TIGERGEO

Verlon Farm, Montgomery, Powys

Geophysical Survey Report
(Caesium Vapour Magnetic – Archaeology)

Version 1.0

Project code: VMP191

Produced for:

Powis Castle Estates

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TIGERGEO

Verlon Farm, Montgomery, Powys

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Non-Technical Summary

A survey was commissioned via Hughes Architects, on behalf of the end client Powis Castle Estates, to prospect a parcel of land at Verlon Farm, Montgomery, Powys for buried structures of archaeological interest. Caesium vapour magnetometers were used for the survey, deployed across a combination of an ATV-towed array and a hand cart.

The past landscapes seems here to have been agrarian and there is little convincing evidence for former settlement or industry although there may be evidence for a small structure attached to a former boundary in the western field. Some anomalies are related to extant earthworks that appear to be parts of a field system while others have been mapped that might indicate more of the same. The ridge and furrow cultivation does not necessarily respect this field system, but their relative date is ambiguous.

In the southwest part of the survey there might be evidence for a former thoroughfare that pre-dates the present road to the west of the site. This could be of medieval date given it appears to be heading towards the site of Arthur's gate into Montgomery. If so, how this relates to the ridge and furrow cultivation also of probable medieval data is unknown as they overlap.

Several different soil and land use contexts are evident within the data that have affected to a variable degree magnetic contrast and hence the detectability of some classes of feature. The lack of artificial mechanisms for soil magnetic susceptibility enhancement, typically heat and originating within settlement, means that the result is entirely dependent upon the natural susceptibility of the soil. This seems unlikely to have had a significant effect upon the interpretation.

Crynodeb Annhechnegol

Comisiynwyd arolwg trwy Hughes Architects, ar ran y cleient terfynol Powis Castle Estates, i archwilio darn o dir yn Fferm Verlon, Trefaldwyn, Powys am olion claddedig o ddiddordeb archaeolegol. Defnyddiwyd magnetomedrau anwedd cesiwm ar gyfer yr arolwg, oedd yn cael eu defnyddio ar draws cyfuniad o arae wedi'u tynnu gan ATV a throl llaw.

Ymddengys bod tirweddau'r gorffennol wedi bod yn amaethyddol ac nid oes llawer o dystiolaeth argyhoeddiadol ar gyfer cyn anheddiad na diwydiant er y gallai fod tystiolaeth o strwythur bach ynghlwm wrth ffin flaenorol yn y cae gorllewinol. Mae rhai anomaleddau'n gysylltiedig â gwrthgloddiau sy'n bodoli ac sy'n ymddangos yn rhannau o system gae tra bod eraill wedi'u mapio a gallai hyn ddynodi mwy o'r un peth. Nid yw'r amaethu crib a rhych o reidrwydd yn adlewyrchu’r system gaeau hon, ond mae eu dyddiad cymharol yn amwys.

Yn rhan de-orllewinol yr arolwg efallai y bydd tystiolaeth ar gyfer cyn dramwyfa sy'n dyddio cyn y ffordd bresennol i'r gorllewin o'r safle. Gallai hyn fod o ddyddiad canoloesol o ystyried ei bod yn ymddangos ei fod yn mynd tuag at safle giât Arthur i mewn i Drefaldwyn. Os felly, nid yw’n bosibl gwybod sut mae hyn yn gysylltiedig ag amaethu crib a rhych hefyd o ddata canoloesol tebygol gan eu bod nhw’n gorgyffwrdd.

Mae sawl cyd-destun defnydd pridd a thir gwahanol yn amlwg yn y data sydd wedi effeithio ar gyferbyniad magnetig gradd amrywiol a dyma’r rheswm dros ganfyddadwyedd rhai mathau o nodweddion. Mae'r diffyg mecanweithiau artiffisial ar gyfer gwella tueddiad magnetig pridd, gwres yn nodweddiadol ac yn tarddu o anheddiad, yn golygu bod y canlyniad yn dibynnu'n llwyr ar dueddiad naturiol y pridd. Mae'n ymddangos nad yw hyn wedi cael effaith arwyddocaol ar y dehongliad.

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1 Introduction

TigerGeo was commissioned via Hughes Architects, on behalf of the end client Powis Castle Estates, to undertake a geophysical survey of a parcel of land at Verlon Farm, Montgomery, Powys. There is a proposal to construct a number of houses and the survey has been required by the local archaeological curator, the Clwyd-Powys Archaeological Trust. Caesium vapour magnetometers were used for the survey, deployed across a combination of an ATV-towed array and a hand cart.

All of the area was surveyed apart from a narrow strip of very steep land adjacent to the road bounding the west of the site.

Country	Wales
County	Powys
Nearest Settlement	Montgomery
Central Co-ordinates	322171,297255
Survey Area (ha)	10.5

2 Context

2.1 Environment

Soilscapes Classification	Slowly permeable seasonally wet acid loamy and clayey soils (17)
Superficial 1:50000 BGS	Till, Devensian – Diamicton (TILLD)
Bedrock 1:50000 BGS	Forden Mudstone Formation – Mudstone (FMF)
Topography	Descends to the north-west and north
Hydrology	Impeded drainage to the east of the stream, artificially drained to the west
Current Land Use	Agricultural – Pastoral
Historic Land Use	Agricultural - Mixed
Vegetation Cover	Grassland (pasture)
Sources of Interference	The eastern part of the survey was sub-divided into a number of small paddocks by wire fences which contribute significantly to the magnetic field and are hence readily apparent in the data. There are also similar contributions from farm buildings and underground utilities

2.2 Archaeology

The following paragraphs are intended as background to the survey only and are based upon a rapid search of CPAT HER data via the Archwilio website. The search indicates that the north-eastern part of the site contains potential archaeological features and finds associated with the Civil War battlefield (of Montgomery). Finds relating to the Civil War are also recorded within the site, although these are more prominent in a field to the south-west, on the opposite side of the B4388 carriageway and outside the survey area.

Possible siege works (PRN 172) are recorded here as upstanding banks that form part of a rectangular enclosure, although these are more likely to be remnant field boundaries of medieval or later date, with any siege works closer to the castle, on the slopes of Frridd Ffaldwyn (Mark Walters p*ers comm*).

Further earthworks are also visible on satellite images in the southern part of the site, although these are not recorded and their origin may be associated with agricultural ditches and drains.

Inspection of these earthworks during survey revealed them to be low but substantial banks and to cross the valley bottom, outlining at least one fairly large rectilinear enclosure. In the northern part the banks recorded as PRN 172 appear to be former field boundaries surviving as lynchets and again part of a rectilinear system.

3 Discussion

3.1 Character & Principal Results

3.1.1 Introduction

The following paragraphs represent an interpretive summary of the survey. The numbers in square brackets refer to individual anomalies described in detail in the catalogue below and shown on DWG 03 onwards.

3.1.2 Data

The data has a number of different characters, mostly dependent upon location but also slightly by method of acquisition, the latter not having a significant effect upon its interpretation. To the east of the stream the data is dominated by strong ferrous-type responses from numerous fences, adjacent farm buildings, underground utilities and service covers and also what appear to be spreads of buried debris.

To the west, the data character is more typical of the locality with reasonable although variable magnetic contrast and a range of textures dependent upon the depth and nature of soil cover.

Magnetic contrast is overall muted although sufficient to allow ridge and furrow cultivation and former land divisions to be evident in the data. These are sources not usually associated with artificial forms of magnetic enhancement, e.g. heating and fermentation and their detection relies upon the natural magnetic susceptibility of the soil. Their detection here is therefore encouraging.

