Dunkeswell Abbey Geophysical Survey
May 2019

Southwest Geophysical and Flotation Services

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1.0 Introduction

Four surveys were carried out near to the site of Dunkeswell Abbey (Devon County Council Heritage Gateway number 1098253; Historic England List Entry Number 1009303) as part of a Community Heritage Project to explore the landscape around the Abbey ruins.

Between 2016 and 2018 an archaeological aerial investigation (formerly the National Mapping Programme or NMP) of the Blackdown Hills Area of Outstanding Natural Beauty was undertaken by AC archaeology and Devon County Council (https://www.devon.gov.uk/historicenvironment/the-devon-historic-environment-record/blackdown-hills-aim-project/). Based on this, three areas were selected for gradiometry (figs 1 & 2): Little Musgrove Farm (NGR 314100 110800), where the NMP evidence from LiDAR (figs 4 & 5) revealed a number of linear earthworks interpreted as Possible Medieval Field Systems (Devon HER ref MDV116063). These earthworks are also clearly visible in the field. Two further smaller gradiometry surveys were carried out in a field adjacent to Burnsome Forde (NGR 313900 110700) where the NMP LiDAR survey revealed a number of irregular and linear earthworks interpreted as Possible Furnace/Extractive site (Devon HER ref MDV54143).

A small resistivity survey was also carried out at Little Musgrove Farm (fig 3), targeted on some of the anomalies revealed in the gradiometry survey.

The purpose of the surveys was to detect any anomalies which might shed light on the nature of the earthworks and possibly any association with the Abbey, plus to detect anomalies not picked by the NMP evidence.

The surveys also provided an outreach opportunity for local members of the public who were instructed in the use of the gradiometer and resistivity meter.

The hamlet of Dunkeswell Abbey is situated at the foot of a steep valley, just over 2km south of the town of Hemyock in Devon (fig 1). The geology of the site is Diamicton Colluvium over a bedrock of Mercia Mudstone Group (British Geological Survey website www.bgs.ac.uk/discovering Geology/ geologyofbritain/viewer.html Accessed 3rd June 2019).

The work was carried out by GeoFlo – Southwest Geophysical and Flotation services assisted by local members of the public.

1.1 Equipment

Fluxgate gradiometer – Bartington Grad 601-2

The Bartington Grad 601-2 is a dual system gradiometer, a form of magnetometer. It comprises two sensor rods carried on a rigid frame, each sensor including two fluxgates aligned at 90° to each other, one set 1m above the other. It measures variations in the magnetic field between the two fluxgates, recorded in *nanoTesla* (nT) at each sampling point within a grid. The manufacturer claims a depth range of approximately three metres. The instrument is most effective when carried at a consistent height, not exceeding 0.3m above the ground.

Magnetometers are especially effective for discovering thoroughly decayed organic materials, such as those which accumulate in ditches and pits, and matter exposed to intensive firing, including industrial areas, hearths and larger ceramics. All of these are likely to give a positive magnetic response, sometimes with a negative halo, giving a dipolar effect. Non-igneous stone features, such as walls and banks, are usually perceived as negative anomalies against a background enhanced by decayed organics.

Resistivity meter – TR/CIA Resistance Meter

A twin probe array was used, with mobile probes at a fixed separation of 500mm and two remote probes of variable spacing. The meter range was 200 Ohm, and minimal filtration was employed to remove any effects of mains electrical earth currents. Resistivity meters work by measuring the resistance to the passing of an electrical current through the ground from one probe to another. Different buried components in the ground have different degrees of conductivity or resistance. Water is the best conductor in the soil so in effect the method is also dependent on the amount of moisture present. As a consequence it can be susceptible to geological and seasonal variations. It is effective in the identification of stone structural remains, organically rich deposits and cut linear features or large pits, where there is sufficient contrast between features and the surrounding buried environment.

