

# Geophysical Survey Report

# Newbridge Lane, Gloweth, Truro

for

**Exeter Archaeology** 

September 2007

J2386

Richard A. J. Smalley BA (Hons) AIFA



**Document Title:** Geophysical Survey Report

Client: Exeter Archaeology

Stratascan Job No: J2386

**Techniques:** Detailed magnetic survey (gradiometry)

National Grid Ref: SW 179 448



Field Team: Claire Graham BA (Hons), Lynda O' Sullivan

**Project Manager:** Simon Stowe BSc. (Hons)

Report written by: Richard Smalley BA (Hons) AIFA

CAD illustration by: Richard Smalley BA (Hons) AIFA

Checked by: Peter Barker CEng MICE MCIWEM MIFA

Stratascan Ltd.

Vineyard House Upper Hook Road Upton upon Severn WR8 0SA

Tel: 01684 592266 Fax: 01684 594142

Email: <u>ppb@stratascan.co.uk</u> www.stratascan.co.uk

L	IST OF	FIG	URES	2				
1	SUMMARY OF RESULTS							
2	INT	ROD	OUCTION	3				
	2.1	Bac	kground synopsis	3				
	2.2	Site	Site location					
<ul><li>2.3</li><li>2.4</li><li>2.5</li></ul>		Des	Description of site					
		Geology and soils						
		Site	Site history and archaeological potential					
2.6		Survey objectives						
	2.7	Surv	vey methods	4				
3	ME	ТНО	DOLOGY	4				
	3.1	Date	e of fieldwork	4				
	3.2	Grid	l locations	4				
	3.3	Surv	vey equipment	4				
	3.4	Sam	apling interval, depth of scan, resolution and data capture	4				
	3.4.1		Sampling interval	4				
	3.4.	2	Depth of scan and resolution	5				
	3.4	3	Data capture	5				
	3.5	Proc	cessing, presentation of results and interpretation	5				
	3.5.	1	Processing	5				
	3.5.	2	Presentation of results and interpretation	6				
4 RE		SULT	`S	6				
	4.1	Area 16						
	4.2	Area 2						
	4.3	3 Area 3						
	4.4	Area	a 4	7				
5	CO	CONCLUSION8						
6	REFERENCES							
	APPE	APPENDIX A – Basic principles of magnetic survey						
APPENDIX B – Glossary of magnetic anomalies								

# LIST OF FIGURES

Figure 1	1:25 000	General location plan
Figure 2	1:2000	Site plan showing location of grids and referencing
Figure 3	1:1500	Plot of raw magnetometer data
Figure 4	1:2000	Trace plot of raw magnetometer data showing positive values
Figure 5	1:2000	Trace plot of raw magnetometer data showing negative values
Figure 6	1:1250	Plot of processed magnetometer data- Areas 1 and 4
Figure 7	1:1250	Abstraction and interpretation of anomalies- Areas 1 and 4
Figure 8	1:1000	Plot of processed magnetometer data- Areas 2 and 3
Figure 9	1:1000	Abstraction and interpretation of anomalies- Areas 2 and 3
Figure 10	1:1500	Abstraction and interpretation of anomalies- All Areas

#### 1 SUMMARY OF RESULTS

The geophysical survey undertaken over approximately 6ha of land near Gloweth, Truro has identified a number of anomalies of possible archaeological origin. Circular cut features have been identified in Areas 2 and 4 and two negative curvilinear anomalies can be seen in Area 1. Pits of a possible archaeological origin have been identified in each of the survey areas. Negative area and linear anomalies indicate the presence of former earthworks, banks or masonry.

#### 2 INTRODUCTION

# 2.1 Background synopsis

Stratascan were commissioned by Exeter Archaeology to undertake a geophysical survey of an area outlined for development.

# 2.2 Site location

The site is located near Newbridge Lane, Gloweth, Truro at OS ref. SW 179 448.

# 2.3 <u>Description of site</u>

The survey area consists of 6-7ha of heavily overgrown agricultural land. Areas 3 and 4 slope to the east.

#### 2.4 Geology and soils

The underlying geology is Devonian sedimentary including sandstone and limestone (British Geological Survey South Sheet, Fourth Edition Solid, 2001).

The overlying soils are known as Denbigh 1 which are typical brown earths. These consist of well drained fine loamy and fine silty soils over rock (Soil Survey of England and Wales, Sheet 5 South West England).

# 2.5 <u>Site history and archaeological potential</u>

No specific details were available to Stratascan.

# 2.6 Survey objectives

The objective of the survey was to locate any features of possible archaeological significance in order that they may be assessed prior to development.