There are no problems with the data and there is nothing that adversely affects interpretation for archaeological purposes.

3.1.3 Geology and soils

The British Geological Survey (BGS) G-Base database (5 km resolution) states total soil iron as 3.4%, which is notably high, against a regional background of 3.5% (15 km). However, this does not itself determine the likely success or not of a survey as the ionic form of the iron affects the degree to which it can become magnetised, i.e. the magnetic susceptibility, and this is affected by a range of geochemical factors.

Soils derived from mudstone tend to produce a muted magnetic contrast but here the till is likely to be dominant, with changes in the make-up and thickness of this evident in the data, as well as the presence or absence of other superficial deposits like alluvium. The soils are seasonally wet and adjacent to streams and springs geochemical variations will exist that can be evident in magnetic data.

In the western field there is an east-west textural transition to minimal texture [7] in the lower slopes and this is most likely due to alluvial cover over the till deposits, this being absent away from the stream. Towards the top of the field the data has more the character of soils derived from mudstone with a thin cover of till. Magnetic contrast is highest in between, on the slopes [1] where the data would suggest greater quantities of till material are present and the soils correspondingly more magnetic.

The lower regions of the steepest western slopes are also associated with lower contrast and here this may be due to colluvial material from upslope, maybe mobilised by the cultivation activity seen in the data.

The same underlying processes will have been active on the eastern slopes but these are overall more gentle and the effect is less apparent. Indeed, much of the central region of this area is alluvium within which was the former stream course (diverted to the present line prior to the Tithe Map of the 1840s). This same region is now wet ground and apparent in the data as a band of low magnetic contrast along the valley bottom.

3.1.4 Land use

Modern land use in the form of wire fences has influenced the result across the eastern fields, as has the presence of underground debris, e.g. at [24], [25] and [18] and underground utilities, most obviously at

[21], [22] and probably [29]. There will be more hidden amongst the strong anomalies from debris close to the buildings of Verlon Farm, judging by the number and position of service covers seen during survey. At [25], where the data suggests a spread or accumulation of magnetic material there is a low mound with a sunken top. To the north, in the next field, a similar spread exists at [28] where it occupies higher ground between the present stream and its former course immediately to the east. Likewise, close to the stream at [32] there is more magnetic material but here it looks less like debris and more like a fill.

There are two sets of cultivation, with [10] across much of the western field and with the character of medieval ridge and furrow. It is crossed by (or crosses) possible land divisions at [13] and [14] which reveals these to be of a different phase. It is likely more extensive than plotted as it is clearest upon the sloping ground and faint to undetectable within the lower ground. There may also be two phases of cultivation: the southern section is at a slightly different angle from the northern.

At [34] in the northeast part of the survey there is another area of former cultivation that may also be ridge and furrow although the straightness of the furrows might suggest later steam ploughing.

The field boundaries have not changed significantly since the Tithe Map in the 1840s although a former field boundary is known at [33].

The stream that now bisects the site is within its original course north of Verlon Farm but has been diverted westwards to the west and south of the buildings, its earlier course being evident in the field northwest of these. Here a strip of low laying wet ground passes between [32] and former boundary [33].

A number of short linear anomalies, mostly of reduced magnetic intensity, e.g. [12], [18], [19] and [20] may relate to drainage structures, this part of the field being relatively flat and wet from springs just above it to the west. Strongly magnetic linear feature [30], probably modern, might also be related to drainage if not buried debris.

3.1.5 Archaeology

In the southwest corner of the site a possible ditch fill (or accumulated soil) [15] is the continuation of [27] which is the line of an enclosure earthwork that seems to have been the northwest corner of a small field. A second, adjoining, enclosure is hinted at by possible fill [17]. This earthwork is parallel to the ditch dividing the western field, conducting a stream issuing from springs to the southwest towards the valley bottom, and it continues into the eastern fields to meet the rising ground.

At the other end of the site, to the northeast, another earthwork which appears to become a lynchet to the west is evident as a texture change [35], presumably due to deeper soil, above a probable fill [36]. This earthwork might be one that has been identified locally as from the Civil War but it could also be associated with land improvement and cultivation activity [34].

Anomalies [2] and [3] in the western field are parallel and resemble field boundaries but not ones that are known from old maps and nor are they respected by the ridge and furrow cultivation. The northern example [2] could be a ploughed down bank similar to that existing across the stream at [36]. At [5] and maybe also [4] there are hints of very small enclosures, small enough to be the drip gullies of huts, in which case the boundaries may be prehistoric.

A probable ditch fill [6] could be part of the same system or otherwise later, perhaps drainage related.

Within the western field there is a striking alignment of pairs of reduced magnetic intensity linear anomalies [8], [11], [13] and [14] that seem, although not continuous, to bound a sinuous area of variable width, indicated by a highlight on the plots. This intersects the ridge and furrow [10] but without providing insight into relative chronology and passes the corner of the enclosure defined by [15]. There is nothing between the pairs of anomalies to suggest the existence of a road surface or similar built structure but the location and alignment of the overall area might suggest a predecessor to the modern road, e.g. one that dipped more into the valley bottom before climbing to meet the existing alignment above the steep northwest slopes. Such an interpretation has to remain conjectural given the scarcity of evidence.

Across much of the site there are short lengths of possible or probable ditch fills, including [9], [23] and [26] but these are otherwise un-diagnostic.

Close to the stream, in the centre of the site, at [32] there may be a small filled or perhaps heated area, although a natural origin is possible. Like the areas [28] to the south, but of different magnetic character, it occupies a high point above the former course of the stream.

3.2 Catalogue

ID	Data Class	Anomaly Class	Form Class	Feature Class	Feature Sub-Class	Comments
1	TMI	Texture	Area	Natural		Geological context
2	TMI	Reduced	Linear - continuous	Agricultural		Reduced linear, aligned NW to SE
3	TMI	Enhanced	Linear - continuous	Fill	Ditch	Possible ditch fill, on same alignment as [2]
4	TMI	Enhanced	Linear - continuous	Fill	Debris	Possible curvilinear ditch fill
5	TMI	Enhanced	Linear - continuous	Fill	Ditch	Possible curvilinear ditch fill, similar to [4]
6	TMI	Enhanced	Linear - continuous	Fill	Ditch	Possible ditch fill, SW to NE alignment. Similar to [3]
7	TMI	Texture	Area	Natural		Geological context
8	TMI	Reduced	Linear – continuous, group	Agricultural?	?	Reduced linear, NW to SE alignment. Similar to [2] and a pair like [13] and [14]
9	TMI	Enhanced	Linear - continuous	Fill	Ditch	Possible ditch fill, W to E alignment
10	TMI	Reduced	Linear - continuous (group)	Agricultural	Cultivation	Area of ridge and furrow, predominantly SW to NE alignment
11	TMI	Reduced	Linear - continuous	Agricultural		Reduced linear, similar to [2] and [8]
12	TMI	Reduced	Linear - continuous	Agricultural		Reduced linear, NE to SW alignment
13	TMI	Reduced	Linear – continuous, group	Agricultural		Reduced linear, similar to [8] and [11]
14	TMI	Reduced	Linear – continuous, group	Agricultural		Reduced linear, similar to [12] and [13]
15	TMI	Enhanced	Linear - continuous	Fill	Ditch	Possible ditch fill, NE to SW alignment
16	TMI	Reduced	Linear - continuous	Agricultural		Reduced linear, similar to [8], [11] and [13]
17	TMI	Enhanced	Linear - continuous	Fill	Ditch	Possible ditch fill, similar to [15]
18	TMI	Reduced	Linear - continuous	Agricultural		Reduced linear, similar to [12] and [14]
19	TMI	Reduced	Linear - continuous	Agricultural		Reduced linear, similar to [12], [14] and [18]
20	TMI	Reduced	Linear - continuous	Agricultural		Reduced linear, similar to [12], [14], [18] and [19]
21	TMI	Strong variable	Linear - continuous	Utility		Probable service

