ARCHAEOLOGICAL SURVEYS

GEOPHYSICAL SURVEY REPORT

Castle Combe Castle

Geophysical Survey

for

Wiltshire County Council

With funding from English Heritage

David Sabin and Kerry Donaldson

March 2007

Ref no. 177

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Report and fieldwork by David Sabin and Kerry Donaldson

Survey date – **from 13th to 27th March 2007**
Ordnance Survey Grid Reference – **ST 8387 7788**

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SUMMARY

Earth resistance survey, detailed magnetometry and magnetic susceptibility were carried out at Castle Combe castle in Wiltshire. The earth resistance survey revealed masonry structures within the inner baileys of the site, whilst magnetometry suggested the outer bailey may have been largely free from development. A large ditch-like feature was located to the north of the northern defences suggesting an in-filled outer defensive ditch that is no longer visible as a topographic feature, the survey also suggests some complexity to the northern defences. Magnetic susceptibility was not considered to be a reliable indicator of anthropogenic activity across the soils of the locality as tests on soils away from the site indicated high levels of natural enhancement. Access to a large part of the site was impeded by dense vegetation and the use of the outer bailey as part of a golf course prevented the earth resistance survey across this part of the site.

1 INTRODUCTION

1.1 Survey background

1.1.1 Archaeological Surveys was commissioned by Wiltshire County Council to undertake a geophysical survey of the castle at Castle Combe with funding from English Heritage as part of their Monument Management Scheme. This survey was undertaken in order to further the understanding of the monument and aid in the ongoing management and preservation of the site. The scheduling of the castle was confirmed in 1981 as Wiltshire 669, and later affirmed in 1992 as the motte and bailey castle 600m north of Castle Combe, National Monument Number 12285.

1.2 Survey objectives

1.2.1 The survey aimed to produce geophysical evidence for the interior layout and development of the castle. It is considered likely that there is good preservation of structures within the interior of the castle’s defensive circuit as no intensive agricultural activity or development is known to have taken place and earthworks are generally well-defined.

1.2.2 The site has been subject to only limited archaeological investigation and is therefore poorly understood. There is a paucity of reliable historic documentation relating to the castle and it is hoped that non-invasive survey may shed further light on how each area within the monument was utilised. Prior to the onset of the geophysical investigation, it was considered that the data should be used in conjunction with all of the limited evidence available which would include topographic analysis, the results of minor archaeological investigations and the historical references to the site.

1.2.3 The initial methodology intended to utilise a range of geophysical techniques at high resolution in order to obtain the best possible information given the limitations of the equipment and the difficulties of access due to vegetation. A number of unforeseen issues resulted in changes to the survey methodology, these are discussed in further detail below. The techniques included: earth resistance survey which is particularly useful at locating masonry remains; detailed magnetometry which is a rapid technique that is useful for locating former cut features and may respond to masonry remains also; magnetic susceptibility survey which responds to shallow magnetic enhancement associated with anthropogenic activity. A ground penetrating radar survey was also carried out by Arrow Geophysics and forms a separate report.

1.3 Site location

1.3.1 The site is located within the Manor House Hotel Golf Course at Castle Combe, Wiltshire, Ordnance Survey grid reference ST 8387 7788. Access is gained to the northern end of the castle by crossing either the 1st or 18th fairways close to the Golf Course Club House, see Plate 1.

Plate 1 Castle Combe castle in the background viewed from the northeast

1.3.2 The castle is relatively isolated from Castle Combe and Upper Castle Combe which lie approximately 800m south southeast and southeast respectively. The B4039 passes some 500m to the northeast and the Fosseway is approximately 700m to the northwest of the castle site.

1.4 Site description

1.4.1 The monument is classified as a motte with associated baileys and covers an area of approximately 4ha. The layout of the site is more complex than the listing suggests. The site sits on a spur of land above the confluence of the Broadmead Brook and the Bybrook. It comprises an irregular outer ringwork which follows the contour of the spur, with an outer bank and ditch to the south, east and west, and also an inner bank on the northern side. Inside the monument, an inner surrounding bank is not well defined and appears to exist only partially. A series of four internal banks and ditches of differing sizes partition the site into irregularly sized enclosures. Although four baileys are usually ascribed to the castle, the internal divisions partition the site into five baileys, four to the northeast of the motte and one to the southeast. The motte itself has been constructed as a shell keep close to the steep south western edge of the monument. This has been formed from earth with stone revetment and walling and stands approximately 8m high on the northern, eastern and southern sides. Within the shell keep is the remains of a tower, approximately 3.5m high, which has been recently consolidated and preserved as part of the Monument Management Scheme, see Plate 2. The NMR entry and further investigation by Chippenham College Practical Archaeology Group in the early 1990s suggests that the inner baileys contain the remains of at least seventeen buildings (WANHS 1992, 1993).

Plate 2 Tower remains having been recently capped with turf – March 2007

1.4.2 For ease of reference, the various parts of the site have been labelled as outer bailey, inner baileys 1 – 4 and motte or shell keep, see Figure 02.

1.4.3 A large portion of the site is covered with trees and scrub growth, however the outer bailey contains the 1st hole (10th up until 2006) of the Manor House Hotel Golf Course and is covered with closely mown grass. An area around the hole has been built up with sand to form the putting green and bunkers. A metalled track allows golfers to enter the outer bailey at the eastern corner and leave at the west, the track takes a route through the outer bailey that curves towards the south then towards the northwest parallel with a bank and ditch that separates the outer bailey from the next inner bailey towards the southwest.

1.4.4 Two pillow mounds are clearly visible within the central part of the outer bailey. They are formed by two low banks approximately 5m wide by 40m long and are orientated northeast to southwest. Shallow linear depressions surround the mounds.

1.4.5 The vegetation across the site is clearly changing rapidly from year to year which is probably as a result of the end of grazing in the early 1990s when the site was developed for golf. The 1974 aerial photograph shown in Plate 3 reveals substantially larger open areas within the inner baileys. These areas have changed from grass and herb cover to briar and thorn thickets. There are a number of ancient stands and formerly coppiced hazel trees suggesting the woodland was well managed in the past. Dilapidated wire fencing is associated with the former use of the site for grazing and for management of game birds.

Plate 3 Aerial photograph of castle site taken in 1974

NMR Air Photograph WAB 807/50 NGR ST8377/8 22.07.74.

With kind permission of Dr Arnold Baker

1.5 Site history, archaeological potential and previous investigations

1.5.1 There has been little site investigation or excavation but much speculation to the construction and use of the monument. There is some belief that the site may have Iron Age origins, with Saxon re-use of the site as a fortification subsequently destroyed by the Danes and a later construction of a 12th century castle on the site. The commentary below examines the documentary evidence for these various theories for the construction and use of the site.

1.5.2 There has been some suggestion that the earthworks may have an Iron Age origin, G.P. Scrope (1853) believed that “ the earthworks….. seem to prove that a British camp existed on this spot before the erection of the Norman fortress in the twelfth century”. The SMR and NMR entries seem to hold contradictory evidence for this. The SMR entry states that “although its position is ideal for a promontory fort its defences, particularly on the north, are not consistent with Iron Age fortification" however the NMR entry states that "the location of the site and the survival of an outer bank at the NE end of the monument suggest the castle may have been built on the site of an earlier promontory fort, dating probably to the Iron Age". These apparently conflicting views of the possible Iron Age origin of the site imply that further investigation is necessary in order to either support or refute this theory.

1.5.3 Clearly there is some contradiction in the view that the castle stands on a previous Iron Age promontory hill fort but there has also been speculation by antiquarian writers regarding the use of the site as a Saxon stronghold, subsequently destroyed by the Danes in the 9th century. Sir Richard Colt Hoare writing in 1821 considered that " the foundations of walls, a raised mound, and other circumstances, induce me to attribute to it a Saxon origin, and history reports its having been ravaged by the Danes". He also has a sketch map of the castle from the same time which shows that the original entrance was further north than today (Hoare 1821). John Aubrey (in Jackson 1862) also supports this theory, and evidence seems to have originated with the writings of William of Worcester, steward to Sir John Fastolf, the Baron of Castle Combe in the mid 15th Century. Cited in Scrope (1852) William of Worcester states "there was a castle in the middle of the park here, seated upon a hill, which was destroyed by the pagan people coming from the kingdom of the Danes, as invaders and enemies of King Alfred, in the year of Christ eight hundred and seventy eight". Despite these antiquarian comments there has been no direct evidence for Saxon occupation or Danish destruction of the site, although the SMR entry states that iron arrow heads, bucklers, spurs and a few "Saxon" coins have been found in the castle area.

1.5.4 The building of the castle is generally attributed to the Dunstanvilles, Barons of Castle Combe during the 12th century although there is some uncertainty to its actual construction date. It is possible that the castle was constructed as the chief seat of the Barony of Combe, when it was consolidated by Reginald de Dunstanville during the reign of Henry I (1100-1135) (Scrope 1853) although it is possible that it was constructed by his son of the same name. Reginald was believed to have supported the Empress Matilda in the civil war against King Stephen (1135-1154) and the SMR and NMR listing suggests a tentative date of c. 1140 to support the evidence that this was an Anarchy Period castle. Other Anarchy Period castles are known to have been built during this time of political instability and many of them in the region were constructed by supporters of Matilda, such as Trowbridge Castle built on the site of a former prehistoric, Saxon and Saxo-Norman settlement (Graham and Davis 1993). Creighton (2000) surmises that the castle is unusual in having no conventional documentation. Confusingly he believes the site is most likely to have been constructed during the reign of Henry I but "an initial Anarchy-period fortification on the site cannot be discounted". William Camden (1610) ascribes the castle to a later generation, Walter de Dunstanville (d. 1194) who was the son (or grandson) of Reginald and he believes that Walter was responsible for the castle construction, likely to be during the reign of Henry II (1154-1189) but this is disputed by Scrope (1853).

1.5.5 By the 14th century it appears that the seat of the Barony had transferred to the Manor House within the village of Castle Combe and a deer park had been created next to the Castle sometime before this (Watts 1996). The outer bailey also contains two medieval pillow mounds. According to William of Worcester the "castellum" had been destroyed by the reign of Henry IV (1399 –1413) (Scrope 1852). John Aubrey states that by the 17th century a market was traditionally held on the site (in Jackson 1862).

1.5.6 During the 19th century, the land owner William Scrope built a tower close to the southern tip of the site to mark the position of the castle. This was destroyed in 1950 but the remains of the tower mound and some substantial masonary blocks are visible. Although there is no documentary evidence, a formalised entrance way has been constructed through the southern bank and is likely to be contemporary with Scrope's tower.

1.5.7 Limited archaeological investigation was carried out by Cotswold Archaeology in 2005 within the shell keep. The remains of a substantial building, possibly the keep, were recorded as part of a programme of works carried out to stabilise the structure, see 1.4.1 and Plate 2. Loose material was removed from inside the structure although the original inner base was not exposed for reasons of structural safety. A single pottery sherd found within loose wall material was given a broad date of 10th to 12th centuries.

1.5.8 Archaeological Surveys have carried out topographic surveys across the site for approximately 5 years. The work was started by David Sabin and Kerry Donaldson prior to the formation of the Archaeological Surveys. The objectives of the survey were primarily to produce a digital terrain model of the site by recording the earthworks in detail using a total station. It was apparent that previous mapping of the site was either inaccurate or did not hold sufficient detail to fully understand its layout. Probably one of the main limiting factors to accurate mapping and surveying in the past had been the location of much of the site within woodland. It was hoped that the new survey work would provide an accurate model of the site that could be interrogated using 3D modelling. The work is ongoing as the terrain is particularly challenging, much of the interior of the site has been recorded in detail although the outer ringwork requires completion. Ordnance Survey base mapping was used for plotting in this report, the map includes building remains and it is presumed that these were recognised and added by the Ordnance Survey.

1.5.9 Site observations made during the course of the geophysical surveys and a topographic survey are listed below:

- medieval pottery sherds possibly of Bath A/B fabric visible on the surface within inner bailey 3 and outside the south western outer earthworks,
- large strap handle of glazed Minety ware outside the north western outer earthworks,
- fragment of sarsen stone immediately to the south of the motte in inner bailey 4,
- fragment of sarsen stone immediately north of the motte in inner bailey 3,

- worked stone fragments to the south of inner bailey 4 – the remains of Scrope's tower,
- burnt stone fragments and clay within the northern defensive banks.

1.5.10 Despite the uncertain and sometimes contradictory documentary evidence for the construction and use of the monument, it seems likely that it is the result of several stages of development and re-use, and there is great archaeological potential within the site.

