Geophysical Report

Development AD Plant, Great Hele Barton, South Moulton, Devon.

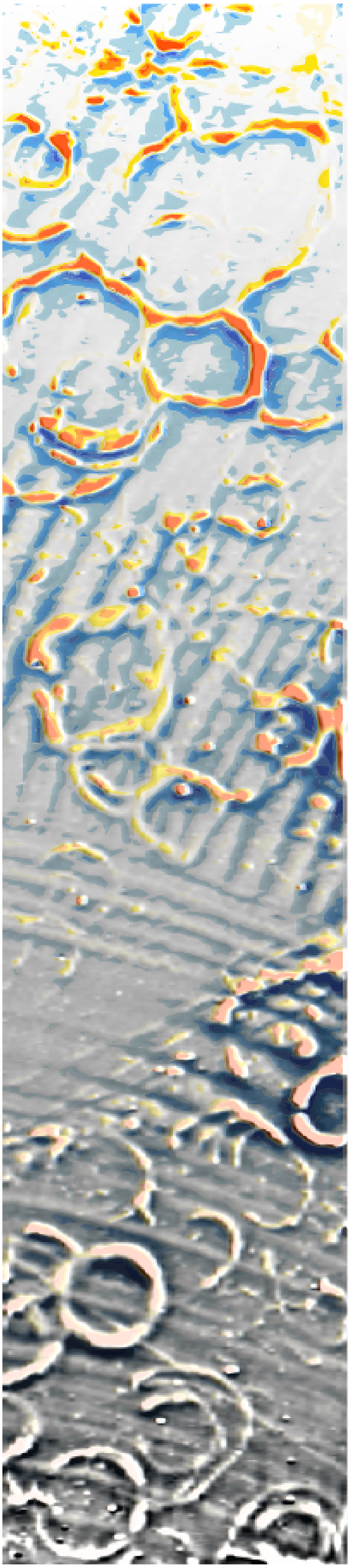
Prepared on behalf of: Greener for Life Energy Ltd

Cornwall Geo-environmental Limited
Telephone: 0845 271 1934
Website: www.cg-e.com
Email reports@cg-e.co.uk
Suite G50, Tremough Innovation Centre, Tremough Campus, Penryn, Cornwall, TR10 9TA
Company Number 6686902

CHARTER 2020

convergence for economic transformation

Supporting The Wildlife Trusts Cornwall



Great Hele Barton

South Molton, Devon

Geophysical Survey Report

Produced for Cornwall Geo-enviromental

Project code GHD141

14th April 2014

R. Fry BA(Hons) MSc, Geophysicist

ArchaeoPhysica Ltd

Kitchener's, Home Farm, Harewood End, Hereford HR2 8JS
Tel. +44 (0) 1989 730 564 www.archaeophysica.com

Non-Technical Summary

A magnetic survey was commissioned by Cornwall Geo-environmental to prospect land at Great Hele Barton, South Molton, Devon for buried structures of archaeological interest.

Two ditches have been identified which may be of archaeological interest and appear to define a former enclosure associated with the site of building shown between the two fields on old Ordnance Survey mapping. The geophysical survey also found evidence of historic land use in the form of multiple phases of past field boundaries.

Digital Data

Item	Sent to	Sent date
CAD – Vector Elements	Rob AC	14/04/14

Audit

Version	Author	Checked	Date
Interim			
Draft Final	R Fry	MJ Roseveare	14/04/14
Final	R Fry	MJ Roseveare	22/04/14
Revision			
OASIS			

Table of Contents

1 Introduction

Land at Great Hele Barton, South Molton, Devon was surveyed to prospect for buried structures of archaeological interest.

1.1 Location

Country	England
County	Devon
Nearest Settlement	South Molton
Central Co-ordinates	272200,124300

2.9 ha of land was surveyed across parts of two fields each under young cereal crop.

1.2 Constraints & variations

An area to the north-west of the survey was not surveyed due to this part of the site being used as a yard for the farm and containing felled trees, farm vehicles, etc.

