opening Side
684	55.6389	-2.3241	26.4	379693.6	638423.7	4	Gate Hinge Side
683	55.6390	-2.3239	26.2	379710.8	638433.5	3	Wooden Fence
682	55.6391	-2.3238	26.0	379713.2	638439.1	2	Wooden Fence
681	55.6391	-2.3236	27.3	379726.3	638439.2	1	Stone Wall

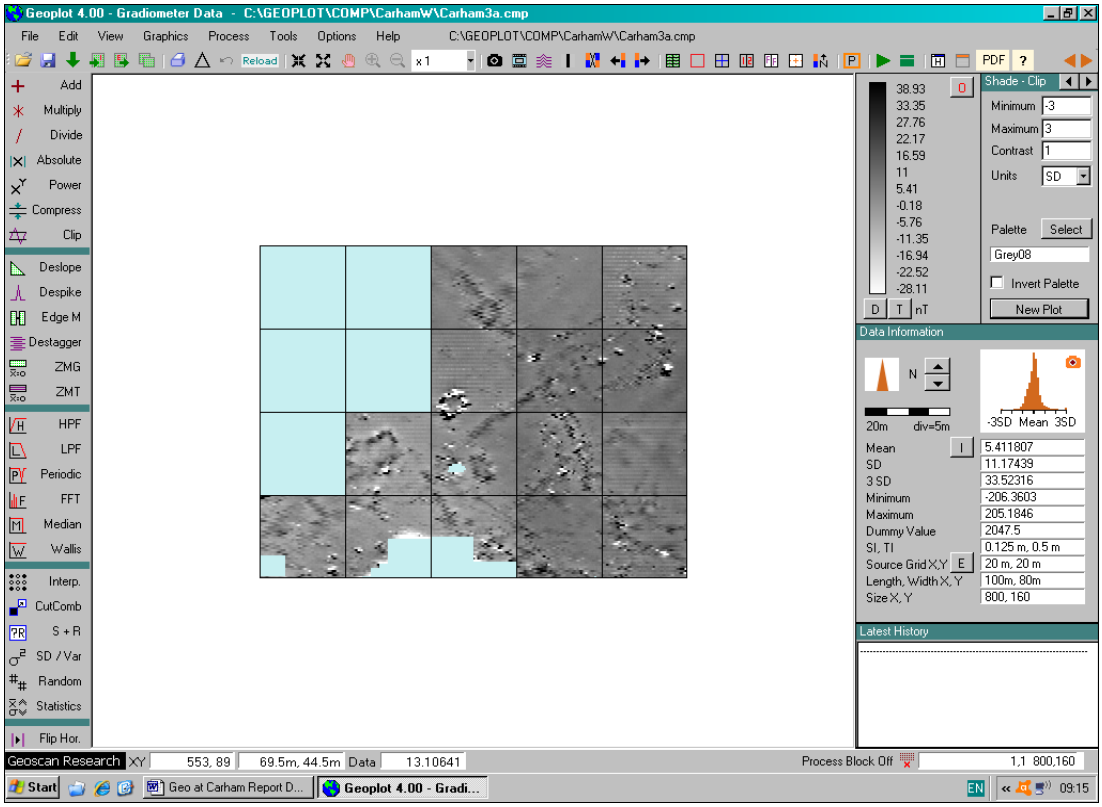


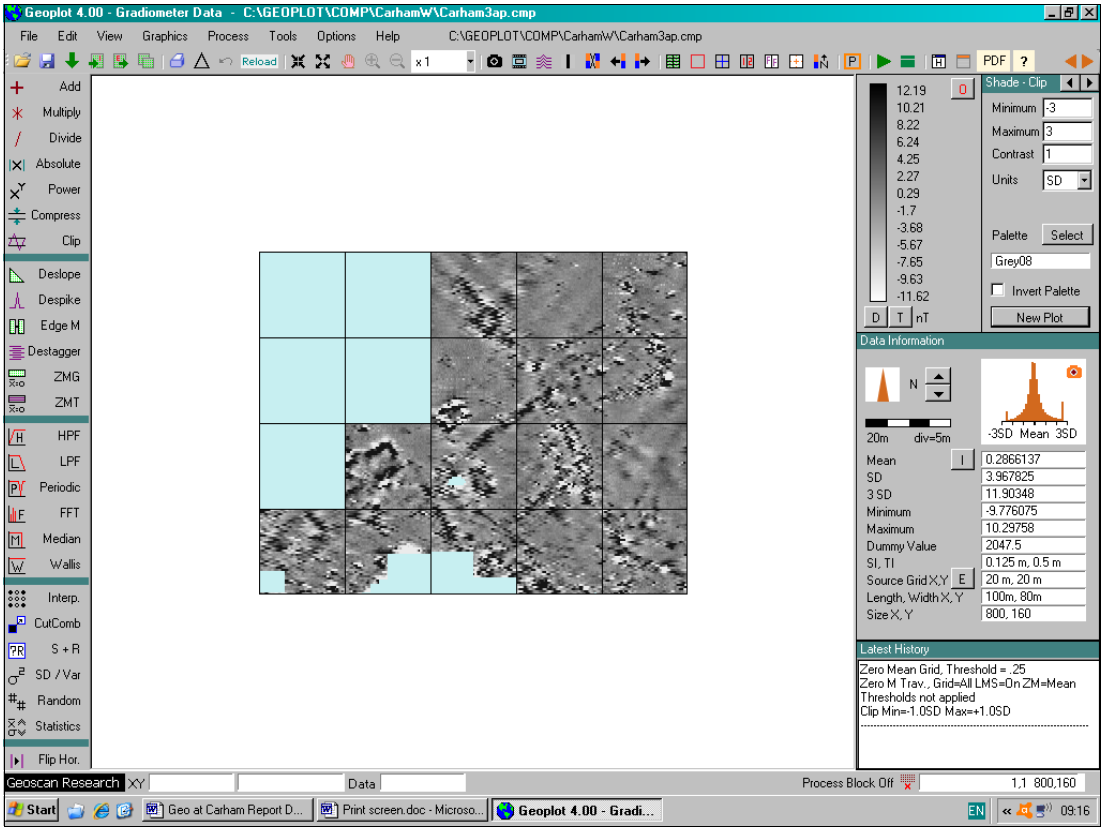
Trace Image 1: Raw Data Version; Carham West, including partials



Trace Image 2: Raw Data Version; Carham East

Screenshots 1 and 2: Carham West: Pre and Post processing images from Geoplot4





Screenshots 3 and 4: Carham East, Pre and Post processing images from Geoplot 4