1.6 Geology and soils

1.6.1 The underlying geology is Great Oolite (BGS 2001). The overlying soils are from the Sherborne association which are brown rendzinas. These consist of shallow well-drained brashy calcareous clayey soils over limestone. (Soil Survey of England and Wales 1983).

1.6.2 The underlying geological and pedological conditions are generally considered suitable for magnetic survey. Conditions for earth resistance survey are influenced by soil moisture content and are often optimum in the late summer period, however, the site is well drained and rainfall during the survey period was very low.

2 METHODOLOGY

2.1 Technical synopsis

2.1.1 To achieve the objectives of the survey it was initially proposed to carry out earth resistance survey, magnetometry and magnetic susceptibility topsoil measurements at very close centres to achieve a high resolution dataset. Standard procedure for earth resistance survey is to collect data at 1m centres, this distance was decreased to 0.5m centres effectively quadrupling the dataset. Standard procedure for magnetometry is to collect data at 0.25m centres along traverses 1m apart, it was intended that this should be decreased to 0.125m centres along traverses 0.5m apart, however, restrictions due to vegetation within the inner baileys prevented data collection and the use of the outer bailey for golf required an increase in the speed of the survey to complete the area within an allocated time slot. Similar issues with time restrictions were encountered to the north of the outer bailey and completely prevented the use of the much slower earth resistance survey outside of the inner baileys. Initial tests of magnetic susceptibility survey suggested that the collection of data at close centres was unlikely to provide a useful dataset and 10m centres were selected.

2.1.2 The electrical resistance or resistivity of the soil depends upon the moisture content and distribution within the soil. Buried features such as walls can affect the moisture distribution and are usually more moisture resistant than other features such as the infill of a ditch. A stone wall will generally give a high resistance response and the moisture retentive content of a ditch can give a low resistance response. Localised variations in resistance are measured in ohms (Ω) which is the SI unit for electrical impedance or resistance. Earth resistance survey within the inner baileys where structural remains were likely was considered the most effective technique.

2.1.3 Magnetometry records localised magnetic fields to a depth of approximately 1m that can relate to former human activity. Alteration of iron minerals present within topsoil is related to activities such as burning and the break down of biological material, effectively the magnetic susceptibility of the soil is increased or enhanced. The enhanced soils become weakly magnetic within the Earth's magnetic field and can accumulate in features such as ditches and pits that are cut into the underlying subsoil. Mapping this magnetic variation can provide evidence of former settlement and land use. Additional technical details can be found in Appendix A. The localised variations in magnetism are measured as sub-units of the tesla which is a SI unit of magnetic flux density. These sub-units are nanoteslas (nT) which are equivalent to 10^{-9} tesla (T).

2.1.4 The magnetic susceptibility of the topsoil is measured in the presence of a magnetic field and is defined as a ratio between the intensity of the induced field to that of the magnetising field. As the two fields are measured in the same units the ratio can effectively be defined using no units although it is common practice to add SI to distinguish measurements from an older system.

2.2 Equipment configuration, data collection and survey detail

2.2.1 The resistivity survey was carried out using a TR Systems Ltd Resistance Meter TRCIA 1.31 with a mobile Twin Probe array. Readings were taken at 0.5m intervals along 0.5m traverses across the site giving 1600 readings within a full 20m x 20m grid.

2.2.2 The detailed magnetic survey was carried out using a Bartington Grad601-2 gradiometer. This instrument effectively measures a magnetic gradient between two fluxgate sensors mounted vertically 1m apart. Two sets of sensors are mounted on a single frame 1m apart horizontally. The instrument is extremely sensitive and is able to measure magnetic variation to 0.1 nanoTesla (nT). All readings are saved to an integral data logger for analysis and presentation. Data was collected at 0.125m centres along traverses 1m apart. The survey area was separated into 20m by 20m grids giving 3200 recorded measurements per grid. This sampling interval is very effective at locating archaeological features.

2.2.3 The magnetic susceptibility survey was conducted using an MS2 meter with MS2D field coil manufactured by Bartington Instruments Ltd. Data was collected at 10m centres where accessible and the field coil responds to a depth of approximately 10cm below the surface. Each position was recorded 3 to 5 times to ensure a representative value free from erratic or spurious readings created by ferrous debris or poor soil contact. The values were entered into PocketGIS software as a point attribute attached to the coordinates of each recording station.

2.2.4 The survey grids were set out using a Topcon GTS802 robotic total station and orientated in order to produce a baseline running along the track linking the baileys, see Figure 03. The baseline was referenced to the Ordnance Survey National Grid using a CSI Wireless dGPS having a sub-metre accuracy.

2.3 Data processing and presentation

2.3.1 Data logged by the resistance meter is downloaded and processed within ArcheoSurveyor software. Survey grids are assembled to form an overall composite of data (composite file) creating a dataset of the complete survey area. Raw data is analysed and displayed within the report as well as processed data, see Figures 04 and 05. Appendix B contains specific information concerning the survey and data attributes and is derived directly from ArcheoSurveyor, this should be used in conjunction with information provided by Figure 03. The following processing has been carried out on data in this survey:

- raw resistance data has been displayed between 1 and 736 Ω ,
- processed data has been displayed between +14 and –14 Ω, negative values are a function of the mathematical operation carried out across the data during processing,
- data has been “despiked” in order to remove spurious high contact responses,
- data is passed through a high pass filter in order to enhance archaeological features.

(Reference should be made to Appendix B for processing details.)

2.3.2 Magnetometry data downloaded from the Grad 601-2 data logger is analysed and processed in specialist software known as ArcheoSurveyor. The software allows greyscale and trace plots to be produced for presentation and display, see Figures 07 - 09. Survey grids are assembled to form an overall composite of data (composite file) creating a dataset of the complete survey area. Appendix B contains specific information concerning the survey and data attributes and is derived directly from ArcheoSurveyor, this should be used in conjunction with information provided by Figure 03. Only minimal processing is carried out in order to enhance the results of the survey for display. Raw data is always analysed as processing can modify anomalies. The following schedule sets out the data and image processing used in this survey:

- clipping of the raw data at ±10nT to improve greyscale resolution,
- clipping of processed data at ±3nT to enhance low magnitude anomalies,
- clipping of trace plots at ±100nT in order to minimise strong readings obscuring low magnitude responses,
- de-stagger is used to enhance linear anomalies,
- zero median traverse is applied in order to balance readings along each traverse.

(Reference should be made to Appendix B for processing details.)

2.3.3 Magnetic susceptibility readings recorded in the field using PocketGIS were downloaded into MapInfo GIS software with Vertical Mapper and displayed as an interpolated colour plot using a fifth order polynomial solution, see Figure 11. No processing is required for this data.

2.3.4 An abstraction and interpretation is offered for all geophysical anomalies located by the survey. A brief summary of each anomaly with an appropriate reference number is set out in list form within the results (Section 3), to allow a rapid assessment of features within each survey area. Where further interpretation is possible or where a number of possible origins should be considered, further more detailed discussion is set out in Section 4.

2.3.5 The main form of data display used in this report is the greyscale plot. Magnetometry data is also displayed as a trace plot. Both 'raw' and 'processed' magnetometry and resistance data have been shown followed by an abstraction and interpretation plot. Magnetic susceptibility data is shown as an interpolated colour plot.

2.3.6 Graphic raster images in TIF format are initially prepared in ArcheoSurveyor for magnetometry and earth resistance data. These images are combined with base mapping using AutoCAD LT 2007 creating DWG file formats. Images are externally referenced to the CAD drawing in order to maintain good graphical quality. Quality can be compromised by rotation of graphics in order to allow the data to be orientated with respect to grid north; this is considered acceptable as the survey results are effectively georeferenced allowing relocation of features using GPS, resection method etc. A digital archive including raster images is produced with this report allowing separate analysis if necessary, see 2.4 below.

2.3.7 Data is plotted against base mapping supplied in digital format by Wiltshire County Council. The mapping is based on Ordnance Survey 1:2500 data and has a representation of banks and ditches using polygons, in addition the mapping indicates the position of wall remains. No features within the base mapping could be confidently used to 'tie in' the survey grids and this was achieved through the use of differential GPS having sub-metre accuracy. It is of note that there appears to be significant errors in the representation of earthworks and the location of wall remains when compared to the GPS coordinates.

2.4 Archive

2.4.1 Survey results are produced in hardcopy using A4 for text and A3 for plots (all plots are scaled for A3). In addition digital data created during the survey is supplied on CD. Further information on the production of the report and the digital formats involved in its creation are set out below.

2.4.2 This report has been prepared using the following software on a Windows XP platform:

- ArcheoSurveyor version 2.1.2.2 (magnetometry/resistivity data analysis),

- Vertical Mapper 2.6 (magnetic susceptibility data analysis),
- AutoCAD LT 2007 (data display and plotting),
- Microsoft Word 2000 (document text),
- PDF Creator version 0.9 (PDF archive).

2.4.3 Digital data is supplied on CD ROM and includes the following files:

- ArcheoSurveyor grid and composite files for resistance and magnetometer data,
- CSV files for raw and processed composites and magnetic susceptibility data,
- geophysical composite file graphics as TIFF images,
- report text as a Word 2000 doc file,
- report text as rich text format (RTF),
- report text as PDF,
- PDFs of all figures
- photographic record in JPEG format.

2.4.4 The CD ROM structure is formed from a tree of directories under the title J177 Castle Combe – CD. Directory titles include Data, Documentation, CAD, PDFs and Photos. Multiple directories exist under Data and hold grid, composite and graphic files with CSV composite data held in export.

2.4.5 The CAD file contains externally referenced graphics that may be rotated, see 2.3.6, with separate A3 size layouts for each figure. Layouts are fixed using frozen layers and named views allowing straightforward plotting or analysis on screen. (Note – CAD files are prepared using AutoCAD's eTransmit function to produce a directory containing the digital drawing along with any externally referenced graphics which may need reloading.)

3 RESULTS

3.1 General overview

3.1.1 The approach to the geophysical survey of the castle had been initially to utilise earth resistance, detailed magnetometry and magnetic susceptibility and to collect data at close centres to provide a high resolution dataset. A number of problems were encountered that resulted in modification to the survey techniques. Restricted access to areas of the site due to vegetation was envisaged prior to commencing the survey however, the utilisation of the outer bailey and areas north of the outer defences by golf severely restricted time available to carry out survey preventing the use of earth resistance. Areas with steep slopes and surface rubble close to the motte or keep were also unsurveyed.

3.1.2 Where earth resistance survey was possible, data was collected at 0.5m centres. A significant portion of the inner part of the site was covered, amounting to approximately 1ha, although no data was collected from the outer bailey due to the presence of golf. Thickets of briar and thorn prevented full coverage of the interior of the site and the larger banks and ditches were avoided as geophysical data was unnecessary for their interpretation. Areas of surface rubble produced poor contact conditions for the resistance meter as did a large number of anthills with bailey 1.

3.1.3 Magnetometry was not possible within the inner baileys due to physical restriction of the instrument by trees and surface vegetation. Data was collected over 2ha and included the outer bailey and a section to the north of the outer northern defences. The proposed methodology for data collection was modified to provide more rapid data collection so that the areas could be cleared ahead of golf. Data was collected at 0.125m centres along traverses 1m apart in zig-zag fashion.

3.1.4 Magnetic susceptibility data collection was also restricted due to problems of access associated with vegetation and golf. In addition a number of measurements taken outside the castle site suggest naturally high levels of magnetic enhancement and it is was considered unlikely that the technique would be a reliable indicator of archaeological features. Data was collected across approximately 2ha and included the outer and inner baileys.

3.2 Earth resistance survey

3.2.1 The listing of sub-headings below attempts to define a number of separate categories that reflect the range and type of features located during the earth resistance survey. A basic explanation of the characteristics of the anomalies is set out for each category in order to justify interpretation. Sub-headings are then used to group anomalies with similar characteristics. A rating is given as either high, medium or low and is intended to be a broad indicator of interpretation confidence. A colour indicator is shown as an aid to cross-referencing with the associated interpretation plot, see Figure 06.

High resistance anomalies associated with structural remains.

The category is used where high resistance anomalies have a linear or rectilinear form and are clearly associated with extant earthworks or exposed masonry. The interpretation has a high confidence rating.

High resistance anomalies possibly associated with structural remains.

The category applies to high resistance anomalies with some linear or rectilinear form. The anomalies may be associated with earthworks. The interpretation has a moderate confidence rating.

High resistance anomalies associated with defensive works.

High resistance generally broad linear anomalies usually associated with extant earthworks. This may be a response to material used to construct a bank, wall, revetment or combination of these. The response may be associated with a distinct change in the geology if this is exposed within the edge of a ditch.

Low resistance anomalies associated with ditches.

Low resistance linear anomalies associated with visible ditches forming part of the defensive works or internal division. The interpretation has a high confidence rating.