Software – Geoscan Geoplot 3.00v

Geoplot 4.00 allows the presentation of data in four graphical forms: dot-density, grey scale, pattern and X-Y (or *trace*) plots. The latter are particularly effective when used in conjunction with other graphical modes to emphasise ferrous magnetic anomalies or other distortions which show as accentuated peaks or troughs. The programme supports statistical analysis and filtering of the data.

1.2 Field method

The survey areas were divided into 20m squares orientated according to existing field boundaries and tied into the OS grid post survey (figs 2 & 3).

1.2(i) *Little Musgrove Farm gradiometry*: Readings were logged at 0.25m intervals along northeast to southwest traverses set 1m apart, in a zig zag pattern.

1.2(ii) *Little Musgrove Farm resistivity*: Readings were logged at 1m intervals along northwest to southeast traverses set 1m apart, in a zig zag pattern.

1.2(iii) *Burnsome Forde East gradiometry*: Readings were logged at 0.25m intervals along northeast to southwest traverses set 1m apart in a zig zag pattern.

1.2(iv) *Burnsome Forde North gradiometry*: Readings were logged at 0.25m intervals along northwest to southeast traverses set 1m apart in a zig zag pattern.

1.3 Gradiometer processing method

1.3(i) Little Musgrove Farm. Preliminary processing revealed some impact from ferrous magnetic features, characterised by sharp dipolar fluctuations ranging from approximately 30nT to over 3000nT. The first two processing sequences were carried out to mitigate the impact of modern ironwork

1. Readings exceeding 30nT either side of 0 were replaced by null (dummy) entries.
2. Any anomalous isolated readings were similarly replaced.
3. Typical regular error due to the zig zag operation of the gradiometer was removed.
4. The mean reading for every traverse was reset to 0.
5. The asymmetric data collection pattern was mitigated by the positive interpolation of data points along the Y axis using the calculation of sin(x)/x.

1.3(ii) Burnsome Forde. Preliminary processing revealed extensive impact from ferrous magnetic features, characterised by sharp dipolar fluctuations ranging from approximately 50nT to over 3000nT. The normal processing sequence would require these replacing with null (dummy) entries to avoid problems with subsequent processing functions designed to accentuate weaker archaeological responses. However this survey has detected significant ferrous magnetic anomalies which when considering the interpretation of this area as a possible Furnace/Extractive site (fig 5) necessitates modification of the normal processing sequence.

1. Typical regular error due to the zig zag operation of the gradiometer was removed.
2. The asymmetric data collection pattern was mitigated by the positive interpolation of data points along the Y axis using the calculation of sin(x)/x.

1.4 Resistivity processing method

1. Isolated high or low readings (noise spikes) were replaced by the mean reading.
2. The impact of geological variation was reduced by the application of a uniform high pass filter with a radius of 8 readings in the X and Y directions.
3. Data were smoothed and weak anomalies highlighted by the application of a low pass filter with a radius of 1 reading in the X and Y directions.
4. Further smoothing was achieved by the positive interpolation of data points along the Y and X axes, using the calculation of sin(x)/x.

2.0 The survey area

2.1 Gradiometry

2.1(i) Little Musgrove Farm *(figs 2 & 8)**:*** The grid comprises 40 contiguous whole and partial squares covering the whole of the field situated immediately to the north of the farm. Visible ferrous magnetic interference was provided by wire fencing in the hedges and an electricity supply pole (**Z**, fig 8). The survey area covered approximately 1.5 ha.

2.1(ii) Burnsome Forde East *(figs 2 & 14):* The grid comprises 2 contiguous whole and partial squares in a small field to the east of Burnsome Forde's garden at the foot of a steep slope to the north. Visible ferrous magnetic interference was provided by wire fencing in the hedge.

2.1(iii) Burnsome Forde North *(figs 2 & 14):* The grid comprises 5 contiguous whole and partial squares in the field to the north of Burnsome Forde. Visible ferrous magnetic interference was provided by wire fencing in the hedge.