#### 2.7 Survey methods

Detailed magnetic survey (gradiometry) was used as an efficient and effective method of locating archaeological anomalies. More information regarding this technique is included in the Methodology section below.

#### 3 METHODOLOGY

#### 3.1 Date of fieldwork

The fieldwork was carried out over six days from 5<sup>th</sup> September 2007. Weather conditions during the survey were dry and sunny.

#### 3.2 Grid locations

The location of the survey grids has been plotted in Figure 2 together with the referencing information. Grids were set out using a Leica 705auto Total Station and referenced to suitable topographic features around the perimeter of the site.

# 3.3 Survey equipment

The magnetic survey was carried out using a dual sensor Grad601-2 Magnetic Gradiometer manufactured by Bartington Instruments Ltd. The Grad601-2 consists of two high stability fluxgate gradiometers suspended on a single frame. Each sensor has a 1m separation between the sensing elements increasing the sensitivity to small changes in the Earths magnetic field.

# 3.4 Sampling interval, depth of scan, resolution and data capture

# 3.4.1 Sampling interval

Readings were taken at 0.25m centres along traverses 1m apart. This equates to 3600 sampling points in a full 30m x 30m grid.

# 3.4.2 Depth of scan and resolution

The Grad601-2 has a typical depth of penetration of 0.5m to 1.0m. This would be increased if strongly magnetic objects have been buried in the site. The collection of data at 0.25m centres provides an appropriate methodology balancing cost and time with resolution. The data is collected at a reading resolution of 0.1nT.

# 3.4.3 Data capture

The readings are logged consecutively into the data logger which in turn is daily down-loaded into a portable computer whilst on site. At the end of each job, data is transferred to the office for processing and presentation.

# 3.5 Processing, presentation of results and interpretation

# 3.5.1 Processing

Processing is performed using specialist software known as *Geoplot 3*. This can emphasise various aspects contained within the data but which are often not easily seen in the raw data. Basic processing of the magnetic data involves 'flattening' the background levels with respect to adjacent traverses and adjacent grids. 'Despiking' is also performed to remove the anomalies resulting from small iron objects often found on agricultural land. Once the basic processing has flattened the background it is then possible to carry out further processing which may include low pass filtering to reduce 'noise' in the data and hence emphasise the archaeological or man-made anomalies.

The following schedule shows the basic processing carried out on all processed gradiometer data used in this report:

1. *Despike* (useful for display and allows further processing functions to be carried out more effectively by removing extreme data values)

```
Geoplot parameters:
X radius = 1, y radius = 1, threshold = 3 std. dev.
Spike replacement = mean
```

2. Zero mean grid (sets the background mean of each grid to zero and is useful for removing grid edge discontinuities)

```
Geoplot parameters:
Threshold = 0.25 std. dev.
```

#### 3. Zero mean traverse

(sets the background mean of each traverse within a grid to zero and is useful for removing striping effects)

Geoplot parameters: Least mean square fit = off

#### 3.5.2 Presentation of results and interpretation

The presentation of the data for each site involves a print-out of the raw data both as greyscale (Figure 3) and trace plots (Figures 4 and 5), together with a greyscale plot of the processed data (Figures 6 and 8). Magnetic anomalies have been identified and plotted onto the 'Abstraction and Interpretation of Anomalies' drawing for the site (Figures 7, 9 and 10).

#### 4 RESULTS

#### 4.1 Area 1

A positive linear anomaly with associated negative anomaly can be noted running approximately east to west across this survey area. This anomaly has been interpreted as being a former field boundary.

Positive area anomalies running approximately north to south in this area indicate the presence of an interrupted ditch system of possible archaeological origin. Other positive area and linear anomalies, indicating cut features such as ditches are evident throughout this survey area.

A number of discrete positive anomalies have been located within Area 1. These anomalies have been interpreted as pits of a possible archaeological origin.

Negative linear and area anomalies indicate the presence of former earthworks or banks within the survey area. A number of these anomalies occur in close proximity to cut features which may suggest some form of bank and ditch arrangement. Two negative curvilinear anomalies can be noted in north western limits of this survey area.

#### 4.2 Area 2

The data collected within Area 2 is dominated by the presence of positive area anomalies indicating cut features of a possible archaeological origin. Two positive curvilinear anomalies evident in the central regions of this area may warrant further investigation.

Negative linear and area anomalies, indicating the presence of former earthworks or banks of a possible archaeological origin can also be noted within Area 2.

A number of discrete positive anomalies interpreted as possible pits are evident in this survey area with a concentration in the south eastern limits.