High resistance anomalies possibly caused by quarrying/ solid geology.

The response is associated with large depressions and although may appear similar to structural remains, it is likely to be associated with minor quarrying and exposure of bedrock. The interpretation has a moderate confidence rating.

High resistance zones possibly associated with structural debris.

Generally amorphous zones of poorly defined high resistance. Structural debris may include solid material immediately adjacent to former masonry structures but may well include poorly defined walling and hard surfaces. The interpretation has a moderate confidence rating.

Low resistance zones associated with visible depressions.

Amorphous or rectangular zones of low resistance associated with increased moisture within the fill of visible depressions. The origin of these features is unclear; it is possible that a number represent former buildings and some may represent minor quarrying, a combination of both is possible. The interpretation has a moderate to low confidence rating.

Very low resistance response caused by wire netting.

The response has been caused by dilapidated wire net fencing formerly used to manage game birds. The interpretation has a high confidence rating.

High/low resistance response associated with track.

Variable response to the current trackway through the site. It is unlikely that the track is ancient in origin. The interpretation has a high confidence rating.

High resistance linear anomaly possibly related to a former track.

The linear anomaly may be associated with a former track or path. The interpretation has a low confidence rating.

3.2.2 High resistance anomalies associated with structural remains.

(1) – High resistance linear and rectilinear anomalies lie immediately outside the motte to the northeast. The anomalies are associated with a raised

area of rectilinear form and partially exposed masonry, there is little doubt that substantial building remains are present within this area.

(2) – High resistance rectilinear anomaly to the southeast of the site is related to partially exposed masonry and an associated earthwork. It is possible that this was a substantial building butting an outer defensive wall.

(3) – Broad linear high resistance anomalies are associated with earthworks and are likely to represent a former masonry structure.

(4) – High resistance anomalies forming rectilinear elements and associated with a rectangular earthwork. The anomalies probably represent masonry building remains.

(5) – Similar to (4).

3.2.3 High resistance anomalies possibly associated with structural remains

(6) – High resistance linear and rectilinear anomalies with an orientation respecting anomalies (1) and defensive earthworks. Possibly associated with building remains.

(7) – Similar to (6).

(8) – High resistance rectilinear anomalies having a different orientation to structural anomalies (1) and clearly associated with surface depressions. The anomalies may be associated with buildings and/or minor quarrying.

(9) – Similar to (8).

(10) – High resistance rectilinear elements possibly associated with a building.

(11) – High resistance poorly defined rectilinear elements. The anomalies lie in a zone where substantial anthills occur and it is clear that these have influenced the readings. It is possible that the anomalies relate to former structures beneath the anthills.

(12) – Similar to (11).

3.2.4 High resistance anomalies associated with defensive works

(13) – High resistance linear anomaly probably relating to a defensive wall.

(14) – High resistance anomalies associated with walling remains visible on the defensive bank.

(15) – High resistance anomaly close to the edge of a defensive ditch may represent walling remains or solid geology close to the surface.

(16) – High resistance linear anomaly associated with a former outer wall.

(17) – High resistance anomalies associated with a bank and ditch.

(18) – High resistance linear anomaly to the side of a defensive ditch. The anomaly may be associated with solid geology exposed during ditch construction.

(19) – Similar to (18) although may represent wall remains along the ditch edge.

(20) – Similar to and possible continuation of (18).

(21) – Similar to and possible continuation of (19).

(22) – High resistance linear anomaly associated with a low bank which may represent a former wall.

(23) – High resistance linear anomaly may represent wall remains close to the ditch edge.

(24) – High resistance linear anomaly caused by wall remains.

3.2.5 *Low resistance anomalies associated with ditches.*

(25) – A low resistance linear anomaly clearly visible as a ditch. The anomaly lies immediately to the northwest of and is parallel to substantial masonry remains. There is some evidence for a continuation of the feature to the northwest and to the southeast where it may possibly curve towards the east.

(26) – Low resistance linear anomaly associated with a defensive ditch separating baileys.

(27) – Continuation of (26).

(28) – Similar to (26).

3.2.6 *High resistance anomalies possibly caused by quarrying/ solid geology.*

(29) – Curving broad high resistance anomaly associated with an amorphous depression probably characteristic of minor quarrying.

(30) – High resistance anomaly associated with exposed bedrock.

(31) – An area of high resistance associated with a depression probably initially caused by construction of the motte with possible later quarrying.

3.2.7 High resistance zones possibly associated with structural debris.

The zones are not individually listed; they are generally amorphous in nature and located close to earthworks and/or resistive anomalies associated with masonry structures.

3.2.8 Low resistance zones associated with visible depressions.

The zones are not individually listed; they are generally sub-rectangular or amorphous in nature and may be associated with minor quarrying or former buildings.

3.2.9 Very low resistance response caused by wire netting.

The anomalies are visible as linear low resistance responses within the central western and southern parts of the surveyed area. Wire netting was observed beneath the vegetation and could clearly be associated with the low responses.

3.2.10 High/low resistance response associated with track.

A mixed linear response clearly associated with the current access route.

3.2.11 High resistance linear anomaly possibly related to a former track.

(32) – Within the southern part of the survey area a high resistance linear anomaly has an approximately east – west orientation dissimilar to adjacent structural remains. By extension of the anomaly towards the east, it is possible that the track passes through a break in the outer defences.

3.3 Magnetometry

3.3.1 The listing of sub-headings below attempts to define a number of separate categories that reflect the range and type of features located during the magnetometry survey. A basic explanation of the characteristics of the anomalies is set out for each category in order to justify interpretation. Sub-headings are then used to group anomalies with similar characteristics. A colour indicator is shown as an aid to cross-referencing with the associated interpretation plot, see Figure 10.

Positive linear anomalies associated with defensive banks.

Positive, generally broad linear anomalies associated with extant earthworks. It is likely that the positive response is associated with a large volume of enhanced soil within the bank. The interpretation has a high confidence rating.

Positive linear anomaly associated with a former defensive ditch.

A broad positive linear response not associated with earthworks and probably representing a former defensive ditch. The interpretation has a high confidence rating.

Negative anomalies possibly associated with stone.

Negative anomalies that may be associated with very shallow stone. The interpretation has a moderate to low confidence rating.

Negative linear anomalies of uncertain origin.

The anomalies are likely to have been caused by material of low magnetic susceptibility within the upper part of the soil profile. This may include limestone and subsoil. The interpretation has a moderate confidence rating.

Positive anomalies of uncertain origin.

The anomalies are probably associated with material of enhanced magnetic susceptibility that forms the fill of former cut features. The interpretation has a moderate confidence rating.

Positive linear anomalies associated with pillow mounds.

Positive linear anomalies clearly associated with pillow mounds within the outer bailey. The origin of the response is uncertain but likely to be related to earthen construction.

Negative linear anomalies associated with pillow mounds.

The anomalies are clearly associated with the pillow mounds and may represent internal structure built with stone.

Area of magnetic debris.

An area of magnetic debris is visible as a concentrated zone of minor dipolar anomalies. This is often caused by fragments of magnetically thermoremnant material such as clinker, slag or ceramic material. The interpretation has a moderate confidence rating.

Anomaly associated with golf track.

A broad linear zone corresponding with the metalled track used by golfers. Generally the response is negative. The interpretation has a high confidence rating.

3.3.2 Positive linear anomalies associated with defensive banks.

(33) – A broad positive linear response associated with the outer bank of the earthwork defences.

(34) – A broad positive linear response associated with the north eastern side of the inner bank of the earthwork defences. There is evidence of burnt stone and clay fragments within the make-up of the bank.

3.3.3 Positive linear anomaly associated with a former defensive ditch.

(35) – A broad positive linear response up to 7m wide mirrors the northern bank of the outer defences. The response is associated with a former ditch that is no longer visible as an earthwork feature. There is evidence for a minor 'causeway' and the feature appears to end abruptly.

3.3.4 Negative anomalies possibly associated with stone.

(36) – A negative response follows the perimeter of (35) on its northern side. The anomaly may be associated with shallow stone or the remains of a minor wall?

(37) – May be similar to (36) the response could also be caused by stone revetment.

3.3.5 Negative linear anomalies of uncertain origin.

(38) – A narrow negative linear response that may represent a pipeline or minor wall?

(39) – A negative linear anomaly possibly associated with pillow mounds, see (48).

(40) - A series of negative linear anomalies close to the metalled golf track may represent an earlier trackway.

(41) – Negative linear anomalies that may provide tentative evidence of structural remains.

3.3.6 Positive anomalies of uncertain origin.

(42) – Several discrete positive anomalies may represent irregular pit-like features.

(43) – A short positive linear anomaly may be associated with the castle defences.

(44) – A positive linear anomaly possibly associated with pillow mounds.

(45) – Poorly defined and fragmented curvilinear anomalies may represent cut features.

(46) – Linear anomalies that may represent cut features.

3.3.7 Positive linear anomalies associated with pillow mounds.

(47) – Positive parallel linear anomalies probably related to earthen construction. The responses are parallel to a series of negative linear anomalies, see (48).

3.3.8 Negative linear anomalies associated with pillow mounds.

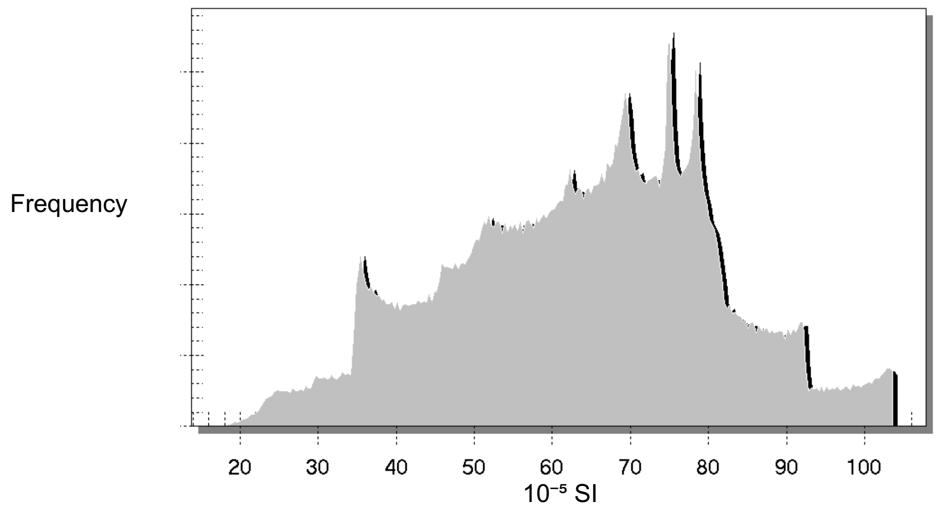
(48) – Negative parallel linear anomalies possibly related to stone structural elements within the pillow mounds.

3.4 Magnetic susceptibility

3.4.1 The magnetic susceptibility survey indicates a wide range of magnetic enhancement from 18 to 205 x 10^{-5} SI, see Figure 11. A mean value of 85 x 10^{-5} SI was calculated from the complete dataset. The values could be considered as indicating significant anthropogenic enhancement, however, test measurements away from the castle site also indicate high levels of topsoil enhancement.

3.4.2 Area 1

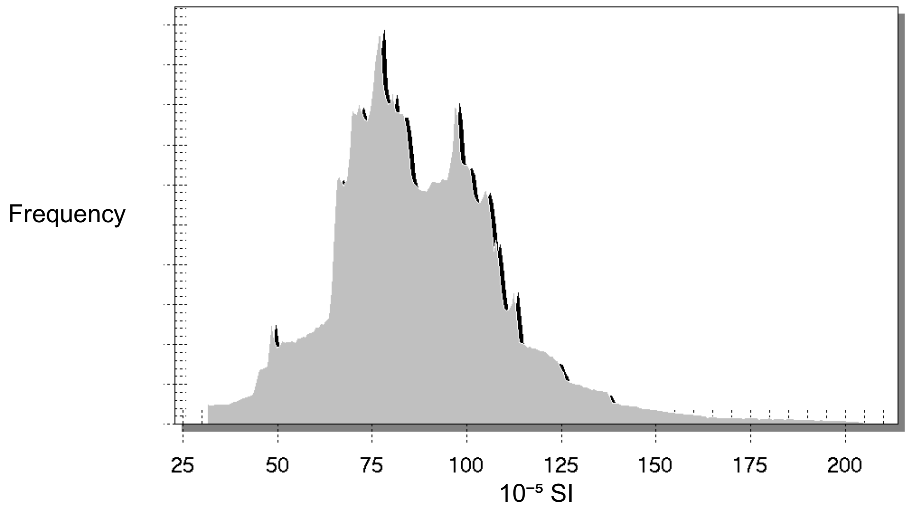
Magnetic enhancement ranges from relatively low adjacent to the motte with values increasing towards the southeast where structural remains are visible as earthworks. Histogram 1 indicates the wide range of values recorded across Area 1.