2 Context

2.1 Archaeology

From a brief examination of the HER through the Heritage Gateway web portal it can be seen that there are cropmarks and other potential prehistoric or Roman-era archaeological sites in the general area. The site's proximity to what could be an older core of Great Hele Barton may suggest elements of a prior farmstead or field system survive nearby (Roseveare 2014).

2.2 Environment

Superficial 1: 50000 BGS	None Recorded
Bedrock 1:50000 BGS	Bude Formation - Sandstone (BF), Bude Formation - Mudstone And Siltstone - bands adjacent to N and S edge area
Topography	The east extent of the site is the highest point within the vicinity, with land sloping away to the south and south-west.
Hydrology	Not Known
Current Land Use	Farming – mixed agricultural
Historic Land Use	Farming – mixed agricultural
Vegetation Cover	Young crop
Sources of Interference	None over the surveyed area

The magnetic susceptibility of the soil across the site is usually suitable for the detection by magnetic survey of archaeological remains cut into natural soil strata. The strength of anomalies produced will be dependant on form and depth, as well as the magnetic contrast of the material making up the archaeological features. Natural variations and accumulations of soil within the survey areas may also be detectable.

3 Methodology

3.1 Survey

3.1.1 Technical equipment

Measured variable	Magnetic flux density / nT
Instrument	Array of Geometrics G858 Magmapper caesium magnetometers
Configuration	Non-gradiometric transverse array (4 sensors, ATV towed)
Sensitivity	0.03 nT @ 10 Hz (manufacturer's specification)
QA Procedure	Continuous observation
Spatial resolution	1.0m between lines, 0.3m mean along line interval

3.1.2 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.

3.2 Data processing

3.2.1 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 between 0.3s and 5.0s
Gridding	Surfer	Kriging, 0.25m x 0.25m
Smoothing	Surfer	Gaussian lowpass 3x3 data
Imaging and presentation	Manifold GIS	

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 and detailed analysis. Specialist analysis is undertaken using proprietary software.

General information on processes commonly applied to data can be found in standard text books and also in the 2008 English Heritage Guidelines "Geophysical Survey in Archaeological Field Evaluation" at http://www.helm.org.uk/upload/pdf/Geophysical_LoRes.pdf.

ArchaeoPhysica uses more advanced processing for magnetic data using potential field techniques standard to near-surface geophysics. Details of these can be found in Blakely, 1996, "Potential Theory in Gravity and Magnetic Applications", Cambridge University Press.

All archived data includes process metadata.

3.3 Interpretation resources

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 is sourced only from British Geological Survey resources and aerial imagery from online sources. Topographic data is usually sourced from the Environment Agency (LiDAR) unless derived from original ArchaeoPhysica survey.

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

3.4 Interpretive classes

3.4.1 Introduction

Key to interpretation is separation of each anomaly into broad classes, namely whether caused by agricultural processes (e.g. ploughing, composting, drainage etc.), geological factors or whether a structure of archaeological interest is likely. Within these anomalies are in turn classified by whether they most likely represent a fill or a drain, or a region of differing data texture, etc. More detailed descriptions are included below.

The actual means of classification is based upon geophysical understanding of anomaly formation, the behaviour of soils, landscape context and structural form. For example, to consider just one form of anomaly: weakly dipolar discrete magnetic anomalies of small size are likely to have shallow non-ferrous sources and are therefore likely to be pits. Larger ones of the same class could also be pits or locally-deeper topsoil but if strongly magnetic could also be hearths. Strongly dipolar discrete anomalies are in all cases likely to be ferrous or similarly magnetic debris, although small repeatedly heated and in-situ hearths can produce similar anomalies.

3.4.2 Agriculture – boundaries

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 this category if they correlate with boundaries 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.

3.4.3 Agriculture – cultivation

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.

3.4.4 Agriculture – drains

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.

3.4.5 Archaeology – fills

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 presence of other sources of magnetic material.

3.4.6 Archaeology – other discrete

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.