ID	Data Class	Anomaly Class	Form Class	Feature Class	Feature Sub-Class	Comments
22	TMI	Strong variable	Linear - continuous	Utility		Probable service
23	TMI	Enhanced	Linear - continuous (group)	Fill	Ditch	Two possible converging ditch fills
24	TMI	Strong variable	Area	Highlight	Debris	
25	TMI	Strong variable	Area	Highlight	Debris	Possible debris fill from diverted channel
26	TMI	Enhanced	Linear - continuous	Fill	Ditch	Possible ditch fill
27	TMI	Enhanced	Linear - continuous	Fill	Ditch	Probable ditch fill, earthwork seen on site. Possible continuation at [15]
28	TMI	Strong variable	Area	Highlight	Debris	
29	TMI	Strong variable	Linear - continuous	Utility		Probable service or drain
30	TMI	Strong enhanced	Linear - continuous	Agricultural	Drain	Probable drain
31	TMI	Enhanced	Linear - continuous	Fill	Ditch	Possible ditch fill
32	TMI	Strong variable	Area	Highlight	Debris	
33	TMI	Observation	Linear - continuous	Agricultural		Known former field boundary, as seen on 1882 OS map
34	TMI	Reduced	Linear - continuous (group)	Agricultural	Cultivation	Probable ridge and furrow, but different to [10]
35	TMI	Texture	Area	Natural		Geological context
36	TMI	Enhanced	Linear - continuous	Fill	Ditch	Probable ditch fill, edge of earthwork seen on site

3.3 Conclusions

Despite the number of anomalies mapped, overall the past landcape seems here to have been agrarian and there is little convincing evidence for former settlement or industry. Some of the linear anomalies relate to extant earthworks that appear to have been former boundaries while others do not but could well have been elements of the same system.

Perhaps the most striking discovery is a sinuous bounded area in the southwestern part of the survey that might be evidence for a former thoroughfare pre-dating the present road to the west of the site. If so, how this relates to the ridge and furrow cultivation of probable medieval data is unknown.

There is scattered evidence for a former field system defined by low banks and lynchets on steeper slopes and elsewhere by short ditch fills. The ridge and furrow cultivation does not necessarily respect this field system, but their relative date is ambiguous. To the southwest they could co-exist but to the north the situation is less clear and there is perhaps (only very tentatively) evidence for a prehistoric date.

Several different soil and land use contexts are evident within the data that have affected to a variable degree magnetic contrast and hence the detectability of some classes of feature. The lack of artificial mechanisms for soil magnetic susceptibility enhancement, typically heat and originating within settlement, means that the result is entirely dependent upon the natural susceptibility of the soil and here, as seen elsewhere in similar situations, this is greatest over the till deposits.

3.4 Caveats

Geophysical survey is reliant upon the detection of anomalous values and patterns in physical properties of the ground, e.g. magnetic, electromagnetic, electrical, elastic, density and others. It does not directly detect underground features and structures and therefore the presence or absence of these within a geophysical interpretation is not a direct indicator of presence or absence in the ground. Specific points to consider are:

- some physical properties are time variant or mutually interdependent with others;
- for a buried feature to be detectable it must produce anomalous values of the physical property being measured;
- any anomaly is only as good as its contrast against background textures and noise within the data.

TigerGeo will always attempt to verify the accuracy and integrity of data it uses within a project but at all times its liability is by necessity limited to its own work and does not extend to third party data and information. Where work is undertaken to another party's specification any perceived failure of that specification to attain its objective remains the responsibility of the originator, TigerGeo meanwhile ensuring any possible shortcomings are addressed within the normal constraints upon resources.

4 Methodology

4.1 Magnetic Principles

4.1.1 Physical concepts

Magnetic survey for any purpose relies upon the generation of a clear magnetic anomaly at the surface, i.e. strong enough to be detected by instrumentation and exhibiting sufficient contrast against background variation to permit diagnostic interpretation. The anomaly itself is dependent upon the chemical properties of a particular volume of ground, its magnetic susceptibility and hence induced magnetic field, the strength of any remanent magnetisation, the shape and orientation of the volume of interest and its depth of burial. Finally the choice and configuration of measurement instrumentation will affect anomaly size and shape.

Sites present a complex mixture of these factors and for some the causative affects are not known. However, depth of burial and size are usually fairly constrained and background susceptibility can be estimated (or measured). The degree of remanent magnetisation is harder to predict and depends on both the natural magnetic properties of the soil and any chemical processes to which it has been subjected. Fortunately heat will raise the susceptibility of most soils and topsoil tends to be more magnetic than subsoil, by volume.

It is hard to draw reliable conclusions about what sort of geology is supportive of magnetic survey as there are many factors involved and in any case magnetic response can vary across geological units as well as being dependent upon post-deposition and erosional processes. In general a relatively non-magnetic parent material contrasting with a magnetisable erosion product, i.e. one which contains iron in the form of oxides and hydroxides, will allow archaeological structures to exhibit strong magnetic contrast against their surroundings and especially if the soil has been heated or subjected to certain processes of fermentation. In the absence of either, magnetic enhancement becomes entirely reliant upon the geochemistry of the soil and enhancement will often be weaker and more variable.

Analysis of the British Geological Survey (BGS) Geochemical Atlas (G-Base) for total soil iron reveals that for England and Wales 50% of the samples (the interquartile range) lie between 1.9% and 3.6% percentage iron with the median at 2.7%.

The principal magnetic iron mineral is the oxide magnetite which sometimes occurs naturally but is more often formed during the heating of soil. Subsequent cooling yields a mixture of this, non-magnetic oxide haematite and another magnetic oxide, maghaemite. Away from sources of heat, other magnetic iron minerals include the sulphides pyrite and greigite while in damp soils complex chemistry involving the hydroxides goethite and lepidocrocite can create strong magnetic anomalies. There are thus a number of different geochemical reaction pathways that can both augment and reduce the magnetic susceptibility of a soil. In addition, this susceptibility may exhibit depositional patterns unrelated to visible stratigraphy.

Most structures of archaeological interest detected by magnetic survey are fills within negative or cut features. Not all fills are magnetic and they can be more magnetic or less magnetic than the surrounding ground. In addition, it is common for fills to exhibit variable magnetic properties through their volume, basal primary silt often being more magnetic than the material above it due to the increased proportion of topsoil within it. However, a fill containing burnt soil may be much more magnetic than this primary silt and sometimes a feature that has contained standing water can produce highly magnetic silts through mechanical depositional processes (depositional remanent magnetisation, DRM).

A third structural factor in the detection of buried structures is the depth of topsoil over the feature. As fills sink, the hollow above accumulates topsoil and hence a structure can be detected not through its own magnetisation but through the locally deeper topsoil above it. The volume of soil required depends upon the magnetic susceptibility of the soil but just a few centimetres are often sufficient. Such a thin deposit can, however, easily be lost through subsequent erosion by natural factors or ploughing.

4.1.2 Instrumentation

The use of the magnetic sensors in non-gradiometric (vertical) configuration avoids measurement sensitisation to the shallowest region of the soil, allowing deeper structures, whether natural or otherwise to be imaged within the sensitivity of the instrumentation. This also allows the detection of shallow broad variations in magnetic susceptibility that might have archaeological significance. Suppression of ambient noise and temporal trends is reduced and therefore need reduction during processing.