Histogram 1 Magnetic susceptibility results for Area 1

3.4.3 Area 2

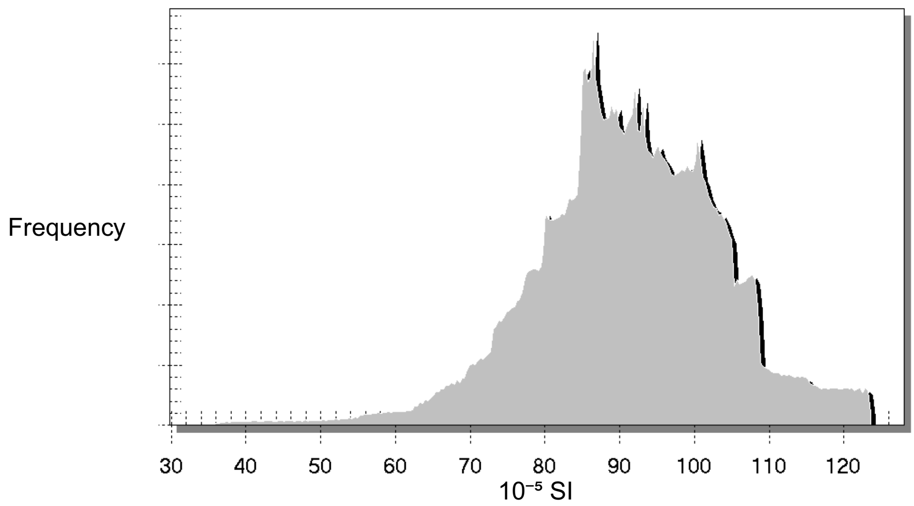
Generally high levels of magnetic enhancement were recorded across the area with isolated low readings and lower levels of enhancement adjacent to the motte towards the southwest. Histogram 2 displays the frequency of values across the area and indicates the isolated nature of the highest recorded value of 205 x 10^{-5} SI which occurs along the south eastern boundary.



Histogram 2 Magnetic susceptibility results for Area 2

3.4.4 Area 3

High levels of magnetic susceptibility were recorded across the area, few values were less than 80 x 10-5 SI. Histogram 3 indicates the small number of low values which may have been caused by the golf track and made ground close to the putting green.



Histogram 3 Magnetic susceptibility results for Area 3

4 DISCUSSION

4.1 Earth resistance survey

4.1.1 The results of the resistance survey indicate the considerable archaeological potential of the castle site. Interpretation of anomalies was approached cautiously, given that the results were generally not well defined, and structural remains were only confidently interpreted where there is a correlation between resistive anomalies and rectilinear or linear earthworks. Using these criteria at least 5 separate stone built structures can be confidently interpreted within the inner baileys. The variation in resistance across the site produces a remarkably similar pattern to a surface model produced from accurately measured points and adds weight to the interpretation, see Figure 12.

4.1.2 High resistance anomalies possibly associated with structural remains occur within the inner baileys, unfortunately resistance data was not obtained from the outer bailey for comparison. It is very likely that many of these anomalies are also associated with former stone structures however, the cautious approach adopted is related to a number of observations made during the survey. Possible structures labelled as 7, 8 and 9 are found adjacent to depressions which are either amorphous or sub-rectangular in nature. The depressions may easily be interpreted as further evidence for buildings, particularly if surrounded by a low bank, but the amorphous nature of some would tend to suggest minor quarrying although it is possible that demolition and stone robbing has obscured their true shape. A large group of possible structures was defined within inner bailey 1, anomalies 11 and 12. The ground surface is highly irregular within this area due to the presence of a large number of anthills formed in favourable conditions by meadow ants. The highly irregular soil depth clearly influenced the resistance data which has prevented confident interpretation for these anomalies also.

4.1.3 Areas of possible structural debris were defined within inner baileys 3 and 4. These amorphous zones of high resistance would be consistent with shallow stone or rubble and although linear and rectilinear elements cannot be readily defined it is possible that they are associated with former structures.

4.1.4 As suggested in 4.1.2, there may be some evidence for minor quarrying across the site as there are several amorphous depressions that would appear to be inconsistent with building remains due to their depth or proximity to earthworks. Quarrying may fall into two separate categories: construction of earthworks combined with extraction of stone for use onsite; prospection for stone and further quarrying after the site has fallen out of use and all easily available stone has been robbed. High resistance anomalies may relate to a combination of shallow stone to the side of the depression, as probably occurs at anomalies 30 and 31, and dumped waste material around the perimeter of the depression, possibly occurring at anomaly 29. Anomalies 30 and 31 occur close to the motte or shell keep and may be associated with the initial construction of it, anomaly 29 is located within inner bailey 3 and would perhaps suggest later quarrying. There is further evidence of quarrying within inner baileys 1 and 2 outside the area accessible for survey.

4.1.5 Defensive earthworks separating each bailey have a generally similar response. The base of the ditches in between inner baileys 1, 2 and 3 are clearly low resistance suggesting increased moisture within the fill. The ditch sides contrast strongly with the base as there is a rapid transition to high resistance, this is likely to be through a combination of increased drainage and the presence of natural rock bands cut through by the cut of the ditch. High resistance close to the edge of the ditches where no bank is apparent, as along the south western sides of inner baileys 1, 2 and 3, may be related to increased drainage or may suggest wall remains particularly in areas where there is evidence for adjacent buildings. For example, it is not clear where high resistance anomaly 23 related to the ditch ends and the south western edge of possible structural anomalies 11 begin. The defensive banks may suggest subtle differences in construction. A low bank between inner baileys 1 and 2 has a high resistance response whereas much of the larger bank between inner baileys 2 and 3 is not clearly defined as a high resistance anomaly (although access was limited by vegetation), however, anomaly 24 may suggest a wall. The large bank between inner baileys 3 and 4 can be seen in section where they are cut by a relatively modern track; the construction technique here is clearly a substantial stone wall with earth and stone rubble mounded up on both sides, accessible parts of the bank produced high resistance.

4.1.6 The outer perimeter of the inner baileys is defined by a low bank although this appears incomplete in areas. The high resistance response revealed where the bank was crossed, see anomalies 13 and 16, would indicate that the perimeter of the inner baileys was surrounded by a wall. Within the outer bailey the perimeter is developed as a substantial bank although it is unclear as to whether this was also combined with a stone wall.

4.1.7 A distinct low resistance linear anomaly is associated with a visible ditch within inner bailey 3, anomaly 25. The ditch lies immediately adjacent to structural remains and there is some tentative evidence from the geophysics that it may extend further to the northwest and to the southeast where it curves to take a more easterly route. The feature would tend to indicate a substantial internal division although would be unsuitable for a defensive feature, a possible open drainage feature is suggested. The possible curve to the southeast is reflected to a degree within the adjacent high resistance anomalies although the data is somewhat obscured by a response to the track. This may suggest an internal layout of structures that does not necessarily reflect the orientation of the major earthwork divisions between the baileys.

4.1.8 The trackway currently used to access the inner baileys and motte has been defined by a variable response within the resistance data, (mainly low resistance). There is no evidence to support this track as an original feature of the castle. A possible track or path, anomaly 32, crosses Inner Bailey 4 and does not appear to have a relationship to structural anomaly 2. Recreational paths and tracks were known to be present within the Victorian period although there are no maps of the specific routes taken.

4.2 Magnetometry data

4.2.1 The results may suggest that the outer bailey remained relatively undeveloped compared to the inner baileys. This should be considered in further detail though as earth resistance survey could not be used due to the presence of golf and a comparative dataset is unavailable. It is possible that the magnetometry has not responded well to structural remains should they be present; earth resistance survey is generally preferred where masonry remains are expected as the technique is often superior. In addition it is likely that some landscaping of the site has occurred during the construction of the golf course which may have affected the viability of the technique, it is known that the western third of the outer bailey has been raised by the deposition of soil and sand to form the putting green and bunkers. However, the relatively clear positive and negative data collected across the pillow mounds and their presence as upstanding earthworks would support evidence that disturbance has been minor and that if structural remains were present then magnetometry would be a viable technique.

4.2.2 The magnetic response relating to the pillow mounds suggests some evidence for internal stone structure. Pillow mounds were constructed in the medieval and post medieval periods to effectively farm rabbits which initially did not survive well in British conditions. The parallel positive and negative response may indicate a series of internal runs constructed in stone. The mounds would appear to be little disturbed with good internal survival.

4.2.3 There is tentative evidence for features within the outer bailey other than the pillow mounds. There are a number of positive curvilinear and linear anomalies which may represent cut features, anomalies 45 and 46, and linear negative anomalies which could be structural, anomalies labelled 41.

4.2.4 The magnetometry has indicated that a large ditch at least partially surrounded the outer defensive bank to the north, anomaly 35. There is no evidence for a ditch from site observations but for a defensive system on relatively flat ground, it is clear that a large ditch should be encountered and would provide material for the adjacent bank on the inner side. The base mapping for this part of the site is poor and it is clear from the earthworks and the geophysics that there is some complexity to the defences that requires further investigation.

4.3 Magnetic susceptibility data

4.3.1 High levels of magnetic susceptibility were expected prior to the survey. Anthropogenic activities within the confines of the castle site were considered very likely to have produced enhanced soils. Observation of high magnetic susceptibility on top of the earthen and stone banks of the defences was not expected and further tests on agricultural areas within the vicinity of the castle site also revealed a high level of magnetic enhancement, a similar range of values to the interior of the castle site was noted. Further tests and samples may be required to understand the origin of the enhancement in more detail but it is likely that the soil properties and minerals present within the soil are major factors. It cannot be confidently stated that variations in magnetic susceptibility across the castle site are purely registering variability in anthropogenic activity.

4.3.2 The results perhaps do indicate less variability within the outer bailey which could be attributed to minor landscaping associated with the golf course and there is some indication that areas close to the motte have a much lower level of enhancement. The latter could be consistent with material of relatively low magnetic susceptibility, such as limestone, eroding from the motte or exposed in adjacent quarrying.

5 CONCLUSION

5.1

5.1.1 The geophysical survey has provided evidence for structural remains within a large proportion of the inner baileys at the castle site perhaps suggesting that these areas were densely occupied. There is good correlation to building remains located by previous fieldworkers although accurate referencing of the base mapping would be required in order to investigate the relationship further.

5.1.2 The geophysical evidence from the outer bailey tends to indicate that the area remained much less developed. The survey provided little evidence of structural remains, a number of linear and curvilinear anomalies were located but further interpretation was not possible.

5.1.3 The location of a large ditch-like anomaly to the north of the northern outer defences of the site would suggest a robust defensive system of at least two large banks and ditches. The presence of a narrow causeway across the outer ditch and a distinct termination to its southern end perhaps indicates a more complex defensive system than is apparent from the earthwork evidence alone.

5.1.4 Geophysics may still provide valuable evidence for the interpretation of the site. Specifically, earth resistance survey within the outer bailey may help to confirm the presence of not of masonry structures, magnetometry and resistance survey in accessible areas immediately to the north, northwest and northeast of the outer defences may further refine interpretation of the defences.

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Appendix A – basic principles of magnetic survey

Iron minerals are always present to some degree within the topsoil and enhancement associated with human activity is related to increases in the level of magnetic susceptibility and thermoremnant material.

Magnetic susceptibility is an induced magnetism within a material when it is in the presence of a magnetic field. This can be thought of as effectively permanent due to the presence of the Earth’s magnetic field.

Thermoremnant magnetism occurs when ferrous material is heated beyond a specific temperature known as the Curie Point. Demagnetisation occurs at this temperature with re-magnetisation by the Earth’s magnetic field on cooling.

Enhancement of magnetic susceptibility can occur in areas subject to burning and complex fermentation processes on biological material; these are frequently associated with human settlement. Thermoremnant features include ovens, hearths and kilns. In addition thermoremnant material such as tile and brick may also be associated with human activity and settlement.

Silting and deliberate infilling of ditches and pits with magnetically enhanced soil can create an area of enhancement compared with the surrounding soils and subsoils into which the feature is cut. Mapping enhanced areas will produce linear and discrete anomalies allowing an assessment and characterisation of hidden subsurface features.

It should be noted that areas of negative enhancement can be produced from material having lower magnetic properties compared to topsoil. This is common for many sedimentary bedrocks and subsoils which were often used in the construction of banks and walls etc. Mapping these ‘negative’ anomalies may also reveal archaeological features.