3.4.7 Archaeology – structures

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 indicating hearths. In some circumstances a less definite category may be assigned to the individual anomalies instead.

3.4.8 Archaeology – zones

On some sites it is 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 anomalies possibly of archaeological interest.

3.4.9 Geology – discrete

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.

3.4.10 Geology – zones

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

3.4.11 Services

All overheard (OH) and underground (UG) services are depicted where these are detectable in the data or may influence aspects of the interpretation.

3.4.12 Texture

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. Where these variations are of interest or relevance to the study they are included in this category.

3.5 Standards & guidance

All work was 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 Field Evaluation", Institute for Archaeologists, 2008.

In addition, all 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 personnel are experienced surveyors trained to use the equipment in accordance with the manufacturer's expectations. All aspects of the work are monitored and directed by fully qualified professional geophysicists.

4 Discussion

4.1 Introduction

The sections below first discuss the geophysical context within which the results need to be considered and then specific features or anomalies of particular interest. Not all will be discussed here and the reader is advised to consult the catalogue (ibid) in conjunction with the graphical elements of this report.

4.2 Principles

In general, topsoil is more magnetic than subsoil which can be slightly more magnetic than parent geology, whether sands, gravels or clays, however, there are exceptions to this. The reasons for this are natural and are due to biological processes in the topsoil that change iron between various oxidation states, each differently magnetic. Where there is an accumulation of topsoil or where topsoil has been incorporated into other features, a greater magnetic susceptibility will result.

Within landscapes soil tends to accumulate in negative features like pits and ditches and will include soil particles with thermo-remanent magnetization (TRM) through exposure to heat if there is settlement or industry nearby. In addition, particles slowly settling out of stationary water will attempt to align with the ambient magnetic field at the time, creating a deposit with depositional remanent magnetization (DRM).

As a consequence, magnetic survey is nearly always more a case of mapping accumulated magnetic soils than structures which would not be detected unless magnetic in their own right, e.g. built of brick or tile. As a prospecting tool it is thus indirect. Fortunately, the mechanisms outlined above are commonplace and favoured by human activity and it is nearly always the case that cut features will alter in some way the local magnetic field.

4.2.1 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. However, this does remove suppression of ambient noise and temporal trends which have to be suppressed later during processing. When compared to vertical gradiometers in archaeological use, there is no significant reduction in lateral resolution when using non-gradiometric sensor arrays and the inability of gradiometers to detect laminar structures is completely avoided.

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.

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. There is, however, some limited contribution from the towing ATV.

4.3 Character & principal results

4.3.1 Geology

The soils and geology of the site have provided a good magnetic contrast, with clear anomalies within the data. The background texture of the data has a mottled character which may disguise small or ephemeral anomalies from archaeological features, however, linear ditch fills are clearly evident. Some slight variation in the strength of the mottled texture are likely to reflect variations in the underlying bedrock and there are occasional moderate amplitude diffuse anomalies that are likely to indicate discrete areas of deeper soil.

4.3.2 Land use

There is clear evidence for a varied past land use over the site from the data collected, and different historic field systems can be identified from the various field boundaries detected. A possible double ditched boundary [3] ('Cornish' hedge), appears to have been an extension of a historic field boundary, seen in old Ordnance Survey (OS) mapping, prior to the expansion of the farm yard. This boundary is however not depicted within this field which would suggest it predates 1889. It appears to meet the corner of the enclosure defined by ditches [1] and [2].

Field boundary [6] appears to run parallel to a linear cropmark approximately 100m to the north, which is depicted on a 1972 OS map but not earlier ones. It is likely therefore that this boundary is also of relatively modern date. A weaker linear anomaly [9], also runs parallel to [6], approximately 50m to the south, suggesting that these features may have been contemporaneous.

Weakly magnetic linear features [4] & [5] may also represent filled in boundaries, possible paths across the field, or in the case of [5], potentially also the route of a pipe or drain.