2.2 Resistivity

2.2(i) Little Musgrove Farm *(figs 3 & 11)**:*** The grid comprises 8 whole 20m squares in the centre of the field, targeted on an area of amorphous anomalies in the gradiometer results.

3.0 Little Musgrove Farm survey results

3.1 Little Musgrove Farm gradiometry survey (figs 6, 7 & 8)

The purpose of this survey was to detect any anomalies which might shed light on the nature of the earthworks and possibly any association with the Abbey, plus to detect anomalies not visible in the NMP LiDAR survey evidence (fig 4). The site has been interpreted as a Possible Medieval Field System (fig 5) and it is worth noting that Medieval buildings are often constructed from materials such as timber and clay. Results of gradiometry surveys of deserted Medieval sites can therefore be variable, as any buildings do not always provide sufficient contrast with the background geology. The presence of earthworks can also mask any underlying archaeological anomalies.

Although some anomalies are directly related to the visible earthworks, the results do not always reflect what can be seen above ground.

The survey results reveal a number of positive and negative linear anomalies, predominantly on a northwest – southeast alignment with coaxial northeast - southwest linears. There are other linears on differing alignments towards the southeast of the field. A comparison with the NMP LiDAR transcriptions (fig 15) reveals a correlation between the gradiometry results and some of the upstanding linear earthworks. There is also a correlation between the gradiometry results and some of the anomalies detected in the resistivity survey. For details on the correspondence between individual anomalies in both gradiometry and resistivity surveys see ***4.1*** and ***4.2*** below.

Several of the linears also correspond with an irregular field boundary on the 1905 OS map (fig 16) which no longer exists.

The gradiometry results also reveal a general scatter of non-linear anomalies across the survey area. A clipped colour plot (fig 7) shows the nature of the spread of this material, where readings higher than 5nT and lower than -5.0nT are included in the maximum and minimum red and blue colour bands. These readings are within the range for cut features containing for thermo remanent/ferrous magnetic material but they could also possibly be associated with modern agricultural practices.

Major anomalies are discussed below. For the comparison between the gradiometry results and the NMP LiDAR transcriptions, see fig 15.

3.1(i) Positive anomalies *(fig 8)*

A Irregular linear anomaly within a range of 4 to 9nT. Possibly associated with the field boundary. Corresponds with linear earthwork on the NMP LiDAR survey.

B Short, weak linear within a range of 2 to 4nT. Within normal range for a ditch/gully.

C Long linear anomaly within a range of 5 to 14nT. Within normal range for a ditch containing strongly thermo remanent residues. Aligns with earthworks on the NMP LiDAR survey.

D Short linear within a range of 5 to 8nT. Within normal range for a ditch containing organic and thermo remanent material. Alignment suggests an association with **E** and **F** below.

E Series of weak, parallel linear anomalies, generally within a range of 2 to 4nT. Alignment suggests a possible association with **D** and **F**. Appearance and readings suggest possible plough marks.

F Strong linear anomaly within a range of 6 to 9nT with possibly associated highly thermo remanent/ferrous magnetic deposit approximately half way along. Alignment suggests an association with **D,** and **F** appears to delineate the extent of **E** westward. Corresponds with earthwork on the NMP LiDAR survey and the former field division on the 1905 OS map (see fig 16).

G Intermittent linear trend, generally within a range of 2 to 5nT. Alignment suggests an association with major linear trend **H**.

H Diffuse and irregular linear anomaly within a range of 6 to 11nT. Within normal range for a ditch containing thermo remanent material. Alignment and location suggest an association with negative magnetic anomaly **b**. Corresponds with earthworks on the NMP LiDAR survey and a major bank and ditch clearly visible in the field.

I Irregular anomaly within a range of 3 to 6nT. Alignment suggests an association with **H**.

J Weak, diffuse linear trend generally within a range of 1 to 2nT. Possible continuation of **H**.

K Short, irregular linear within a range of 3 to 6nT. Possible association with major linear trend **H**.