Magnetic survey or magnetometry can be carried out using a fluxgate gradiometer and may be referred to as gradiometry. The gradiometer is a passive instrument consisting of two fluxgate sensors mounted vertically 1m apart. The instrument is carried about 30cm above the ground surface and the upper sensor measures the Earth’s magnetic field as does the lower sensor but this is influenced to a greater degree by any localised buried field. The difference between the two sensors will relate to the strength of magnetic field created by the buried feature. If no enhanced feature is present the field measured by both sensors will be similar and the difference close to zero.

There are a number of factors that may affect the magnetic survey and these include soil type, local geology and previous human activity. Situations arise where magnetic disturbance associated with modern services, metal fencing, dumped waste material etc., obscures low magnitude fields associated with archaeological features.

Appendix B – survey and data information

Raw resistance data

COMPOSITE

Filename: Res.xcp
Instrument Type: TR/CIA (Resistance)
Units: Ohm
Collection Method: ZigZag
Dummy Value: -2147483648
Origin: Zero

Dimensions
Composite Size (readings): 360 x 240
Grid Size: 20 x 20
X Interval: 0.5
Y Interval: 0.5

Stats
Max: 736.29
Min: 0.05
Std Dev: 32.50
Mean: 98.22

Processes: 1
1 Base Layer

Source Grids: 30
1 Col:0 Row:1 grids\30.asg
2 Col:0 Row:2 grids\27.asg
3 Col:1 Row:1 grids\29.asg
4 Col:1 Row:2 grids\26.asg
5 Col:1 Row:3 grids\25.asg
6 Col:2 Row:1 grids\28.asg
7 Col:2 Row:2 grids\23.asg
8 Col:2 Row:3 grids\24.asg
9 Col:3 Row:1 grids\13.asg
10 Col:3 Row:2 grids\10.asg
11 Col:3 Row:3 grids\09.asg
12 Col:3 Row:4 grids\08.asg
13 Col:3 Row:5 grids\05.asg
14 Col:4 Row:0 grids\12.asg
15 Col:4 Row:1 grids\11.asg
16 Col:4 Row:2 grids\01.asg
17 Col:4 Row:3 grids\02.asg
18 Col:4 Row:4 grids\03.asg
19 Col:4 Row:5 grids\04.asg
20 Col:5 Row:0 grids\16.asg
21 Col:5 Row:1 grids\14.asg
22 Col:5 Row:4 grids\07.asg
23 Col:5 Row:5 grids\06.asg
24 Col:6 Row:0 grids\17.asg
25 Col:6 Row:1 grids\15.asg
26 Col:7 Row:0 grids\21.asg
27 Col:7 Row:1 grids\18.asg
28 Col:7 Row:2 grids\19.asg
29 Col:8 Row:0 grids\22.asg
30 Col:8 Row:1 grids\20.asg

Processed resistance data

COMPOSITE

Filename: Res-proc.xcp
Instrument Type: TR/CIA (Resistance)
Units: Ohm
Collection Method: ZigZag
Dummy Value: -2147483648
Origin: Zero

Dimensions
Composite Size (readings): 360 x 240
Grid Size: 20 x 20
X Interval: 0.5
Y Interval: 0.5

Stats
Max: 14.03
Min: -14.25
Std Dev: 9.62
Mean: -0.67

Processes: 17
1 Base Layer
2 Edge Match (Area: Top 40, Left 120, Bottom 79, Right 159) to Bottom edge
3 Add/Subtract -10 (Area: Top 32, Left 0, Bottom 168, Right 119)
4 Edge Match (Area: Top 40, Left 200, Bottom 82, Right 279) to Top edge
5 Add/Subtract -15 (Area: Top 19, Left 200, Bottom 100, Right 359)
6 Edge Match (Area: Top 27, Left 0, Bottom 179, Right 159) to Right edge
7 Edge Match (Area: Top 160, Left 109, Bottom 237, Right 222) to Top edge
8 Add/Subtract -10 (Area: Top 160, Left 123, Bottom 237, Right 222)
9 Add/Subtract -5 (Area: Top 160, Left 136, Bottom 172, Right 159)
10 Edge Match (Area: Top 14, Left 200, Bottom 92, Right 279) to Right edge
11 Edge Match (Area: Top 11, Left 280, Bottom 111, Right 349) to Left edge
12 Add/Subtract -10 (Area: Top 14, Left 200, Bottom 90, Right 279)
13 Edge Match (Area: Top 12, Left 208, Bottom 39, Right 349) to Bottom edge
14 Add/Subtract 10 (Area: Top 40, Left 280, Bottom 100, Right 319)
15 High pass Gaussian filter: Window: 21 x 21
16 Clip at 2 SD
17 Clip at 1 SD

Raw magnetometry data

COMPOSITE

Filename: Mag-raw.xcp
Instrument Type: Grad 601 (Magnetometer)
Units: nT
Collection Method: ZigZag
Sensors: 2 @ 1.00 m spacing.
Dummy Value: 32702
Origin: One

Dimensions
Composite Size (readings): 1440 x 180
Grid Size: 20 x 20
X Interval: 0.125
Y Interval: 1

Stats
Max: 10.00
Min: -10.00
Std Dev: 3.72
Mean: -0.71

Processes: 4
1 Base Layer
2 Clip from -10 to 10
3 De Stagger: Grids: All Mode: Both By: -2 intervals
4 Clip from -10 to 10

Source Grids: 50
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2 Col:0 Row:2 grids\44.asg
3 Col:0 Row:3 grids\45.asg
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7 Col:0 Row:7 grids\49.asg
8 Col:0 Row:8 grids\50.asg
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10 Col:1 Row:2 grids\36.asg
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46 Col:8 Row:2 grids\03.asg
47 Col:8 Row:3 grids\04.asg
48 Col:8 Row:4 grids\20.asg
49 Col:8 Row:5 grids\21.asg
50 Col:8 Row:6 grids\22.asg

Processed magnetometry data

COMPOSITE

Filename: Mag-proc.xcp
Instrument Type: Grad 601 (Magnetometer)
Units: nT
Collection Method: ZigZag
Sensors: 2 @ 1.00 m spacing.
Dummy Value: 32702
Origin: One

Dimensions
Composite Size (readings): 1440 x 180
Grid Size: 20 x 20
X Interval: 0.125
Y Interval: 1

Stats
Max: 3.00
Min: -3.00
Std Dev: 1.82
Mean: 0.05

Processes: 5
1 Base Layer
2 Clip from -10 to 10
3 De Stagger: Grids: All Mode: Both By: -2 intervals
4 DeStripe Median Traverse: Grids: All
5 Clip from -3 to 3

Archaeological Surveys

Geophysical Survey
Castle Combe Castle

Map of survey area

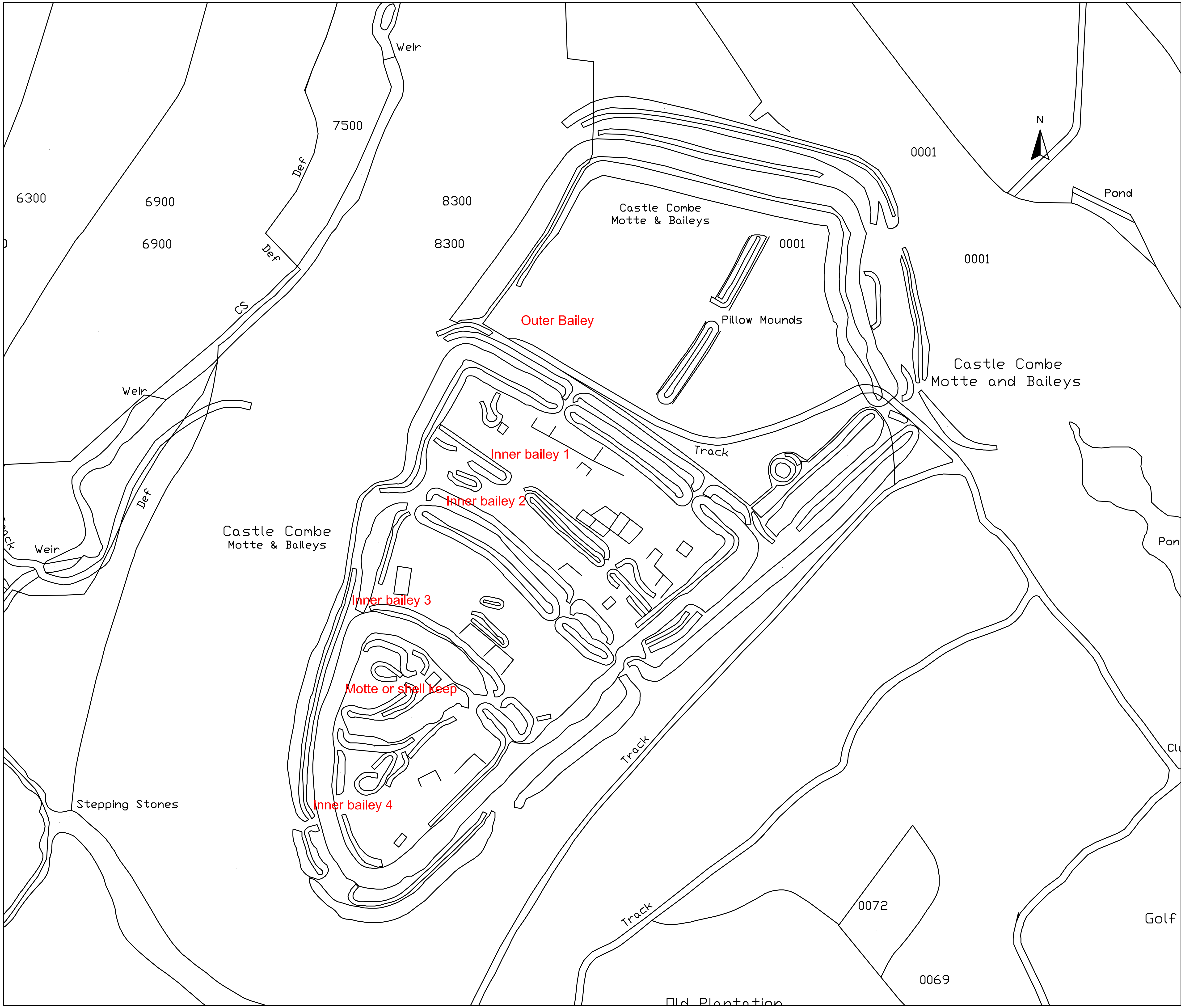
Reproduced from OS Explorer map no.156 1:25 000 by permission of Ordnance Survey on behalf of The Controller of Her Majesty's Stationery Office.