# 4.3 Area 3

As in Area 3 the data from Area 2 is dominated by the presence of cut features in the form of positive area anomalies. These cut features are in close proximity to a number of negative area anomalies indicating former earthworks or banks. The large quantity and size of the anomalies may suggest that they are related to some form of intrusive ground work or possibly of a geological origin.

A rectilinear arrangement of anomalies in the south eastern limits of this area may suggest the presence of an enclosure comprising of banks and ditches.

Pits of a possible archaeological origin are evident throughout this survey area in the form of discrete positive anomalies.

#### 4.4 Area 4

A curvilinear anomaly can be noted in the south western limits of Area 4. This circular anomaly may be related to a ring ditch of a round barrow or some other prehistoric feature. Two positive linear anomalies can be seen running approximately north east to south west towards the circular feature. Further investigation would be necessary in order to ascertain as to whether these anomalies are contemporary with each other. Another curvilinear feature can be noted in the eastern limits of the survey area. Other positive linear anomalies indicating cut features are evident within this survey area.

Discrete positive anomalies evident throughout Area 4 have been interpreted as pits of a possible archaeological origin.

Negative linear and area anomalies located within this survey area represent former earthworks or banks. It is interesting to note two discrete negative anomalies within the circular ditch feature.

Two large field boundaries can be noted in this area. One runs approximately north to south, the other is oriented approximately east to west.

A large area of magnetic disturbance is evident in the western limits of Area 4. This disturbance suggests some form of ground disturbance having taken place. The disturbance is restricted to the west of the field boundary and as a result is likely to post date it.

#### 5 CONCLUSION

The gradiometer survey undertaken over approximately 6ha of agricultural land has located a number of anomalies of possible archaeological origin. A number of curvilinear features have been noted in Areas 1, 2 and 4. These anomalies may indicate prehistoric activity having taken place within the site. Further investigation would be required in order to ascertain the nature of these anomalies and discern as to whether they are contemporary with each other.

A linear arrangement of positive area anomalies suggests the presence of an interrupted ditch system running approximately north to south through Area 1. In Area 3 a number of positive linear anomalies are arranged in a roughly square feature, possibly representing an enclosure in the south eastern limits.

Discrete positive anomalies, interpreted as possible pits, have been identified in all four survey areas.

#### 6 REFERENCES

British Geological Survey, 2001. *Geological Survey Ten Mile Map, South Sheet, Fourth Edition (Solid)*. British Geological Society.

Soil Survey of England and Wales, 1983. Soils of England and Wales, Sheet 5 Southwest England.

# **APPENDIX** A – Basic principles of magnetic survey

Detailed magnetic survey can be used to effectively define areas of past human activity by mapping spatial variation and contrast in the magnetic properties of soil, subsoil and bedrock.

Weakly magnetic iron minerals are always present within the soil and areas of enhancement relate to increases in *magnetic susceptibility* and permanently magnetised *thermoremnant* material.

Magnetic susceptibility relates to the induced magnetism of a material when in the presence of a magnetic field. This magnetism can be considered as effectively permanent as it exists within the Earth's magnetic field. Magnetic susceptibility can become enhanced due to burning and complex biological or fermentation processes.

Thermoremnance is a permanent magnetism acquired by iron minerals that, after heating to a specific temperature known as the Curie Point, are effectively demagnetised followed by re-magnetisation by the Earth's magnetic field on cooling. Thermoremnant archaeological features can include hearths and kilns and material such as brick and tile may be magnetised through the same process.

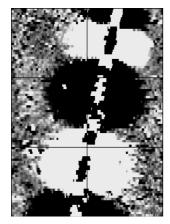
Silting and deliberate infilling of ditches and pits with magnetically enhanced soil creates a relative contrast against the much lower levels of magnetism within the subsoil into which the feature is cut. Systematic mapping of magnetic anomalies will produce linear and discrete areas of enhancement allowing assessment and characterisation of subsurface features. Material such as subsoil and non-magnetic bedrock used to create former earthworks and walls may be mapped as areas of lower enhancement compared to surrounding soils.

Magnetic survey is carried out using a fluxgate gradiometer which is a passive instrument consisting of two sensors mounted vertically either 0.5 or 1m apart. The instrument is carried about 30cm above the ground surface and the top sensor measures the Earth's magnetic field whilst the lower sensor measures the same field but is also more affected by any localised buried field. The difference between the two sensors will relate to the strength of a magnetic field created by a buried feature, if no field is present the difference will be close to zero as the magnetic field measured by both sensors will be the same.

Factors affecting the magnetic survey may include soil type, local geology, previous human activity, disturbance from modern services etc.