4.3.3 Archaeology

Two strong linear anomalies forming two ditches [1] & [2] are positioned at a right-angle to each other, with an apparent entrance at the east-corner. The curve to the western end of the ditch at [2] implies that the ditch may continue in a south-west direction to form an enclosed rectangle. From historic mapping a building was positioned between the two fields at approximately the position of [7], and these ditches may relate in some way to this structure, however, there is no direct evidence to support this.

An area containing some rather ambiguous enhanced magnetic fills [10] may be of archaeological importance, however, could also be a feature of the background mottling and hence of natural origin.

4.4 Conclusions

Two ditches [1] & [2] may be of archaeological interest and especially as they appear to relate to a former building sited at [7]. An area of magnetic texture potentially of archaeological interest may also be contained within [10] although this is tentative.

The rest of the magnetic anomalies appear to relate to elements of former field systems apparent on one or more old OS maps.

4.5 Caveats

Geophysical survey is a systematic measurement of some physical property related to the earth. There are numerous sources of disturbance of this property, some due to archaeological features, some due to the measuring method, and others that relate to the environment in which the measurement is made. No disturbance, or 'anomaly', is capable of providing an unambiguous and comprehensive description of a feature, in particular in archaeological contexts where there are a myriad of factors involved.

The measured anomaly is generated by the presence or absence of certain materials within a feature, not by the feature itself. Not all archaeological features produce disturbances that can be detected by a particular instrument or methodology. For this reason, the absence of an anomaly must never be taken to mean the absence of an archaeological feature. The best surveys are those which use a variety of techniques over the same ground at resolutions adequate for the detection of a range of different features.

Where the specification is by a third party ArchaeoPhysica will always endeavour to produce the best possible result within any imposed constraints and any perceived failure of the specification remains the responsibility of that third party.

Where third party sources are used in interpretation or analysis ArchaeoPhysica will endeavour to verify their accuracy within reasonable limits but responsibility for any errors or omissions remains with the originator.

Any recommendations are made based upon the skills and experience of staff at ArchaeoPhysica and the information available to them at the time. ArchaeoPhysica is not responsible for the manner in which these may or may not be carried out, nor for any matters arising from the same.

4.6 Bibliography & selected reference

Aspinall *et al*, 2008. "Magnetometry for Archaeologists", Geophysical Methods for Archaeology, Altamira Press

Blakely, 1996, "Potential Theory in Gravity and Magnetic Applications", Cambridge University Press

David *et al*, 2008, "Geophysical Survey in Archaeological Field Evaluation", English Heritage

Gaffney *et al*, 2002, "Technical Note 6: The use of geophysical techniques in archaeological evaluations", Institute for Archaeologists

Milsom, 2003, "Field Geophysics", 3rd edition, The Geological Field Guide Series, Wiley