The theoretical slightly reduced lateral resolution inherent to using non-gradiometric sensor arrays is practically not an issue and especially if processing includes a vertical pseudo-gradient conversion. The non-gradiometric system is thus overall a more capable configuration than the short gradiometers often used for archaeological studies.

Caesium instrumentation has a greater sensitivity than fluxgate instruments, however, at the 10 Hz sampling rate used here this increase in sensitivity is limited to about one order of magnitude. Greater benefit is obtained from a better signal-to-noise ratio meaning that sub-nanoTesla measurement is more practically achieved.

The array system is designed to be non-magnetic and to contribute virtually nothing to the magnetic measurement, whether through direct interference or through motion noise.

4.2 Magnetic Survey

4.2.1 Technical equipment

Measured variable	Total Magnetic Intensity / nT after removal of regional trend
Instrument	Array of Geometrics G858 Magmapper caesium magnetometers
Configuration	Non-gradiometric transverse array (ATV towed and handcart)
Sensitivity	0.03 nT @ 10 Hz (manufacturer's specification)
QA Procedure	Continuous observation
Spatial resolution	1.0m between lines, 0.25m mean along line interval

4.2.2 Monitoring & quality assessment

The system continuously displays all incoming data as well as line speed and spatial data resolution per acquisition channel during survey. Rest mode system noise is therefore easy to inspect simply by pausing during survey, and the continuous display makes monitoring for quality intrinsic to the process of undertaking a survey. Rest mode test results (static test) are available from the system.

4.3 Magnetic Data Processing

4.3.1 Procedure

All data processing is minimised and limited to what is essential for the class of data being collected, e.g. reduction of orientation effects, suppression of single point defects (drop-outs or spikes) etc. The processing stream for this data is as follows:

Process	Software	Parameters
Measurement & GNSS receiver data alignment	Proprietary	
Temporal reduction, regional field suppression	Proprietary	Bandpassed 0.3 – 10.0s
Gridding	Surfer	Kriging, 0.25m x 0.25m
Smoothing	Surfer	Gaussian lowpass 3x3 data (0.75m)
Pseudo-gradient conversion	Proprietary	1m vertical

Potential field processing procedures are used where possible on gridded data from the above processing, allowing simulation of vertical gradient data, separation of deep and shallow magnetic sources, etc. The initial processing uses proprietary software developed in conjunction with the multisensor acquisition system. Gridded data is ported as data surfaces (not images) into Manifold GIS for final imaging, contouring and detailed analysis. Specialist analysis is undertaken using proprietary software.

4.4 Magnetic Interpretation

4.4.1 Introduction

Numerous sources are used in the interpretive process, which takes into account shallow geological conditions, past and present land use, drainage, weather before and during survey, topography and any previous knowledge about the site and the surrounding area. Old Ordnance Survey mapping is consulted and also older sources if available. Geological information (for the UK) is sourced only from British Geological Survey resources and aerial imagery from online sources. LiDAR data is usually sourced from the Environment Agency or other national equivalents, SAR from NASA and other topographic data from original survey.

Information from nearby surveys is consulted to inform upon local data character, variations across soils and near-surface geological contexts. Published data from other surveys may also be used if accompanied by adequate metadata.

Interpretation of magnetic data is undertaken using total intensity data, vertical pseudo-gradient and where relevant, shallow field, component models in parallel although for clarity only a subset of these may be presented in the report.

4.4.2 The contribution from geology and soils

On some sites, e.g. some gravels and alluvial contexts, there will be anomalies that can obscure those potentially of archaeological interest. They may have a strength equal to or greater than that associated with more relevant sources, e.g. ditch fills, but can normally be differentiated on the basis of anomaly form coupled with geological understanding. Where there is ambiguity, or relevance to the study, these anomalies will be included in this category.

Not all changes in geological context can be detected at the surface, directly or indirectly, but sometimes there will be a difference evident in the geophysical data that can be attributed to a change, e.g. from alluvium to tidal flat deposits, or bedrock to alluvium. In some cases the geophysical difference will not exactly coincide with the geological contact and this is especially the case across transitions in soil type.

Geophysical data varies in character across areas, due to a range of factors including soil chemistry, near surface geology, hydrology and land use past and present. These all contribute to the texture of the data, i.e. a background character against which all other anomalies are measured.

4.4.3 Agricultural inputs

Coherent linear dipolar enhancement of magnetic field strength marking ditch fills, narrow bands of more variable magnetic field or changes in apparent magnetic susceptibility, are all included within the category of former field boundaries if they correlate with those depicted on the Tithe Map or early Ordnance Survey maps. If there is no correlation then these anomaly types are not categorised as a field boundaries.

Banded variations in apparent magnetic susceptibility caused by a variable thickness of topsoil, depositional remanent magnetisation of sediments in furrows or susceptibility enhancement through heating (a by product of burning organic matter like seaweed) tend to indicate past cultivation, whether ridge-based techniques, medieval ridge and furrow or post medieval 'lazy beds'. Modern cultivation, e.g. recent ploughing, is not included.

In some cases it is possible to identify drainage networks either as ditch-fill type anomalies (typically 'Roman' drains), noisy or repeating dipolar anomalies from terracotta pipes or reduced magnetic field strength anomalies from culverts, plastic or non-reinforced concrete pipes. In all cases identification of a herring bone pattern to these is sufficient for inclusion within this category.

4.4.4 Features of archaeological interest

Any linear or discrete enhancement of magnetic field strength, usually with a dipolar character of variable strength, that cannot be categorised as a field boundary, cultivation or as having a geological origin, is classified as a fill potentially being of archaeological interest. Fills are normally earthen and include an often invisible proportion of heated soil or topsoil that augments local magnetic field strength. Inverted anomalies are possible over non-earthen fills, e.g. those that comprise peat, sand or gravel within soil. This category is subject to the 'habitation effect' where, in the absence of other sources of magnetic material, anomaly strength will decrease away from sources of heated soil and sometimes to the extent of non-detectability.

Former enclosure ditches that contained standing water can promote enhanced volumetric magnetic susceptibility through depositional remanence and remain detectable regardless of the absence of other sources of magnetic enhancement.

Anything that cannot be interpreted as a fill tends to be a structure, or in archaeological terms, a feature. This category is secondary to fills and includes anomalies that by virtue of their character are likely to be of archaeological interest but cannot be adequately described as fills. Examples include strongly magnetic bodies lacking ferrous character that might indicate hearths or kilns. In some cases anomalies of ferrous character may be included.

On some sites the combination of plan form and anomaly character, e.g. rectilinear reduced magnetic field strength anomalies, might indicate the likely presence of masonry, robber trenches or rubble foundations. Other types of structure are only included if the evidence is unequivocal, e.g. small ring ditches with doorways and hearths. In some circumstances a less definite category may be assigned to the individual anomalies instead.

It is sometimes possible to define different areas of activity on the basis of magnetic character, e.g. texture and anomaly strength. These might indicate the presence of middens or foci within larger complexes. This category does not indicate a presence or absence of discrete anomalies of archaeological interest.