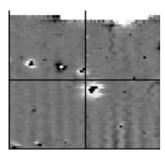
# APPENDIX B - Glossary of magnetic anomalies

# Bipolar



A bipolar anomaly is one that is composed of both a positive response and a negative response. It can be made up of any number of positive responses and negative responses. For example a pipeline consisting of alternating positive and negative anomalies is said to be bipolar. See also dipolar which has only one area of each polarity. The interpretation of the anomaly will depend on the magnitude of the magnetic field strength. A weak response may be caused by a clay field drain while a strong response will probably be caused by a metallic service.

# **Dipolar**

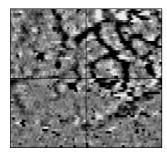


This consists of a single positive anomaly with an associated negative response. There should be no separation between the two polarities of response. These responses will be created by a single feature. The interpretation of the anomaly will depend on the magnitude of the magnetic measurements. A very strong anomaly is likely to be caused by a ferrous object.

#### Positive anomaly with associated negative response

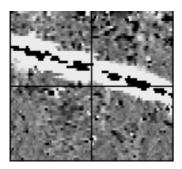
See bipolar and dipolar.

#### Positive linear



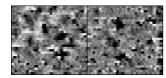
A linear response which is entirely positive in polarity. These are usually related to infilled cut features where the fill material is magnetically enhanced compared to the surrounding matrix. They can be caused by ditches of an archaeological origin, but also former field boundaries, ploughing activity and some may even have a natural origin.

# Positive linear anomaly with associated negative response



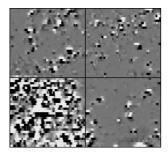
A positive linear anomaly which has a negative anomaly located adjacently. This will be caused by a single feature. In the example shown this is likely to be a single length of wire/cable probably relating to a modern service. Magnetically weaker responses may relate to earthwork style features and field boundaries.

#### Positive point/area



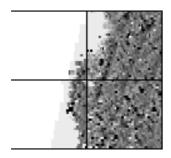
These are generally spatially small responses, perhaps covering just 3 or 4 reading nodes. They are entirely positive in polarity. Similar to positive linear anomalies they are generally caused by infilled cut features. These include pits of an archaeological origin, possible tree bowls or other naturally occurring depressions in the ground.

# Magnetic debris



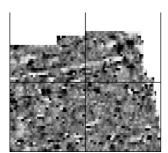
Magnetic debris consists of numerous dipolar responses spread over an area. If the amplitude of response is low (+/-3nT) then the origin is likely to represent general ground disturbance with no clear cause, it may be related to something as simple as an area of dug or mixed earth. A stronger anomaly (+/-250nT) is more indicative of a spread of ferrous debris. Moderately strong anomalies may be the result of a spread of thermoremnant remnant material such as bricks or ash.

# Magnetic disturbance



Magnetic disturbance is high amplitude and can be composed of either a bipolar anomaly, or a single polarity response. It is essentially associated with magnetic interference from modern ferrous structures such as fencing, vehicles or buildings, and as a result is commonly found around the perimeter of a site near to boundary fences.

# **Negative linear**

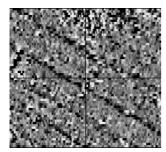


A linear response which is entirely negative in polarity. These are generally caused by earthen banks where material with a lower magnetic magnitude relative the background top soil is built up. See also ploughing activity.

#### Negative point/area

Opposite to positive point anomalies these responses may be caused by raised areas or earthen banks. These could be of an archaeological origin or may have a natural origin.

### Ploughing activity



Ploughing activity can often be visualised by a series of parallel linear anomalies. These can be of either positive polarity or negative polarity depending on site specifics. It can be difficult to distinguish between ancient ploughing and more modern ploughing, clues such as the separation of each linear, straightness, strength of response and cross cutting relationships can be used to aid this, although none of these can be guaranteed to differentiate between different phases of activity.

#### **Polarity**

Term used to describe the measurement of the magnetic response. An anomaly can have a positive polarity (values above 0nT) and/or a negative polarity (values below 0nT).

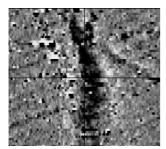
#### **Strength of response**

The amplitude of a magnetic response is an important factor in assigning an interpretation to a particular anomaly. For example a positive anomaly covering a  $10\text{m}^2$  area may have values up to around 3000nT, in which case it is likely to be caused by modern magnetic interference. However, the same size and shaped anomaly but with values up to only 4nT may have a natural origin. Trace plots are used to show the amplitude of response.