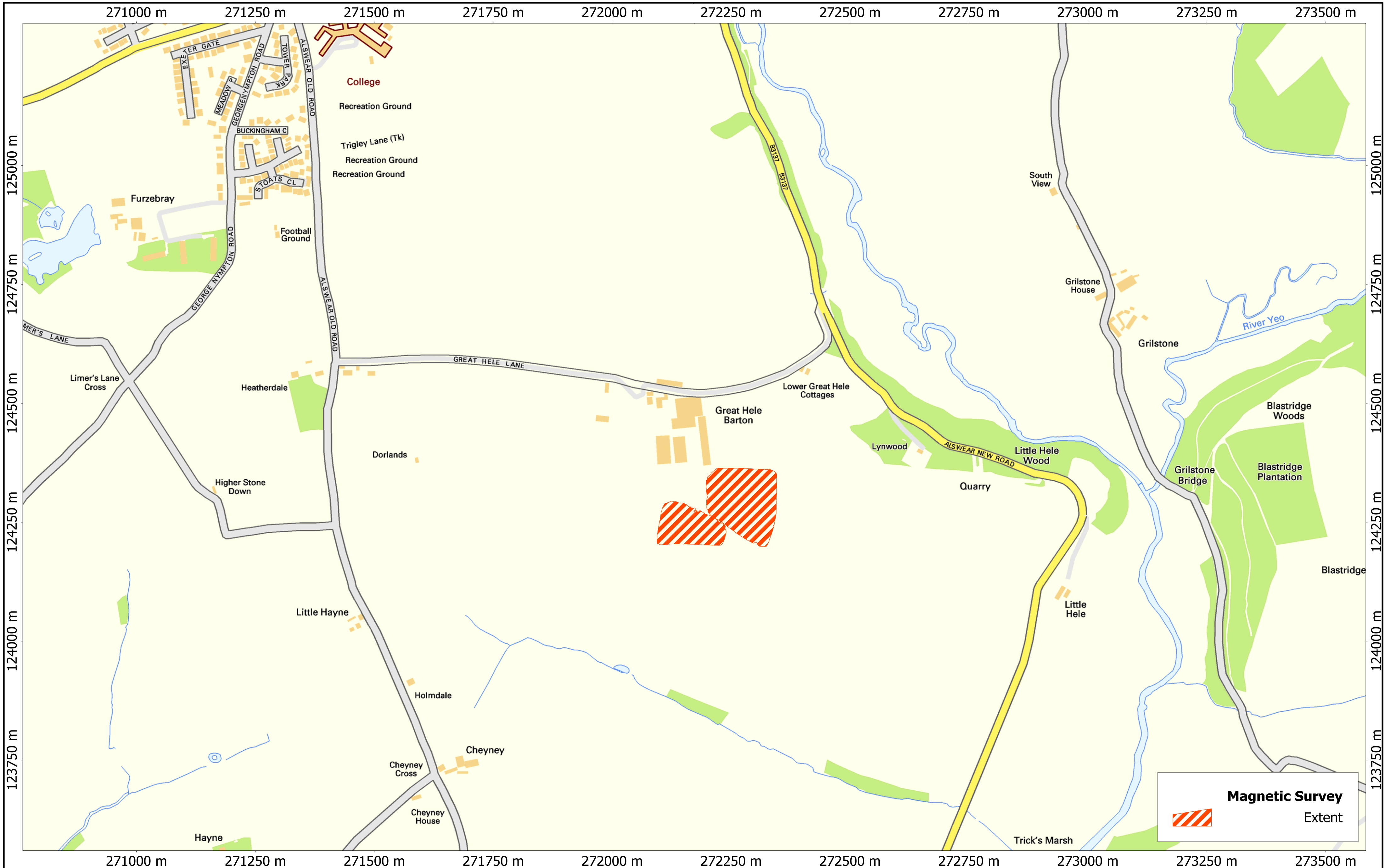
Schmidt, A., 2013, "Geophysical Data in Archaeology: A Guide to Good Practice", ADS

Roseveare, A., 2014, Great Hele Barton, South Molton, Devon: Specification for Geophysical Survey (Written Scheme of Investigation). ArchaeoPhysica Ltd. Hereford.

Scollar, 1990, "Archaeological Prospecting and Remote Sensing", Topics in Remote Sensing 2, Cambridge University Press

Tarling *et al* (ed.), 1999, "Palaeomagnetism and Diagenesis in Sediments", Geological Society, London, Special Publications, 151

Telford *et al*, 1990, "Applied Geophysics", 2nd Edition, Cambridge University Press