4.5 Glossary

Acronym	**Type**	**Definition**
A	Physical quantity	SI unit Amp of electric current
BGS	Organisation	British Geological Survey
CIfA	Organisation	Chartered Institute for Archaeologists
dB	Physical quantity	Decibel, unit of amplification / attenuation
DRM	Process	Depositional Remanent Magnetisation
EAGE	Organisation	European Association of Geoscientists and Engineers
EGNOS	Technology	European Geostationary Navigation Overlay Service
ERT	Technology	Electrical resistivity tomography
ETRS89	Technology	European Terrestrial Reference System (defined 1989)
ETSI	Organisation	European Telecommunications Standards Institute
EuroGPR	Organisation	European Ground Penetrating Radar Association, the trade body for GPR professionals
G-BASE	Data	British Geological Survey Geochemical Atlas
GeolSoc	Organisation	Geological Society of London, the chartered body for the geological profession
GNSS	Technology	Global Navigation Satellite System
GPR	Technology	Ground penetrating radar
GPS	Technology	Global Positioning System (US)
inversion	process	A combination of forward and backward modelling intended to construct a 2D or 3D model of the physical distribution of a variable from data measured on a 1D or 2D surface. It is fundamental to ERT survey
IP	Physical quantity	Induced polarisation (or chargeability) units mV/V or ms
m	Physical quantity	SI unit metres of distance
mbgl	Physical quantity	Metres below ground level
MHz	Physical quantity	SI unit mega-Hertz of frequency
MS	Physical quantity	Magnetic susceptibility, unitless
mS	Physical quantity	SI unit milli-Siemens of electrical conductivity
nT	Physical quantity	SI unit nano-Tesla of magnetic flux density

Acronym	Type	Definition
OFCOM	Organisation	The Office of Communications, the UK radio spectrum regulator
Ohm	Physical quantity	SI unit Ohm of electrical resistance
OS	Organisation	Ordnance Survey of Great Britain
OSGB36	Data	The OS national grid (Great Britain)
OSTN15	Technology	Current coordinate transformation from ETRS89 to OSGB36 co-ordinates
RDP	Physical quantity	Relative Dielectric Permittivity, unitless
RTK	Technology	Real Time Kinematic (correction of GNSS position from a base station)
s	Physical quantity	SI unit seconds of time
TMI	Physical quantity	Total magnetic intensity (measured flux density minus regional flux density)
TRM	Process	Thermo-Remanent Magnetisation
V	Physical quantity	SI unit Volt of electric potential
WGS84	Data	World Geodetic System (defined 1984)

4.6 Selected reference

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4.7 Archiving and dissemination

An archive is maintained for all projects, access to which is permitted for research purposes. Copyright and intellectual property rights are retained by TigerGeo on all material it has produced, the client having full licence to use such material as benefits their project. Where required, digital data and a copy of the report can be archived in a suitable repository, e.g. the Archaeology Data Service, in addition to our own archive.

The archive contains all survey and project data, communications, field notes, reports and other related material including copies of third party data (e.g. CAD mapping, etc.) in digital form. Many are in proprietary formats while report components are available in PDF format.

The client will determine the distribution path for reporting, including to the end client, other contractors, local authority etc., and will determine the timetable for upload of the project report to the OASIS Grey Literature library or supply of report or data to other archiving services, taking into account end client confidentiality.

TigerGeo reserves the right to display data rendered anonymous and un-locatable on its website and in other marketing or research publications.

5 Supporting information

5.1 Standards and quality (archaeology)

TigerGeo is developing an Integrated Management System (IMS) towards ISO certification for ISO9001, ISO14001 and OHSAS18001/ISO45001. For work within the archaeological sector TigerGeo has been awarded CIfA (Chartered Institute for Archaeologists) Registered Organisation status.

A high standard of client-centred professionalism is maintained in accordance with the requirements of relevant professional bodies including the Geological Society of London (GeolSoc) and the Chartered Institute for Archaeologists (CIfA). Senior members of TigerGeo are professional members of the GeolSoc (FGS), CIfA (MCIfA & ACIfA grades) and other appropriate bodies, including the European Association of Geoscientists and Engineers (EAGE) Near Surface Division (MEAGE) and the Institute of Professional Soil Scientists (MISoilSci).

In addition TigerGeo is a member of EuroGPR and all ground penetrating and other radar work is in accordance with ETSI EG 202 730.

The management team at TigerGeo have almost 50 years of combined experience of near surface geophysical project design, survey, interpretation and reporting, based across a wide range of shallow geological contexts. Added to this is the considerable experience of our lead geophysicists in a variety of commercial and academic roles. All geophysical staff have graduate and in many cases also post-graduate relevant qualifications pertaining to environmental geophysics from recognised centres of academic excellence.

During fieldwork there is always a fully qualified (to graduate or post-graduate level) supervisory geophysicist leading a team of other geophysicists and geophysical technicians, all of whom are trained and competent with the equipment they are working with. Data processing and interpretation is carried out by a suitably qualified and experienced geophysicist under the direct supervision and guidance of the Senior Geophysicist. All work is monitored and reviewed throughout by the Senior Geophysicist who will appraise all stages of a project as it progresses.

Data processing and interpretation adheres to the scientific principles of objectiveness and logical consistency. A standard set of approved external sources of information, e.g. from the British Geological Survey, the Ordnance Survey and similar sources of data, in addition to previous TigerGeo projects, guide the interpretive process. Due attention is paid to the technical constraints of method, resolution, contrast and other geophysical factors.

There is a strong culture of internal peer-review within TigerGeo, for example, all reports pass through a process of authorship, technical review and finally proof-reading before release to the client. Technical queries resulting from TigerGeo's work are reviewed by the Senior Geophysicist to ensure uniformity of response prior to implementing any edits, etc.

Work is undertaken in accordance with the high professional standards and technical competence expected by the Geological Society of London and the European Association of Geoscientists and Engineers.

All work for archaeological projects is also conducted in accordance with the following standards and guidance:

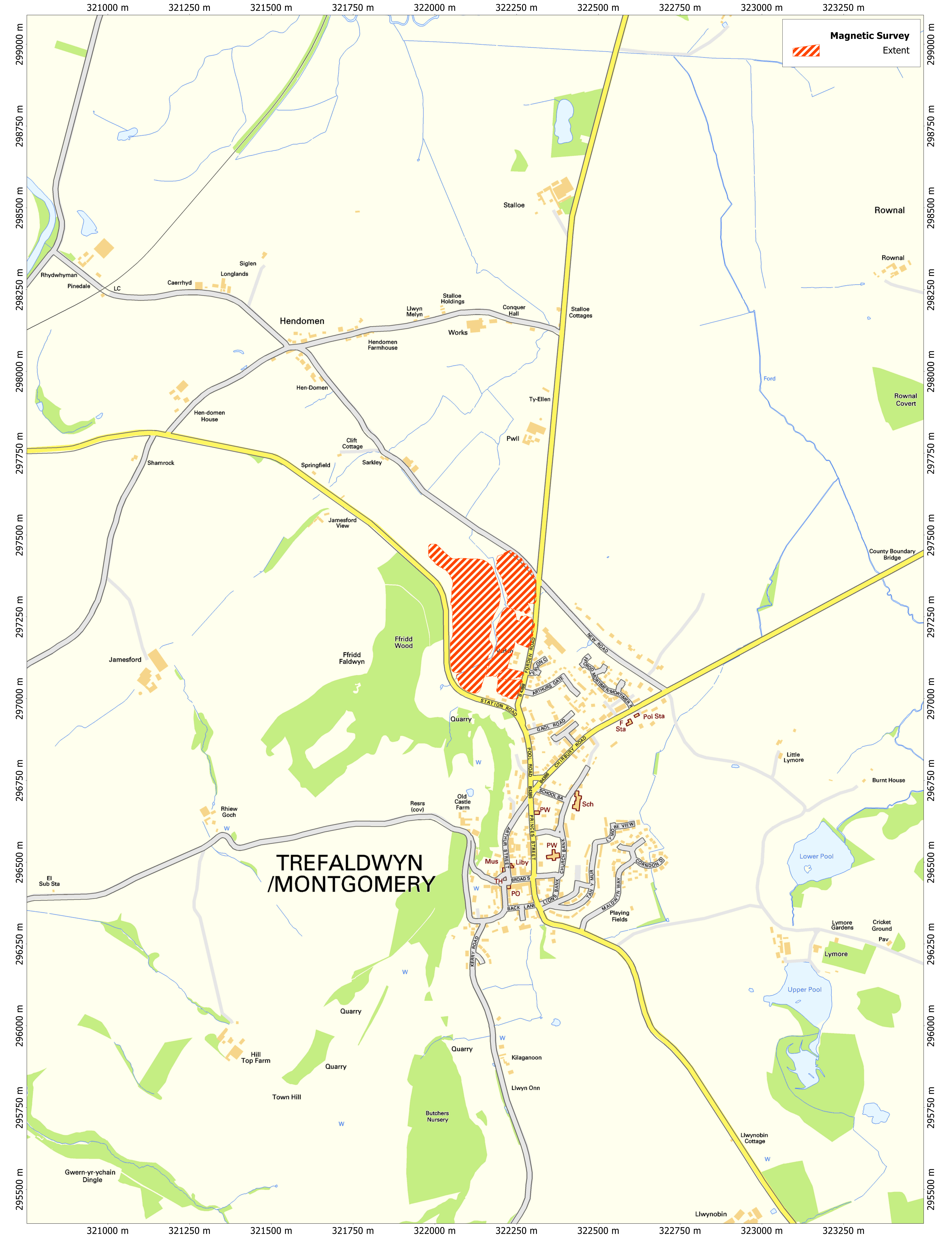
- David et al, "Geophysical Survey in Archaeological Field Evaluation", English Heritage, 2008;
- "Standard and guidance for Archaeological Geophysical survey", Chartered Institute for Archaeologists, 2014 (Updated 2016);