Site centred on OS NGR ST 8387 7788

SCALE 1:25 000

0m 500 1000m

FIG 01

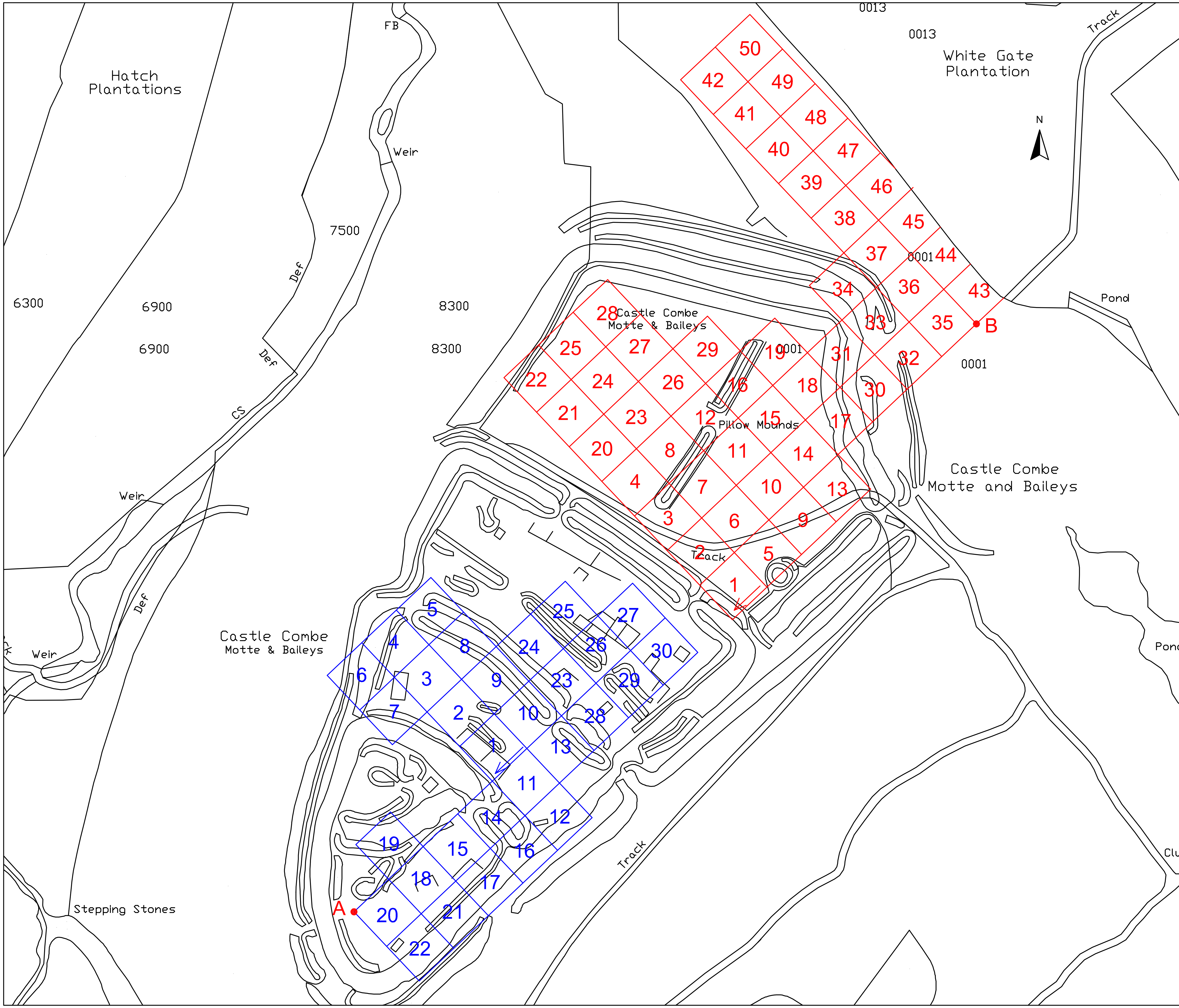


Archaeological Surveys

Geophysical Survey
Castle Combe Castle

Map of castle site

FIG 02



Archaeological Surveys

Geophysical Survey
Castle Combe Castle

Referencing information and grid numbers

Based on OS coordinates (OSGB36)

A 383771.82, 177758.90

B 384033.60, 178006.03

Baseline points A-B are not intervisible and were set to a local grid using a total station. Referencing of points A-B to OSGB36 was acheived using differential GPS giving a possible sub-metre accuracy.

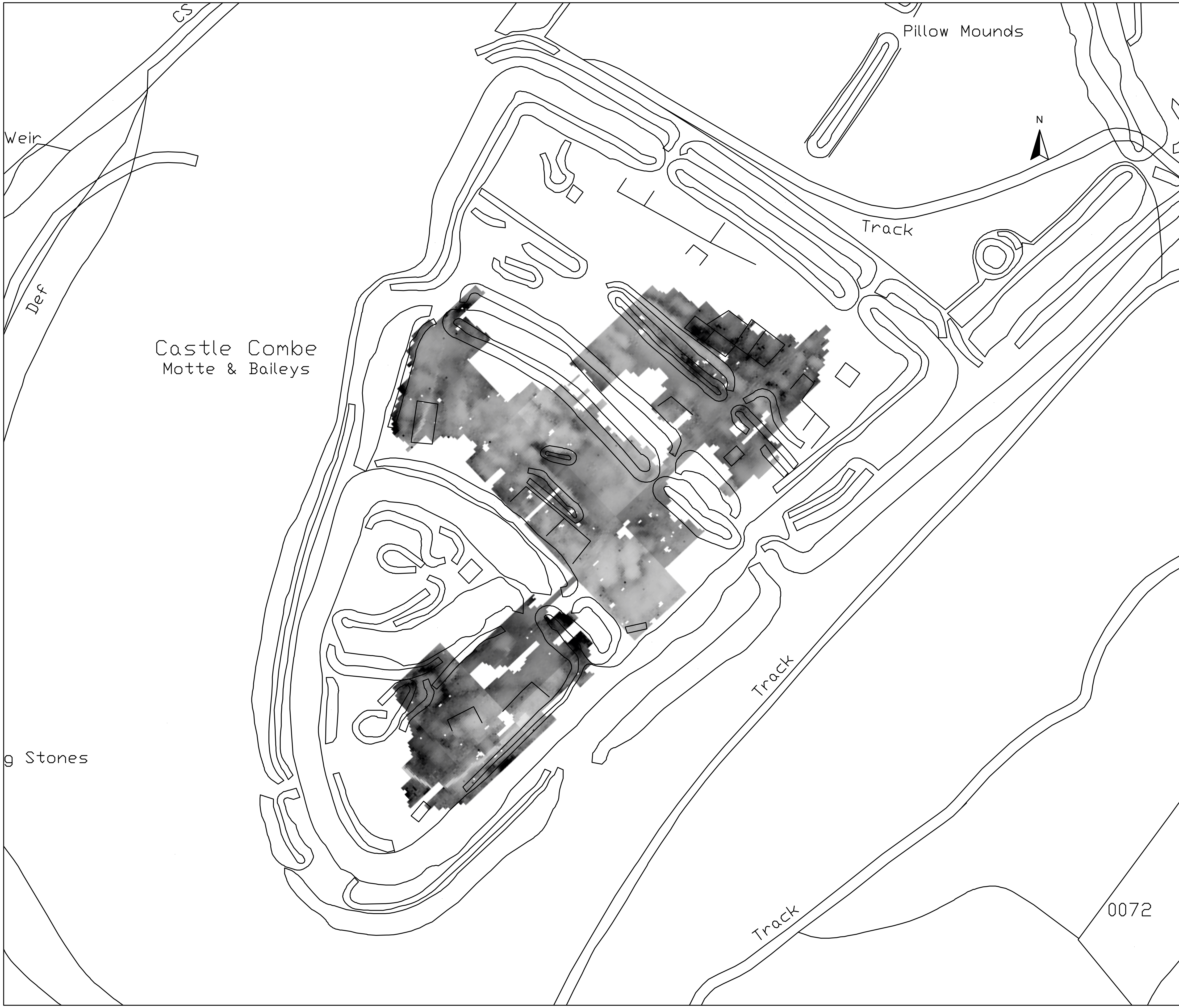
Magnetometry start and traverse direction

Resistance start and traverse direction

SCALE 1:1500

0m 10 20 30 40 50m

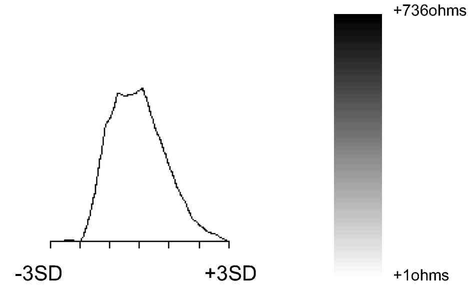
FIG 03



Archaeological Surveys

Geophysical Survey
Castle Combe Castle

Greyscale plot of raw resistance data



SCALE 1:1000

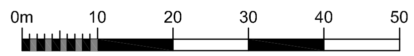
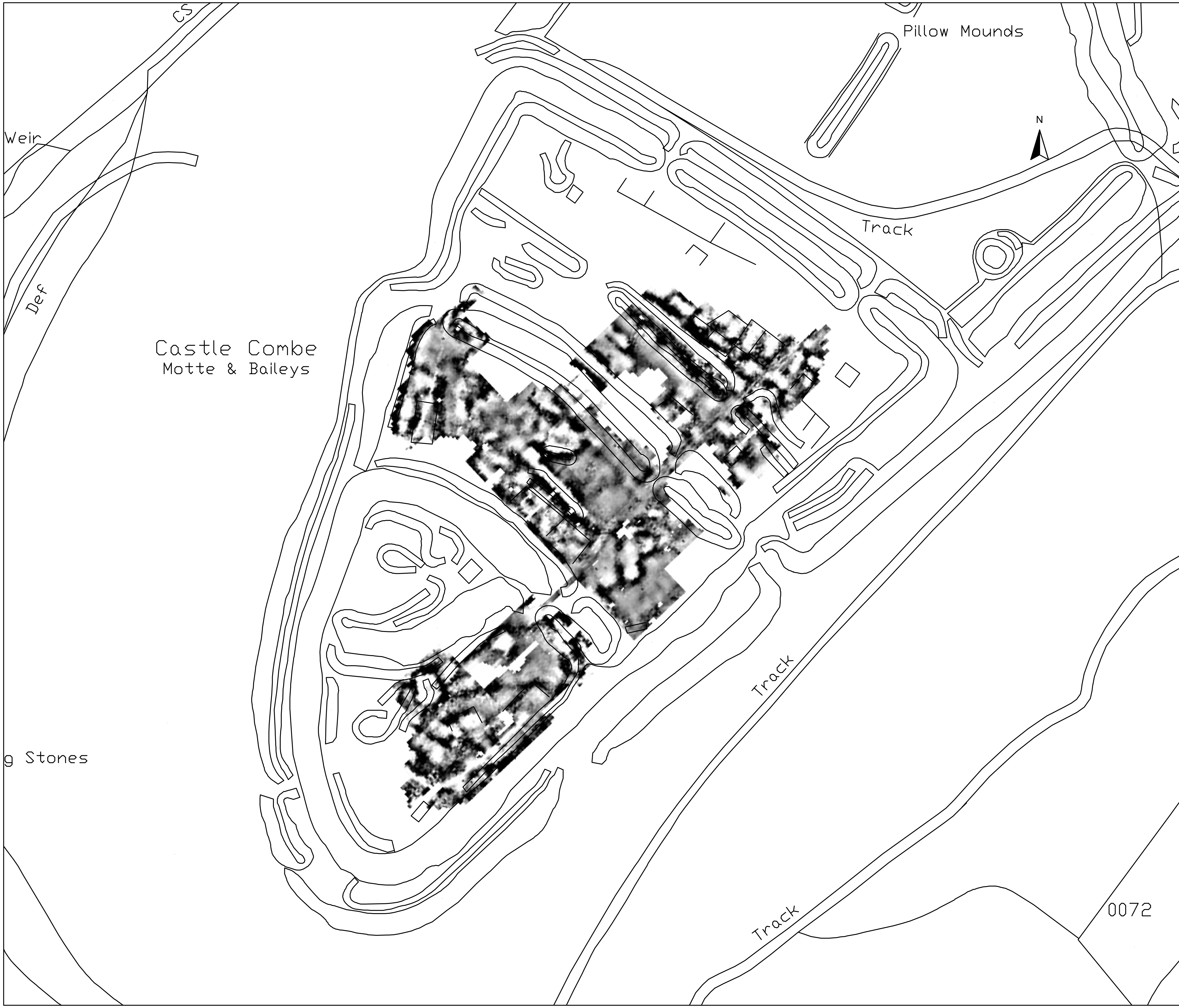


FIG 04



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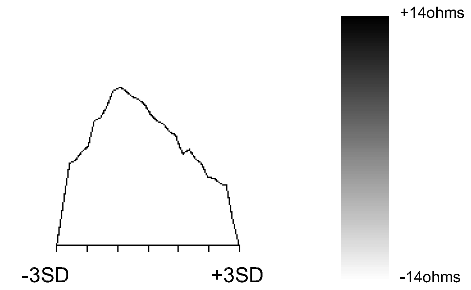
Greyscale plot of processed resistance data