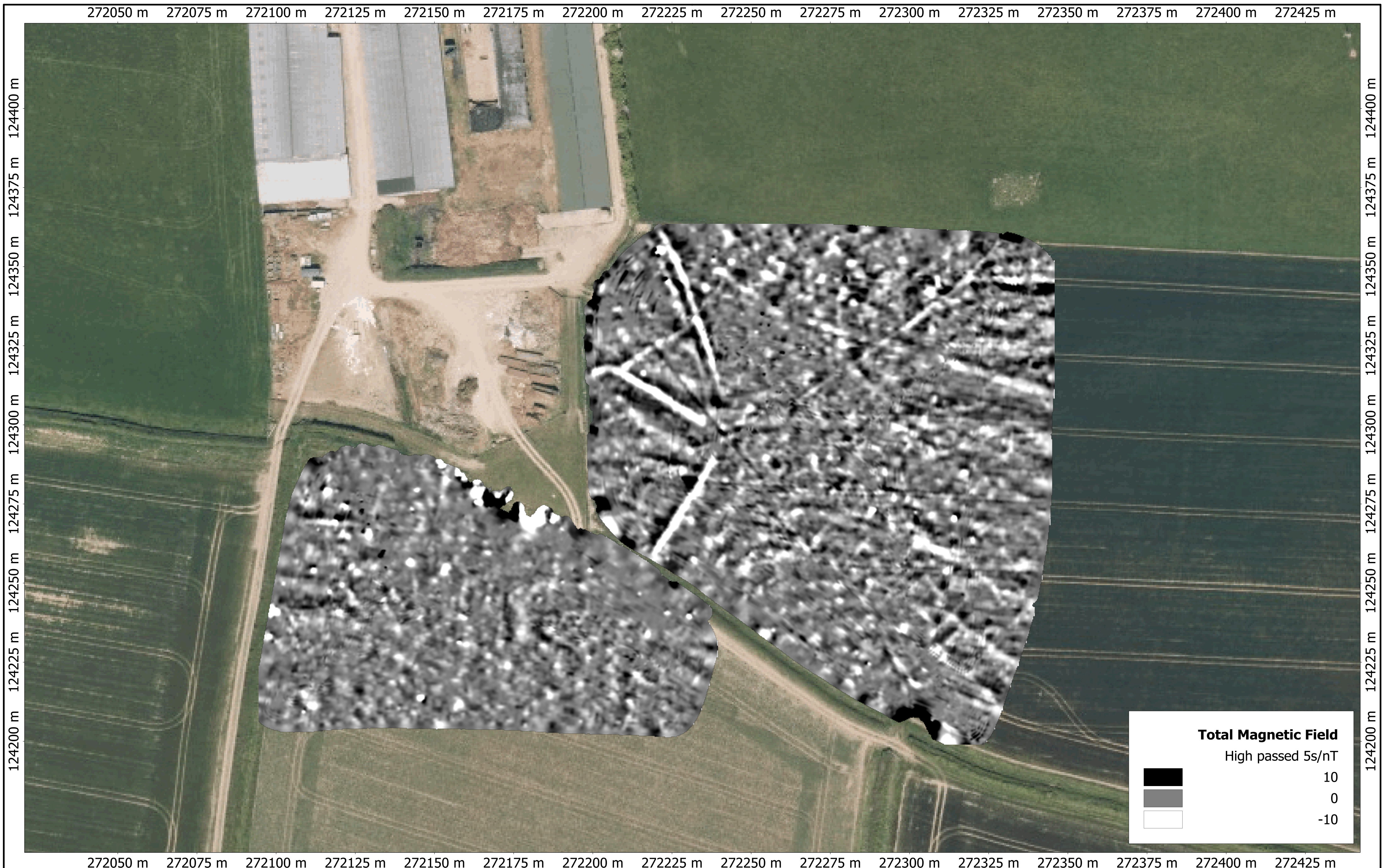


GHD141 Great Hele Barton, South Molton, Devon

DWG 01 Location Map

ArchaeoPhysica Ltd

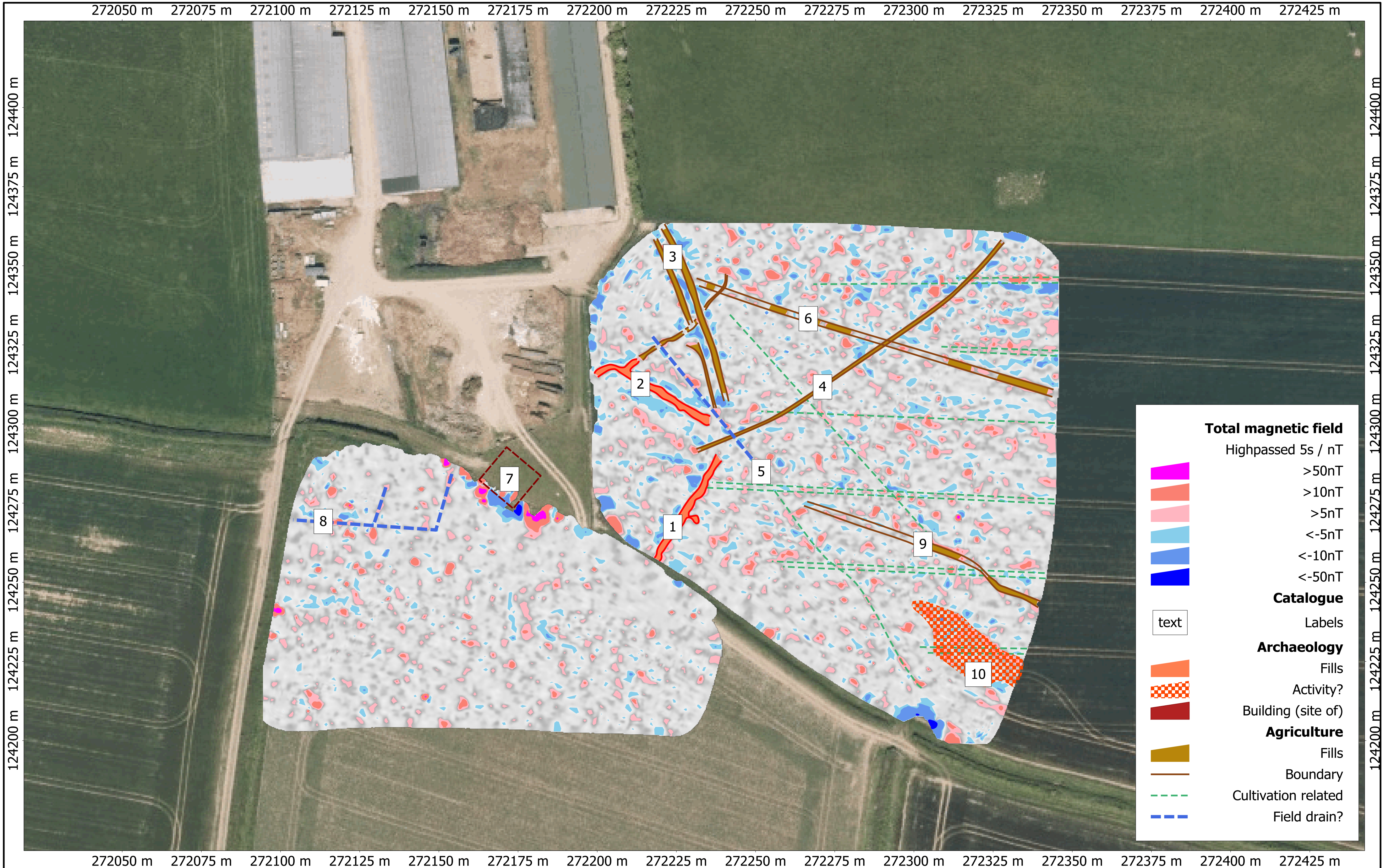
Orthographic Centre X: 272172.71 m Centre Y: 124429.24 m Scale: 1:10000 @ A4 Spatial Units: Meter. Do not scale off this drawing



GHD141 Great Hele Barton, South Molton, Devon
DWG 02 Magnetic Data Map

ArchaeoPhysica Ltd

Orthographic Centre X: 272231.45 m Centre Y: 124295.89 m Scale: 1:1500 @ A4 Spatial Units: Meter. Do not scale off this drawing



GHD141 Great Hele Barton, South Molton, Devon
DWG 03 Catalogue Map

ArchaeoPhysica Ltd

Orthographic Centre X: 272230.65 m Centre Y: 124296.28 m Scale: 1:1500 @ A4 Spatial Units: Meter. Do not scale off this drawing