and TigerGeo meets with ease the requirements of English Heritage in their 2008 Guidance "Geophysical Survey in Archaeological Field Evaluation" section 2.8 entitled "Competence of survey personnel".

5.2 Key personnel

Martin Roseveare, MSc BSc(Hons) MEAGE FGS MCIfA	**Senior Geophysicist, Director**
Martin specialised (MSc) in geophysical prospection for shallow applications and since 1997 has worked in commercial geophysics. Elected a GeolSoc Fellow in 2009 he is now working towards achieving CSci. A member of the European Association of Geoscientists & Engineers, he has served on the EuroGPR and CIfA GeoSIG committees and on the scientific committees of the 10th and 11th Archaeological Prospection conferences. He has reviewed papers for the EAGE Near Surface conference, was a technical reviewer of the Irish NRA geophysical guidance and is a founding member of the ISSGAP soils group. Professional interests include the application of geophysics to agriculture and the environment, e.g. groundwater and geohazards. He is also a software writer and equipment integrator with significant experience of embedded systems.	
Anne Roseveare, BEng(Hons) DIS MISoilSci	**Operations Manager, Environmental Geophysicist - Data Analyst**
On looking beyond engineering, Anne turned her attention to environmental monitoring and geophysics. She is a Member of the British Society of Soil Science (BSSS) and has specific areas of interest in soil physics & hydrology, agricultural applications and industrial sites. Amongst other contributions to the archaeological geophysics sector over the last 18 years, Anne was the founding Editor of the International Society for Archaeological Prospection (ISAP) and is a founding member of the ISSGAP soils group. Specifications, logistics, safety, data handling & analysis are integral parts of her work, though she is happily distracted by the possibilities of discovering lost cities, hillwalking and good food.	
Jennifer Smith, MSc	**Fieldwork Manager, Environmental Geophysicist**
Jen developed an interest in all aspects of topographical and geophysical survey whilst studying for a MSc in Archaeological Science at the University of Bristol. During her studies she obtained valuable experience in the use of and data analysis for various terrestrial geophysical techniques as well as develop her interest further by adding marine geophysical techniques to her working theoretical knowledge. She has worked as a near-surface geophysicist within archaeology for several years and has developed a good knowledge of UK geology. Outside of work, Jen is currently learning Java code but is easily distracted by keeping fit, exploring the world or some other hobby.	
Daniel Lewis, MA BA(Hons) ACIfA	**Consultant Archaeologist**
Daniel studied archaeology at the University of Nottingham and worked in field archaeology for many years, managing urban and rural fieldwork projects in and around Herefordshire. When the desk became more appealing he jumped into the world of consulting, working on small and large multi-discipline projects throughout England and Wales. At the same time, he returned to University, gaining an MA in Historic Environment Conservation. With over 15 years' experience in the heritage sector, Daniel has a diverse portfolio of skills. Here he ensures that geophysical work within the heritage sector is well grounded in the archaeology. His spare time includes much running up mountains	
Luigi Benente, MSc	**Consultant Environmental Geophysicist**
Luigi is an experienced geologist specialized in geophysics, who gained a blend of practical and technical experience within explorations carried out in Italy, Peru, Colombia, Ecuador, Mexico, Uzbekistan, Thailand and Nigeria. Resourceful and hardworking with a positive attitude in problem solving, he has the ability to lead a team through challenging tasks, organizing people and equipment in order to hit the goal in safety and with time conscious professionalism. He is attracted to discover hidden things within the earth and after celebrating with friends, good wine, good beer and lots of food he is able to repair most broken things...	

Alexandra Gerea, MSc, BSc, PhD Candidate	**Geophysical Processor & Analyst**
Alexandra has a BSc in Geophysics and an MSc in Applied Geo-biology and started a PhD in the UK after living in Portugal for six months working on her master's degree. Since 2008 she has used most mainstream processing applications across electrical, magnetic and radar methods. She combines a love of nature and science and is currently studying plant roots in agricultural environments using geophysical methods. When not doing that she enjoys travelling, hiking, nature, yoga, books, foreign languages and cats. Two years ago she found a passion for electronics and started building different devices including intelligent gardening systems and coding in Python.	



VMP191 Verlon Farm, Montgomery, Powys

DWG 01 - Site Location

Orthographic Scale: 1:10000 @ A3 Spatial Units: Meter. Do not scale off this drawing