L & M Irregular dipolar anomalies generally within a range of 7 to 24nT. Within the range for strongly thermo remanent/ferrous magnetic deposits. Alignment follows the predominant northwest – southeast trend. Possibly diffuse ditch fills.

N Short curvilinear anomaly within a range of 8 to 15nT. Within normal range for a ditch containing strongly thermo remanent deposits.

O Irregular linear trend within a range of 8 to 18nT. May possibly intersect with **G**. Partially corresponds with the former field division on the 1905 OS map (see fig 16).

P Linear anomaly running perpendicular to the dominant northwest – southeast linear trend. Within a range of 6 to 13nT. Within normal range for a ditch containing thermo remanent residues. Corresponds with earthworks on the NMP LiDAR survey.

Q Irregular dipolar anomalies within a range of 12 to 30+nT. Within the range for strongly thermo remanent and ferrous magnetic material, suggestive of concentrated anthropogenic activity or possibly demolition rubble. South-eastern anomaly in **Q** corresponds with earthworks on the NMP LiDAR survey and partially with one corner of the former field division on the 1905 OS map (see fig 16).

R Parallel linears generally within a range of 6 to 9nT but rising to as high as 28nT in places. Within normal range for ditches containing strongly thermo remanent/ferrous magnetic deposits. Corresponds with earthworks on the NMP LiDAR survey.

S & T Parallel linears within a range of 3 to 5nT. Within normal range for ditches containing organic and weakly thermo remanent residues. **S** and **T** run perpendicular to **R** suggesting an association which is supported by the NMP LiDAR survey. Possibly a discrete series of enclosures.

U Weak linear within a range of 1 to 4nT. Within normal range for a ditch/gully. Appears to intersect with **S** and **T** but the alignment of **U** does not respect these anomalies and follows the dominant northwest – southeast trend suggesting a possible different activity phase.

V & W Weak linear anomalies within a range of 1 to 3nT. Within normal range for a ditches/gullies containing organic fills. Location and alignment suggests a possible association with earthworks on the NMP LiDAR survey.

3.1(ii) Negative anomalies *(fig 8)*

a Diffuse and irregular linear anomaly within a range of -3 to -6nT. Alignment suggests an association with positive magnetic anomalies in **E**. Possibly could be bank material associated with an abrupt downhill slope to the southwest which was unsurveyable due to the steep incline.

b Irregular linear trend, generally within a range of -4 to -9nT. Alignment and location suggest an association with positive magnetic anomaly **H**. Corresponds with earthworks on the NMP LiDAR survey and a major bank clearly visible in the field.

c Short linear anomaly within a range of -2 to -4nT. Alignment and location suggests an association with **b**.

d & e Short linear anomalies on the same alignment within a range of -3 to -5nT. Within the range for ditches/gullies with stony fills.

f Long linear anomaly within a range of -2 to -9nT. Within normal range for a bank or stone filled ditch/gully. Corresponds with earthworks on the NMP LiDAR survey. Appears to be associated with the dominant northwest – southeast and northeast – southwest alignment.

g Weakly negative linear within a range of -2 to -3nT. Within normal range for a bank or stone filled ditch/gully. Corresponds with earthworks on the NMP LiDAR survey and aligns with the dominant northwest – southeast linear trend.

h Weakly negative linear within a range of -2 to -4nT. Within normal range for a bank or stone filled ditch/gully. Possible association with positive linear **U**.

3.2 Little Musgrove Farm resistivity survey *(figs 9, 10 & 11)*

The survey was sited on three areas of amorphous dipolar anomalies detected by the gradiometry survey (**L, M** and **Q**, fig 6). These areas were chosen because the gradiometry readings are within the range for thermo remanent/ferrous magnetic material and it was hoped that the resistivity survey might shed light upon the nature of these anomalies.

The resistivity survey has also detected a number of linear anomalies which correspond with the linears in the gradiometry results (fig 8) and the NMP LiDAR survey evidence (fig 5).