#### Thermoremnant response

A feature which has been subject to heat may result in it acquiring a magnetic field. This can be anything up to approximately +/-100 nT in value. These features include clay fired drains, brick, bonfires, kilns, hearths and even pottery. If the heat application has occurred insitu (e.g. a kiln) then the response is likely to be bipolar compared to if the heated objects have been disturbed and moved relative to each other, in which case they are more likely to take an irregular form and may display a debris style response (e.g. ash).

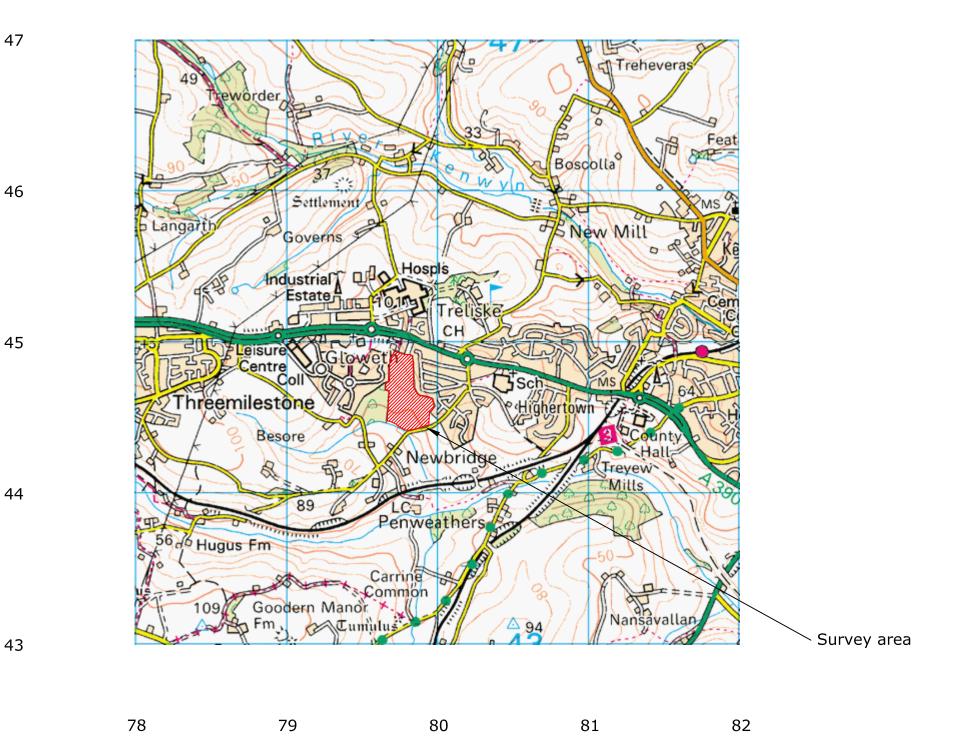
# Weak background variations



Weakly magnetic wide scale variations within the data can sometimes be seen within sites. These usually have no specific structure but can often appear curvy and sinuous in form. They are likely to be the result of natural features, such as soil creep, dried up (or seasonal) streams. They can also be caused by changes in the underlying geology or soil type which may contain unpredictable distributions of magnetic minerals, and are usually apparent in several locations across a site.

Reproduced from Ordnance Survey's 1:25 000 map of 1998 with the permission of the controller of Her Majesty's Stationery Office. Crown Copyright reserved. Licence No: AL 50125A Licencee: Stratascan Ltd. Vineyard House Upper Hook Road Upton Upon Severn WR8 0SA

OS 100km square = SW





Issue No.	Date	Description			
-	-	-			
-	-	-			
-	Penzonce	Scotland  Classow  Newcastle  England  Class  Crimaly  Shiffield  Clincoln  Wales  O Temperature  A Mondatoria			
		Survey area			
		Jul vey alea			
Sito or	ntrod	on NGR			

Amendments

Site centred on NGR

SW 798 448

Client

EXETER ARCHAEOLOGY

Project Title Job No. 2386
GEOPHYSICAL SURVEY NEWBRIDGE LANE, GLOWETH, TRURO

Subject

LOCATION PLAN OF SURVEY AREA

# GEOPHYSICS FOR ARCHAEOLOGY

AND ENGINEERING VINEYARD HOUSE UPPER HOOK ROAD

UPTON UPON SEVERN UK WR8 0SA

T: +44 (0)1684 592266 F: +44 (0)1684 594142 E: info@stratascan.co.uk

<u> </u>								
www.stratascan.co.uk								
Scale	0m 5	00 1000m						
1:25 000								
Plot	Checked by	Issue No.						
A3	SAS	01						
Survey date	Drawn by	Figure No.						
SEPT 07	RAJS	01						