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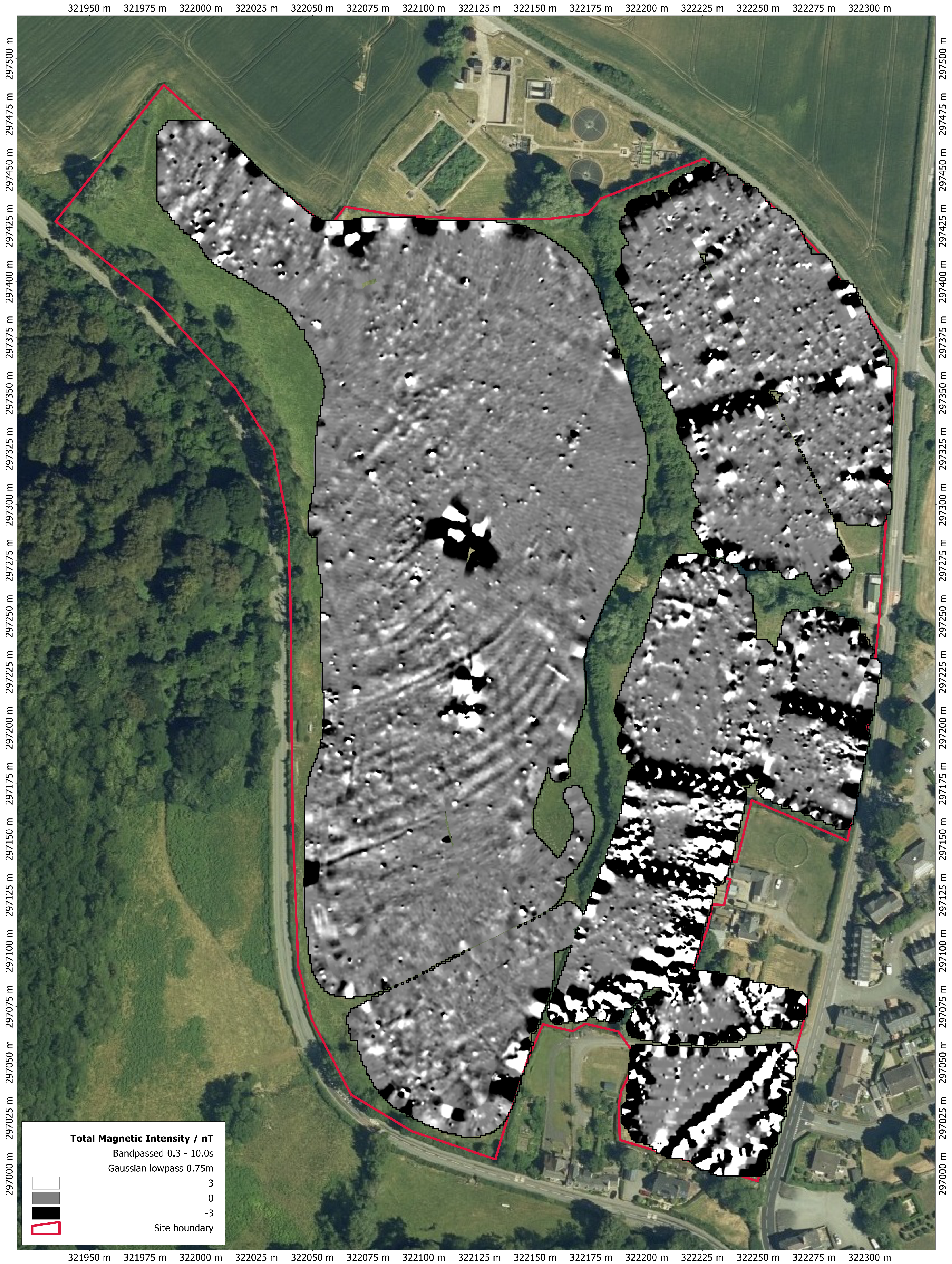

VMP191 Verlon Farm, Montgomery, Powys

DWG 02a - Total Magnetic Intensity (TMI) Data

Orthographic Scale: 1:1500 @ A3 Spatial Units: Meter. Do not scale off this drawing

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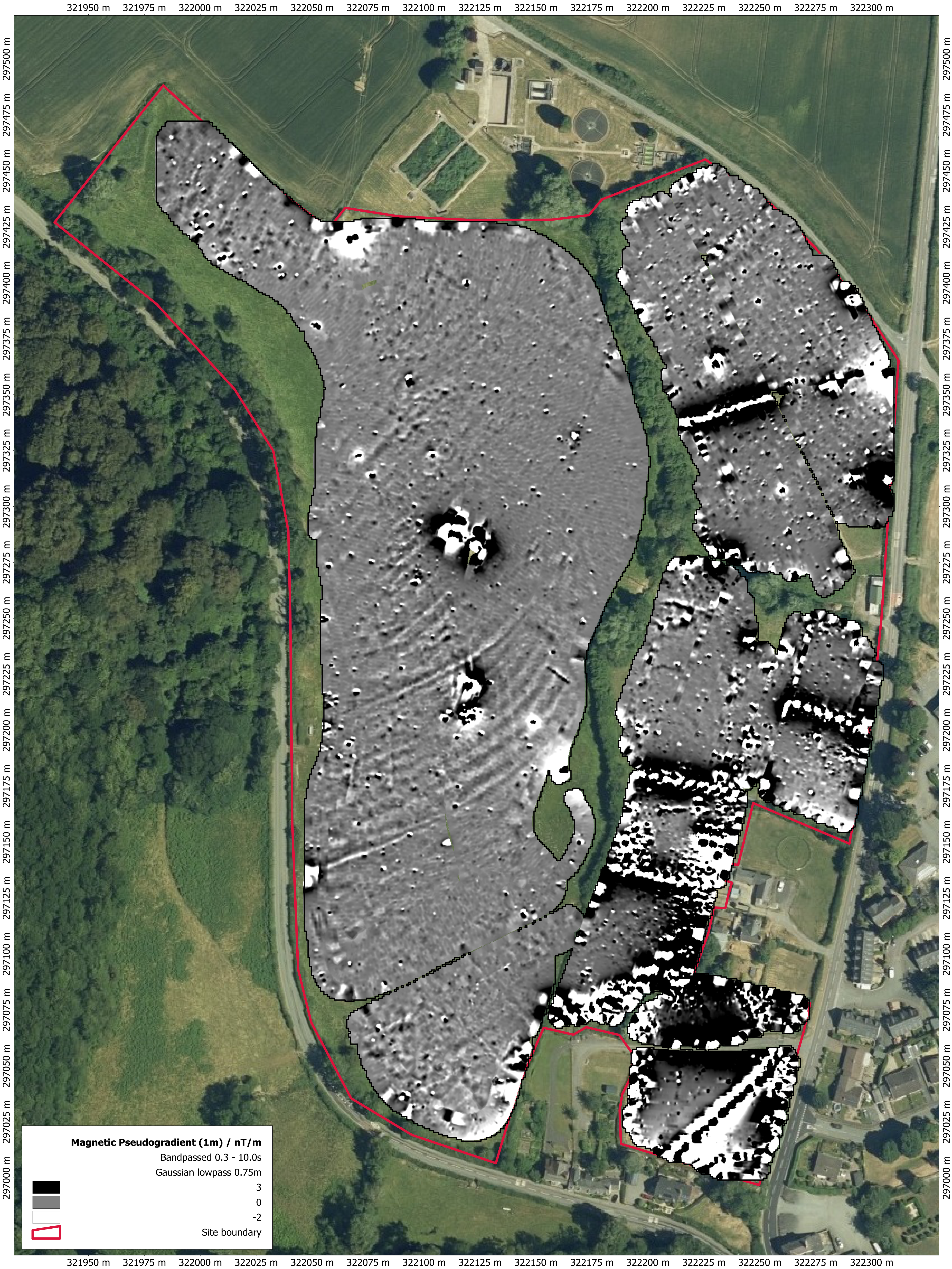