Areas of high and low resistance are shown in figs 9 & 10. Fig 11 highlights anomalies where the degree of confidence in them relating to identifiable archaeological features is higher.

Note: The readings below are after the use of a high pass filter enabling high and low resistance data to be expressed in a bipolar form.

3.2(i) Lower resistivity anomalies *(fig11)*

1 Linear anomaly, readings from -4 to -7 ohms. Within normal range for a ditch. Corresponds with positive magnetic anomaly **F**, earthwork on the NMP LiDAR survey and former field boundary on the 1905 OS map (fig 16).

2 Intermittent linear with readings from -3 to -6 ohms. Corresponds with negative magnetic anomalies **d** and **e**.

3 Long linear anomaly with readings from -4 to -8 ohms. Corresponds with negative magnetic anomaly **f** and earthwork on the NMP LiDAR survey.

4 Short linear anomaly, readings from -2 to -7 ohms. Within normal range for a ditch. Not detected by the gradiometry survey but could be masked by the strong dipolar anomalies in **M**.

5 Short, irregular linear with readings from -9 to -11 ohms. Within normal range for a ditch/cut feature. Location could suggest a possible association with high resistance anomaly **8** below.

3.2(ii) Higher resistivity anomalies *(fig 11)*

6 Linear anomaly with readings from 5 to 10 ohms. Within normal range for a bank, associated with low resistance anomaly **3**.

7 & 8 Amorphous anomalies with readings generally from 11 to 20 ohms. Within the range for deposits of buried stone/rubble. **8** corresponds with south-eastern area of positive magnetic anomaly **Q**.

4.0 Burnsome Forde gradiometry survey results

4.1 Burnsome Forde East (figs 12, 13 & 14)

The results are dominated by very strong dipolar anomalies with readings generally within a range of 20 – 60+nT. The landowner regularly comes across slag material in this area, particularly where the ground slopes steeply upwards to the north. Slag was also noted on the surface whilst carrying out the survey, plus the Lidar NMP Transcription (fig 5) interprets this area as a possible Furnace/Extractive site. This could explain the nature of the gradiometry readings.

4.2(i) Ferrous magnetic anomalies (fig 14)

A Irregular anomaly within a range of 16 to 45nT. Most likely to be partially caused by ferrous magnetic material in the field boundary but it is possible that it could also be due to the presence of slag material in the slope to the north.

B Parallel linears generally within a range of 10 to 43nT. Correspond with ditches noted whilst carrying out the survey.

4.2 Burnsome Forde North (figs 12, 13 & 14)

The survey has detected a number of dipolar linear anomalies, generally on an east – west alignment. Some of these correspond with the linears recorded on the NMP LiDAR survey (fig 4) and were clearly visible in the field whilst carrying out the survey. Readings towards the south of this area are particularly high, consistently rising to 3000nT. This area is located at the top of a sleep slope where similarly high readings were detected in ***3.2*** above and could possibly be due to concentrations of slag material, particularly when considering the interpretation of this area as a possible Furnace/Extractive site (fig 5).

4.2(i) Positive anomalies (fig 14)

C Irregular anomaly within a range of 5 to 12nT. Within normal range for a cut feature containing thermo remanent deposits. Interpretation is limited due to truncation by limit of survey.

D Short, irregular linear within a range of 5 to 9nT. Within normal range for a ditch/cut feature containing thermo remanent material.

E & F Parallel linears generally within a range of 7 to 13nT but rising to 27nT in places. Within normal range for a ditches containing strongly thermo remanent/ferrous magnetic material.

4.2(ii) Ferous magnetic anomalies (fig 14)

G Dipolar anomalies generally within a range of 20 to 50nT but frequently rising to 3000nT. Possible demolition rubble from a former building, Beancroft, shown on the 1905 OS map (fig 16).

H Parallel linear trend within a range of 20 to 3000nT indicating strongly thermo remanent and ferrous magnetic deposits.