SCALE 1:1000

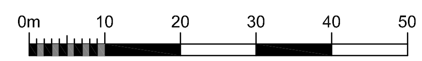
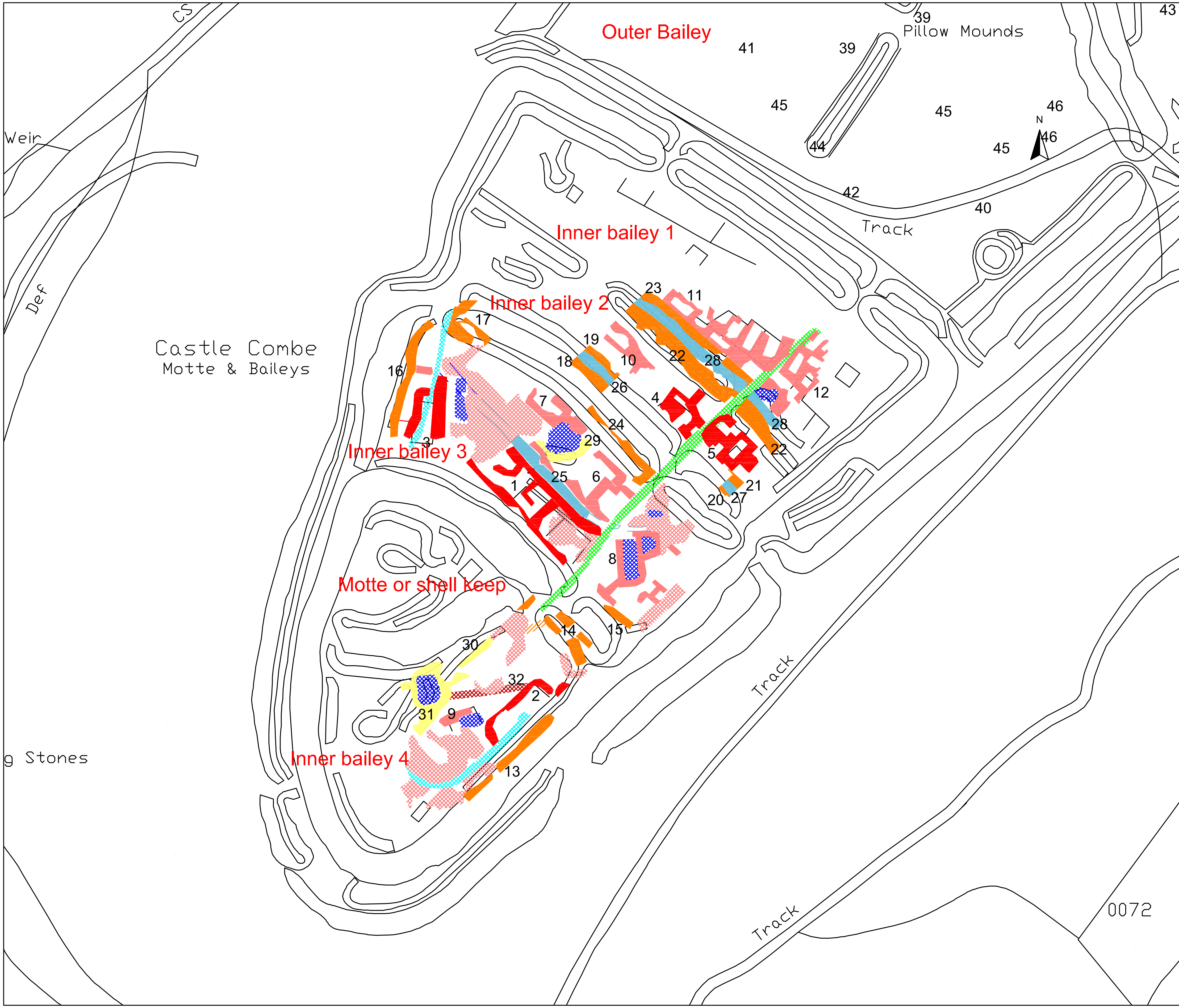


FIG 05



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Abstraction and interpretation of resistance anomalies

- High resistance anomalies associated with structural remains
- High resistance anomalies possibly associated with structural remains
- High resistance anomalies associated with defensive works
- Low resistance anomalies associated with ditches
- High resistance anomalies possibly caused by quarrying/ solid geology
- High resistance zones possibly associated with structural debris
- Low resistance zones associated with visible depressions
- Very low resistance response caused by wire netting
- High/low resistance response associated with track
- High resistance linear anomaly possibly associated with a former track

SCALE 1:1000

0m 10 20 30 40 50

FIG 06

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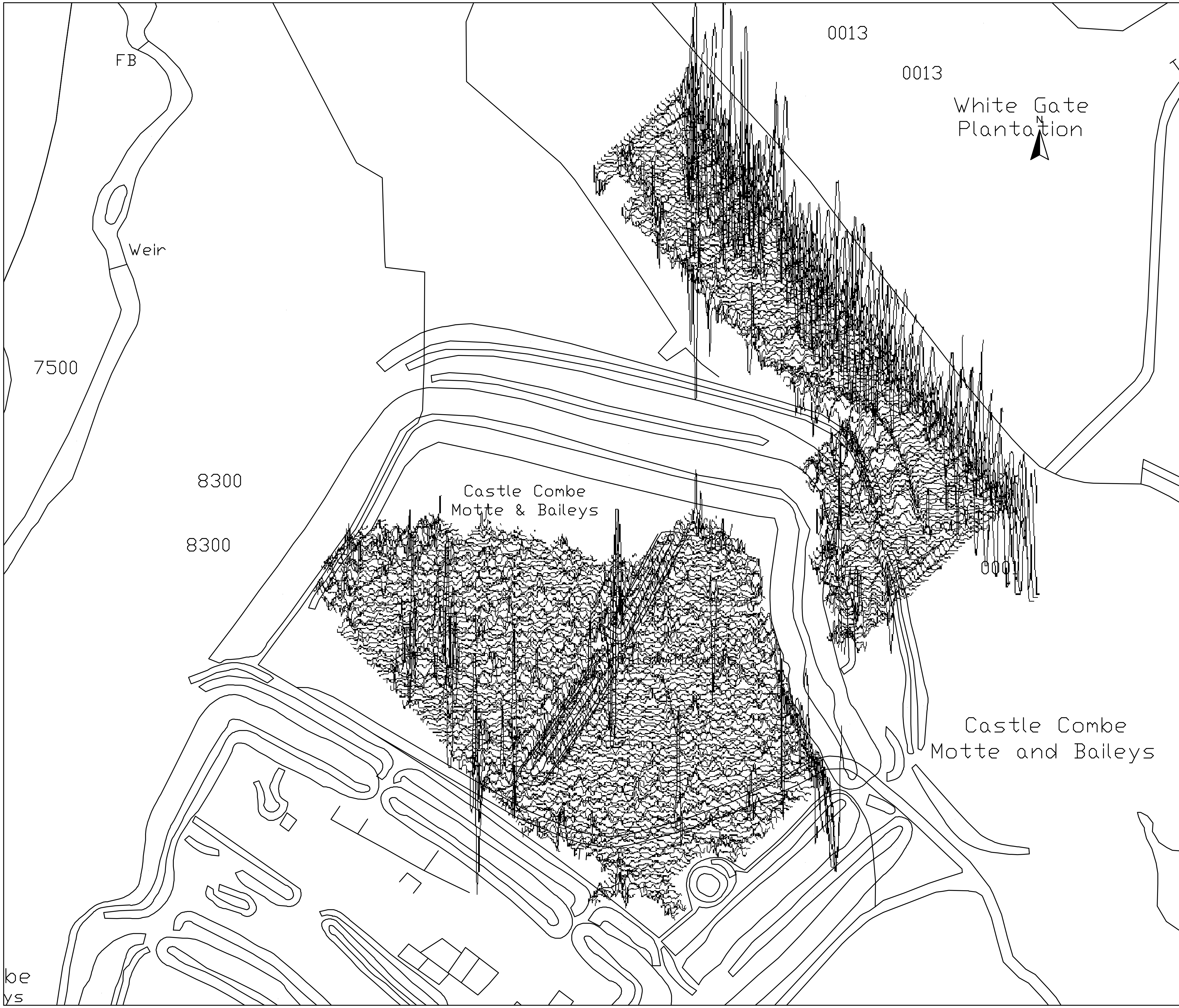
Greyscale plot of raw magnetometer data

SCALE 1:1000

FIG 07



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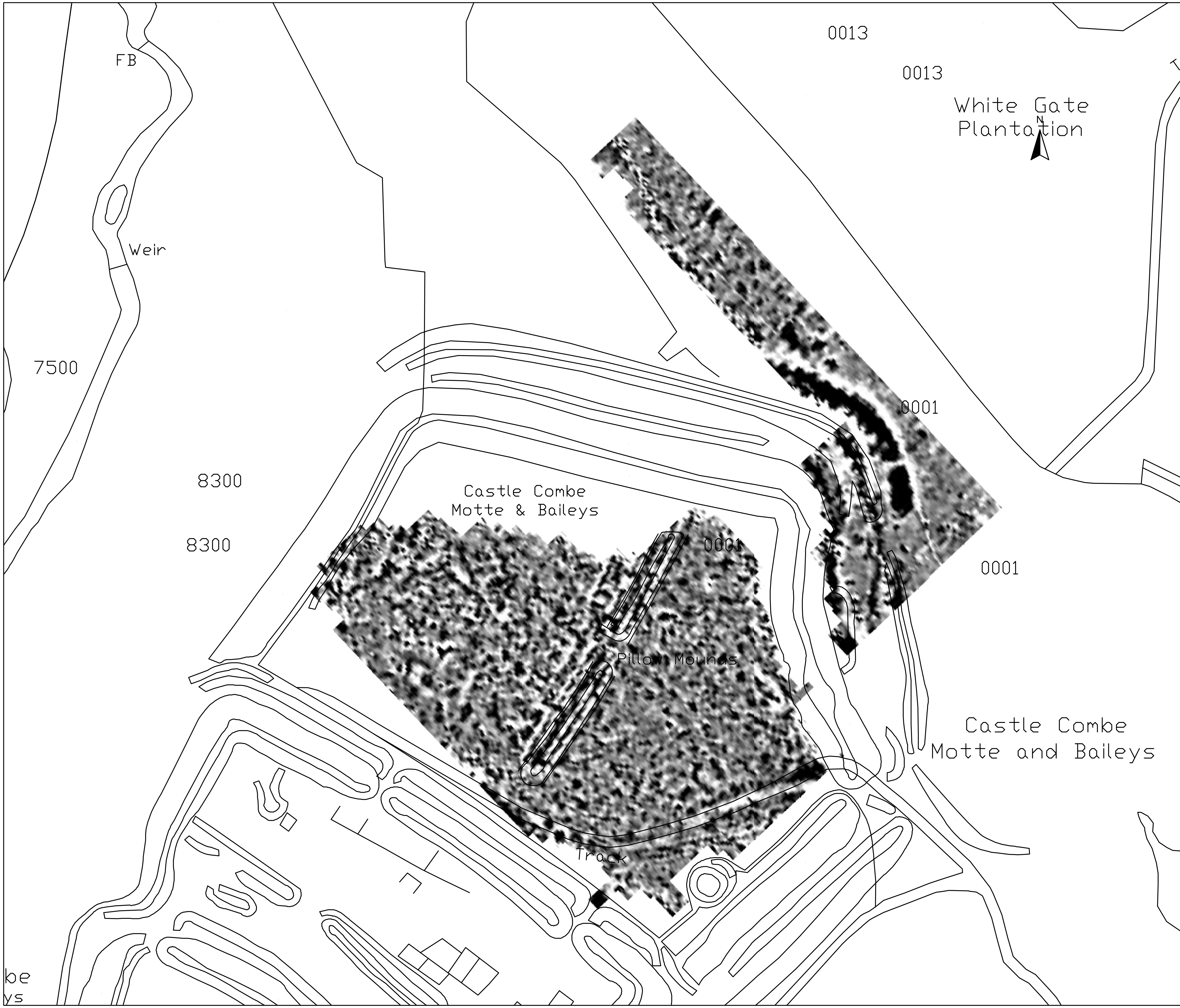
Traceplot of raw magnetometer data

Approximately 30nT/ cm vertical displacement.

Data has been clipped at ± 100nT.