VMP191 Verlon Farm, Montgomery, Powys
DWG 02b - 1m Pseudogradient (PSG) Data

Orthographic Scale: 1:1500 @ A3 Spatial Units: Meter. Do not scale off this drawing
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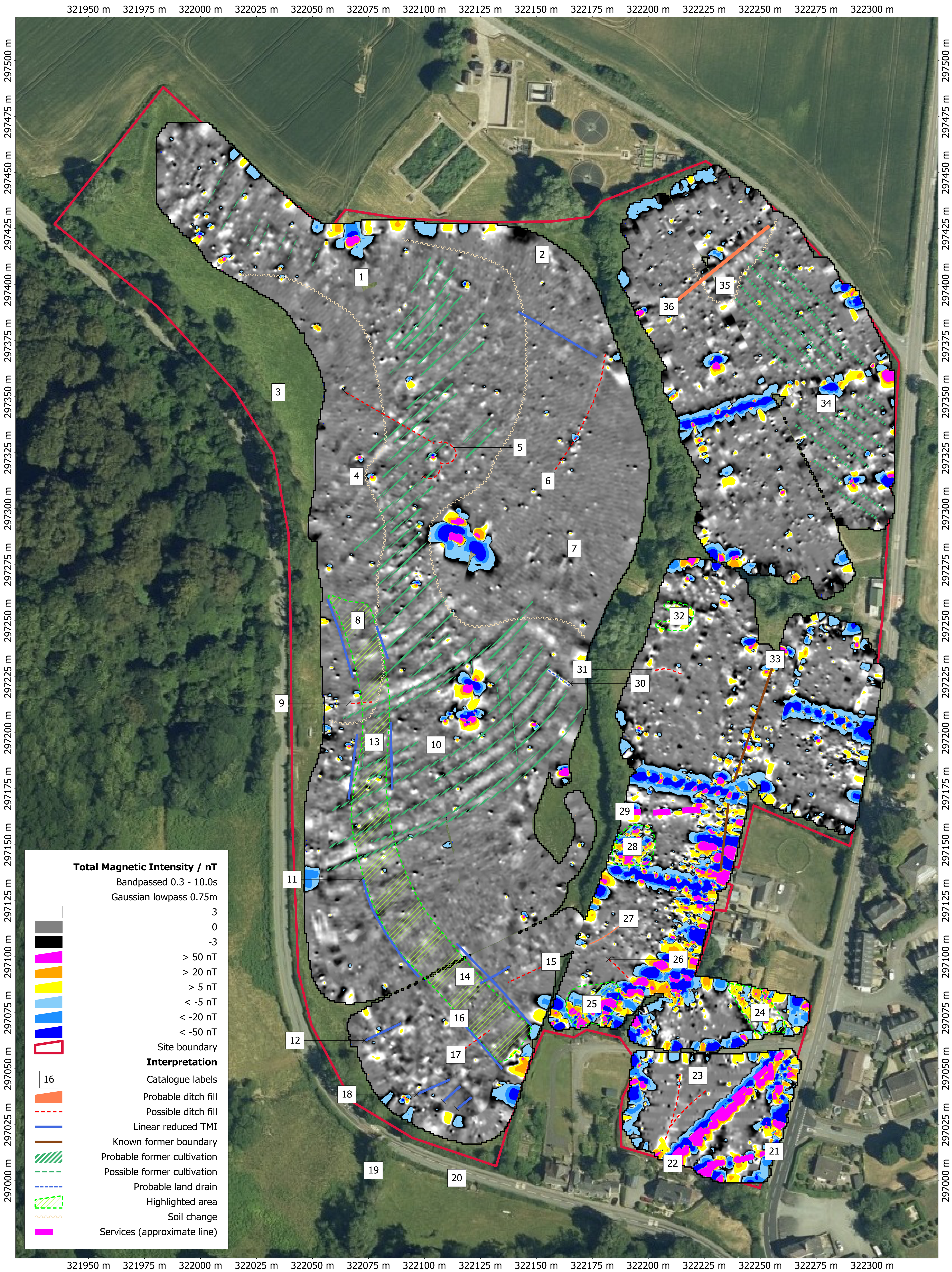

VMP191 Verlon Farm, Montgomery, Powys
DWG 03 - Interpretation

Orthographic Scale: 1:1500 @ A3 Spatial Units: Meter. Do not scale off this drawing
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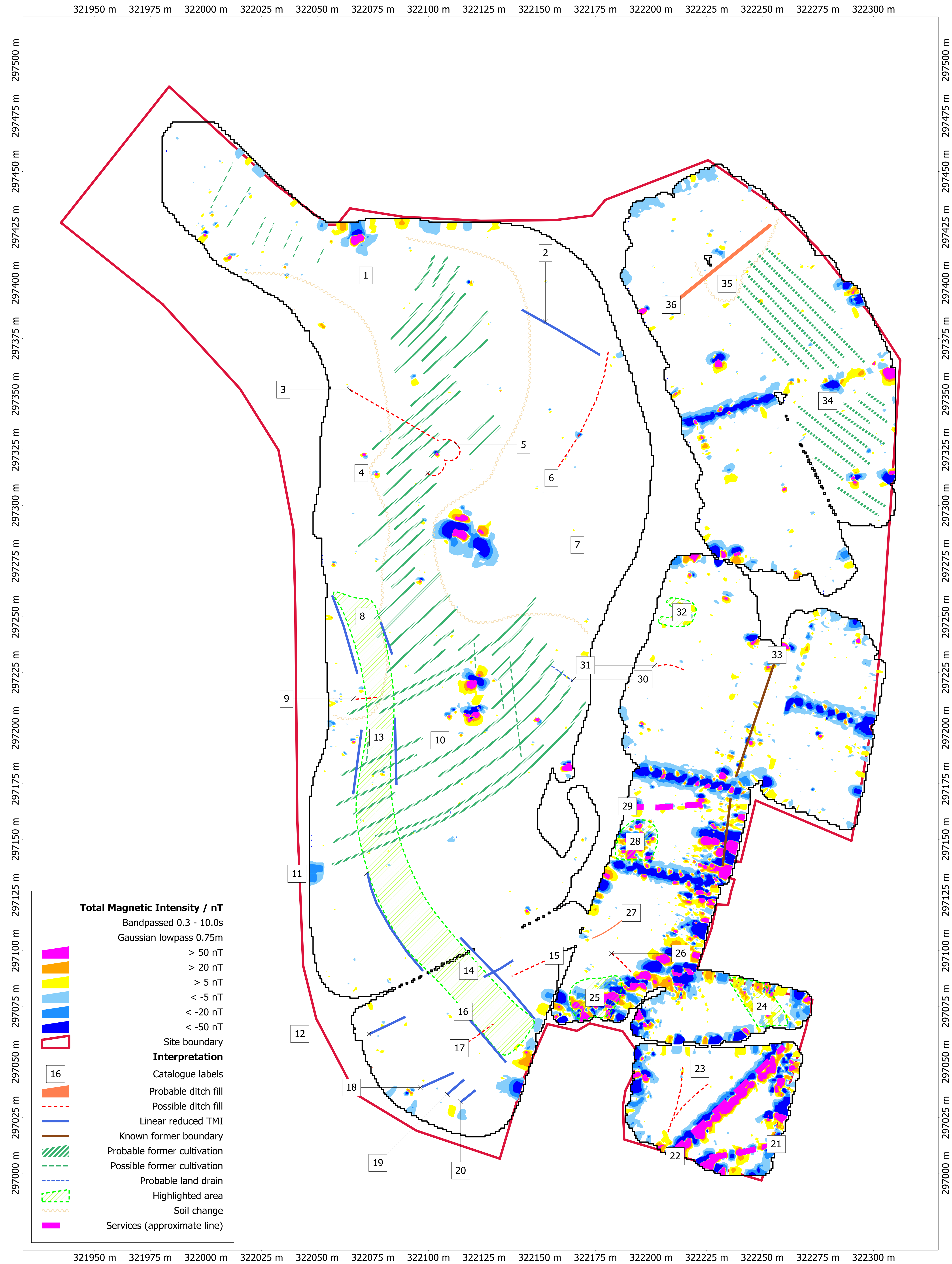

VMP191 Verlon Farm, Montgomery, Powys
DWG 04 - Interpretation Vector Only

Orthographic Scale: 1:1500 @ A3 Spatial Units: Meter. Do not scale off this drawing
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