SCALE 1:1000

FIG 08



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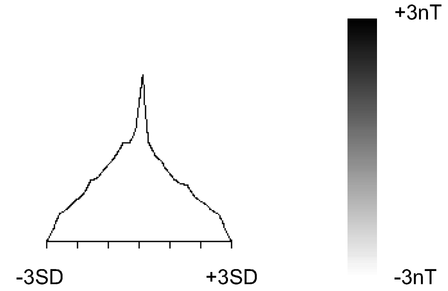
Greyscale plot of processed magnetometer data



SCALE 1:1000

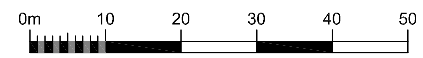
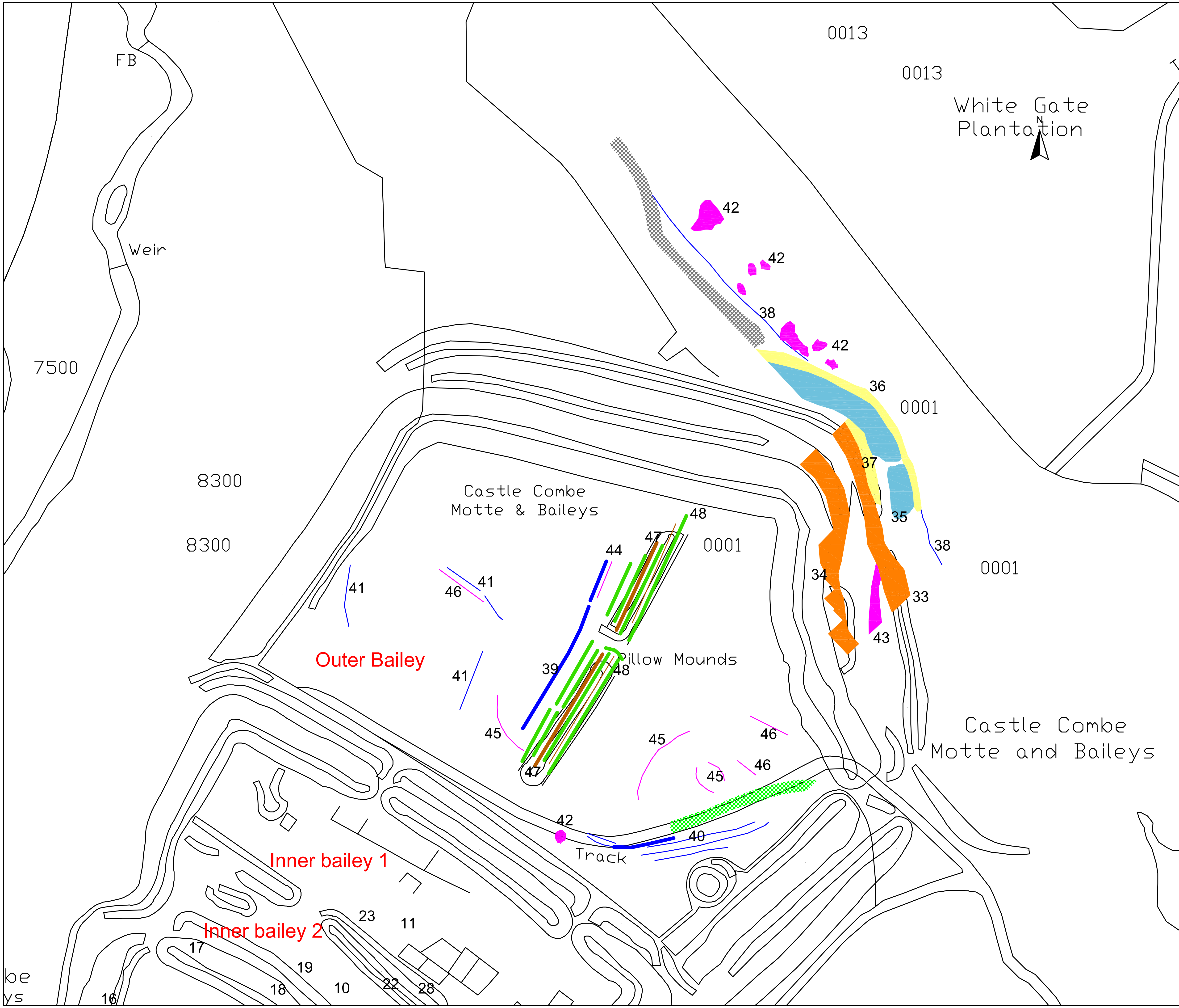


FIG 09



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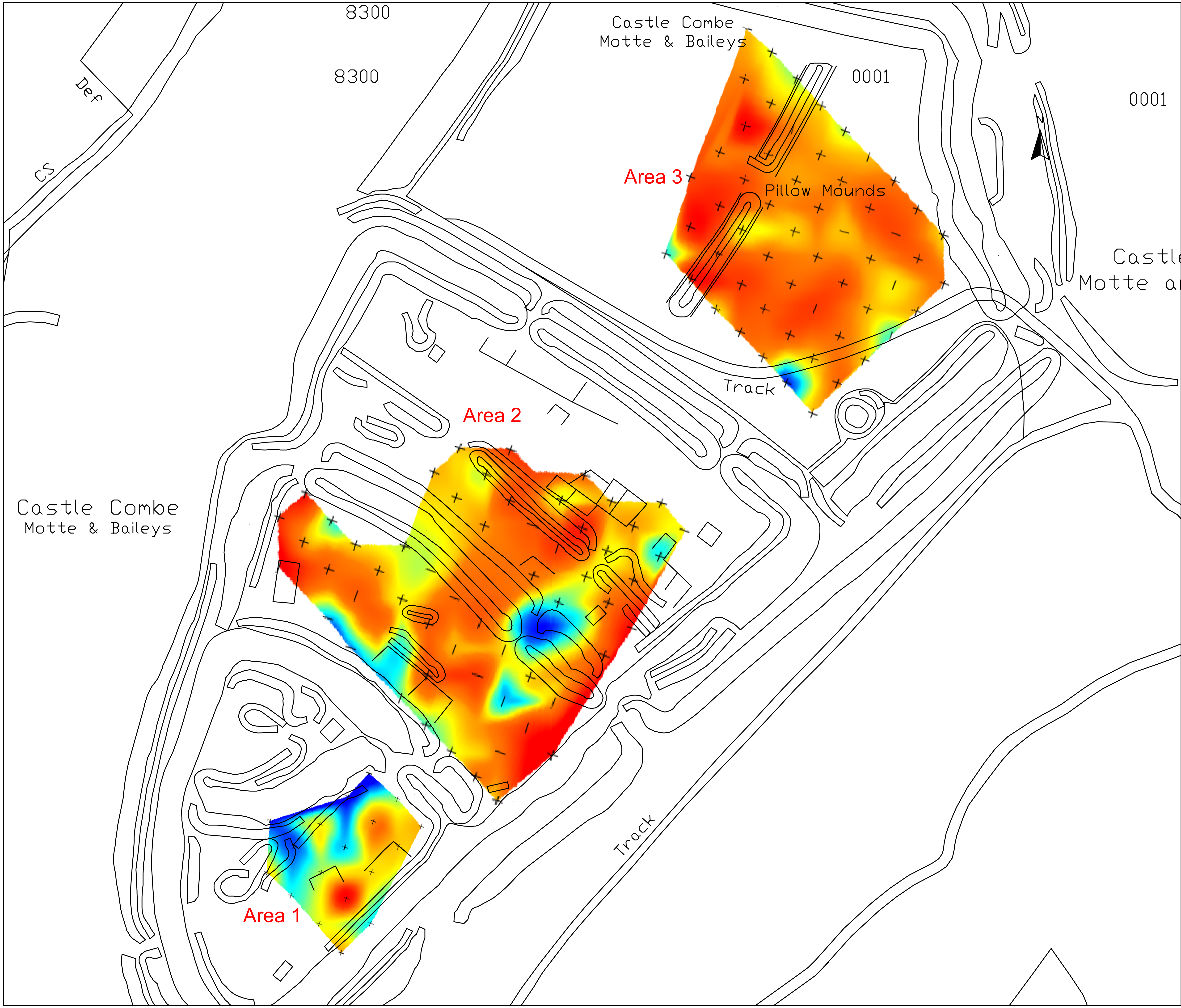
Abstraction and interpretation of magnetometer anomalies

- Positive linear anomalies associated with defensive banks
- Positive linear anomaly associated with former defensive ditch
- Negative anomalies possibly associated with stone
- Negative linear anomalies of uncertain origin
- Positive anomalies of uncertain origin
- Positive linear anomalies associated with pillow mounds
- Negative linear anomalies associated with pillow mounds
- Magnetic debris - spread of magnetically thermoremnant/ferrous material
- Anomaly associated with golf track

SCALE 1:1000

0m 10 20 30 40 50

FIG 10



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Interpolated plot of magnetic susceptibility data

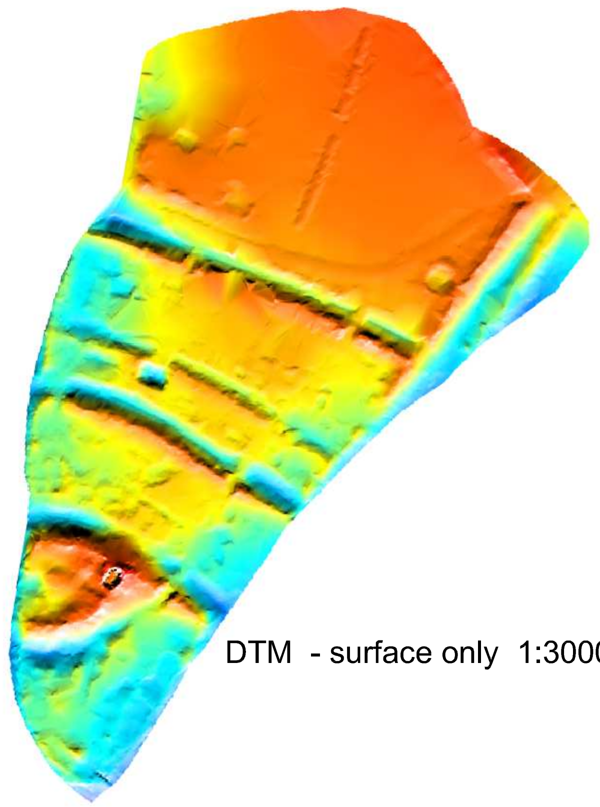
10^{-5} SI

50 70 90 150

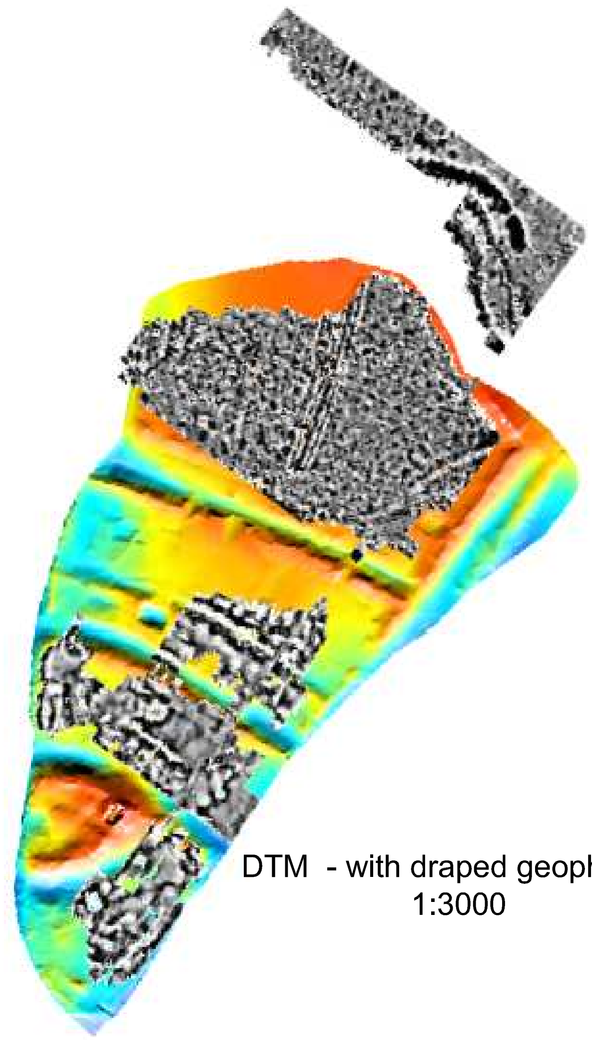
SCALE 1:1000

0m 10 20 30 40 50

FIG 11

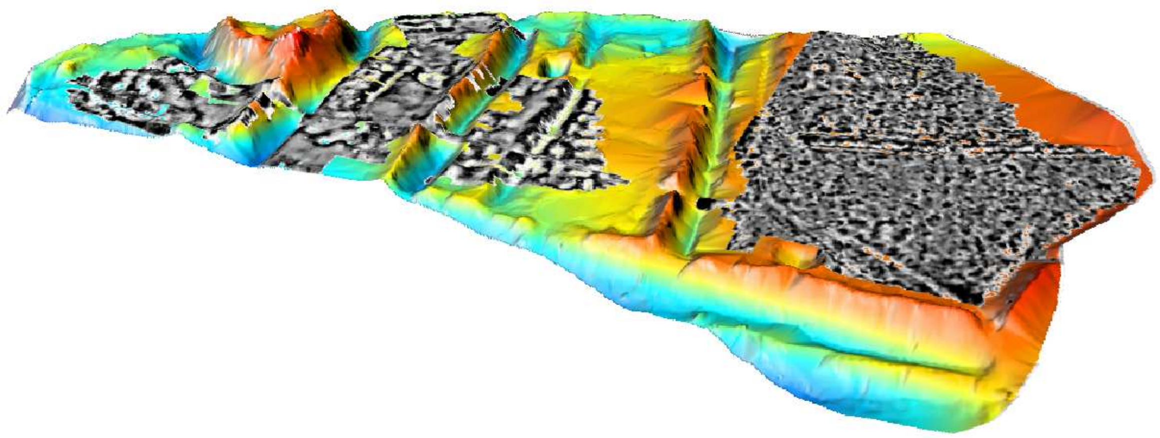


DTM - surface only 1:3000



DTM - with draped geophysics 1:3000

DTM - 3D view from the east with vertical exaggeration



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Digital Terrain Models

FIG 12