I Parallel linears with readings consistently of 3000nT indicative of a high concentration of ferrous magnetic material. Corresponds with ditches clearly visible in the field and recorded on the NMP LiDAR survey.

5.0 Conclusion

The degree of confidence in identified anomalies is generally fairly high. The Little Musgrove Farm gradiometry and resistivity surveys have both detected linear anomalies, many of which correspond with the evidence from the NMP LiDAR survey and earthworks still visible in the field. Differences in alignments of some of these linears could suggest different phases of activity. There also areas where the groupings of dipolar anomalies in the gradiometry results and corresponding high resistance anomalies in the resistivity could suggest concentrated areas of anthropogenic activity or possibly building rubble.

It is not possible to say if any of these anomalies are contemporary with the Abbey itself, although the proximity of the field to the Abbey site would suggest an association.

The results for Burnsome Forde reveal a number of very strong linear dipolar anomalies with readings within the range for ferrous magnetic material. This supports the Devon HER interpretation of the area being a possible Furnace/Extractive site.

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Acknowledgements

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Fig 1: Location of surveys

Devon County Council OS Map Copying Licence Number: 100019783

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Location of surveys

0 500 metres 2000

Fig 2: Location of gradiometry surveys

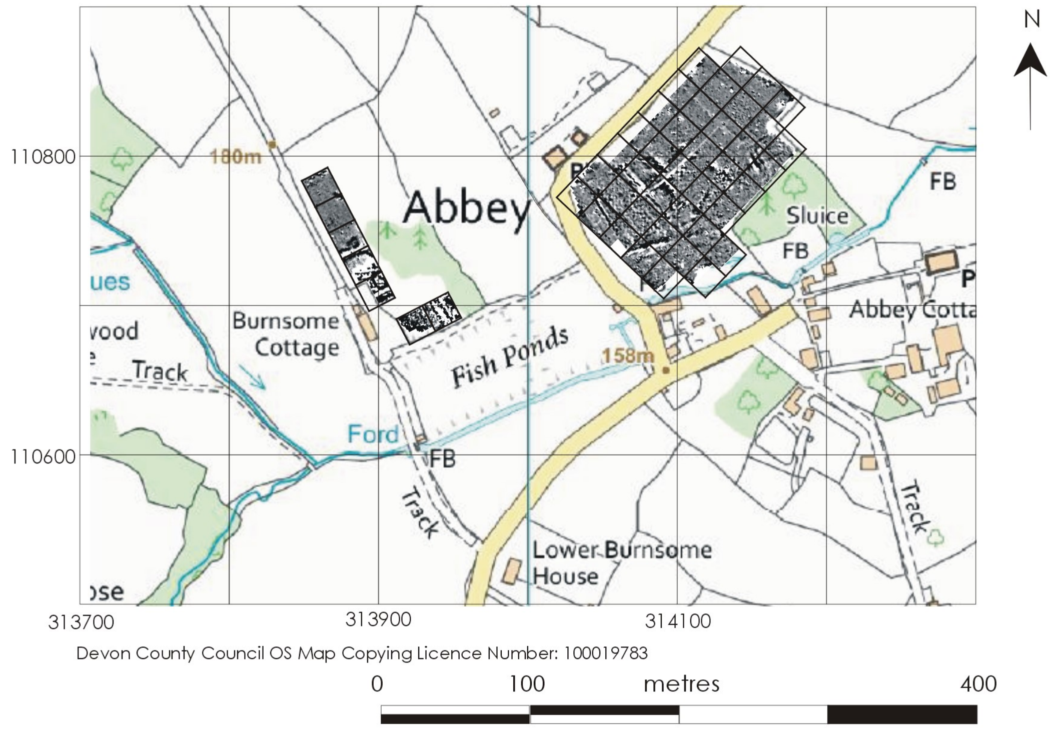

Fig 3: Location of resistivity survey

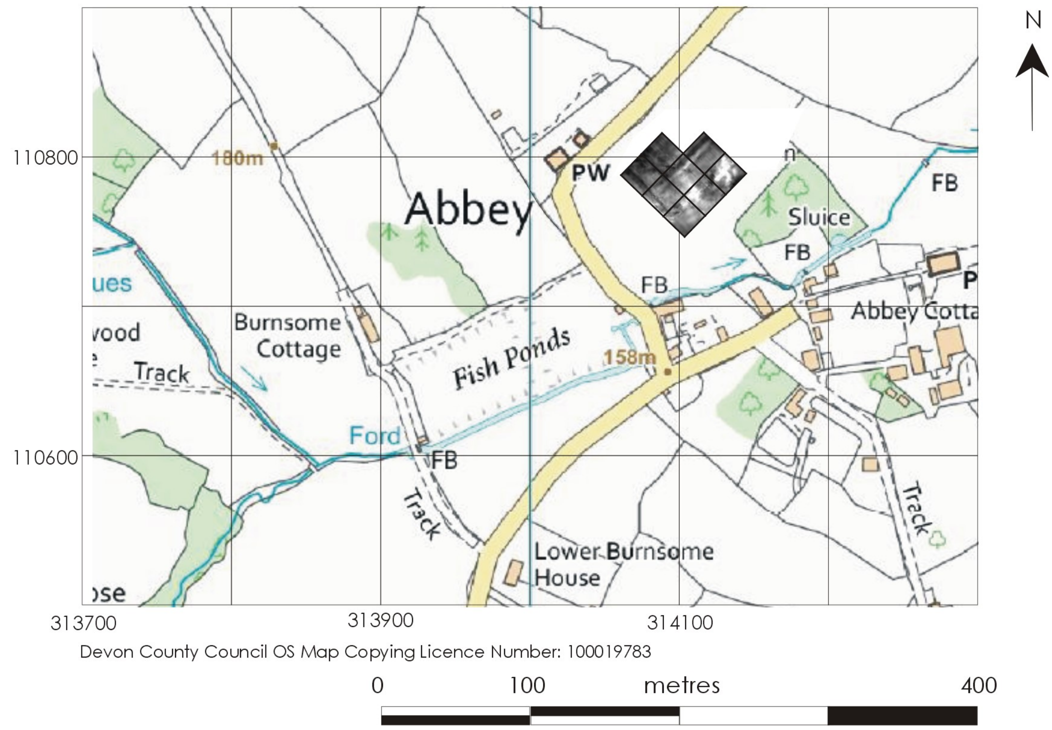

Fig 4: National Mapping Programme (NMP) LiDAR survey evidence

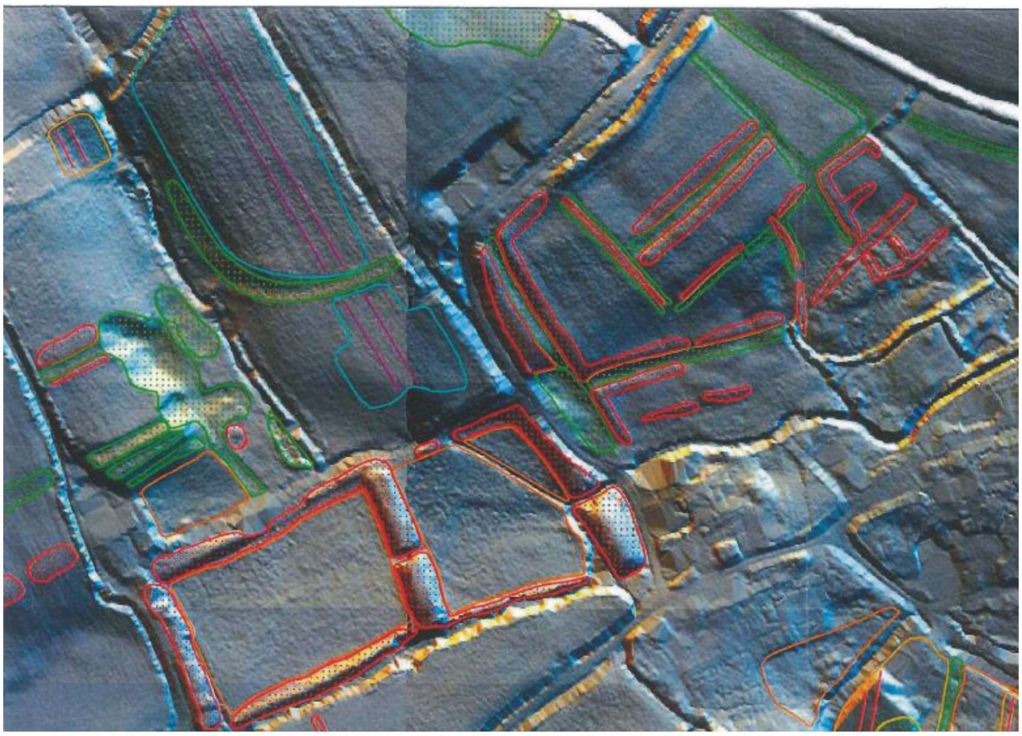

Fig 5: NMP transcriptions

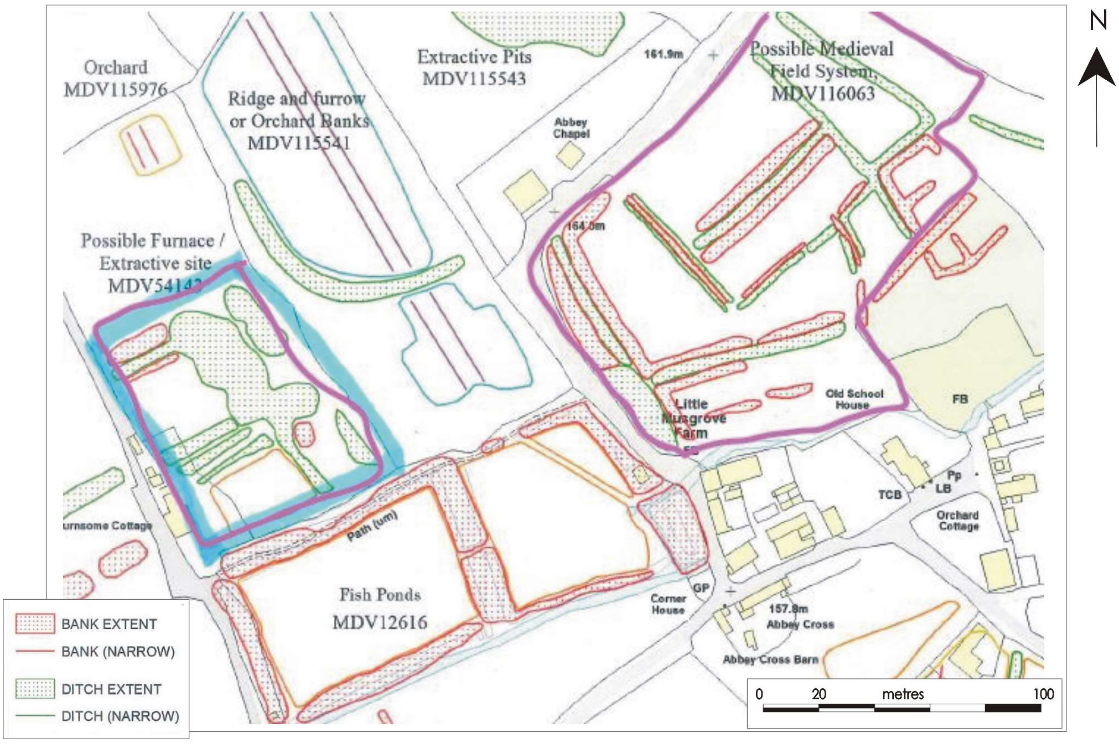

Fig 6: Little Musgrove Farm
gradiometry survey results

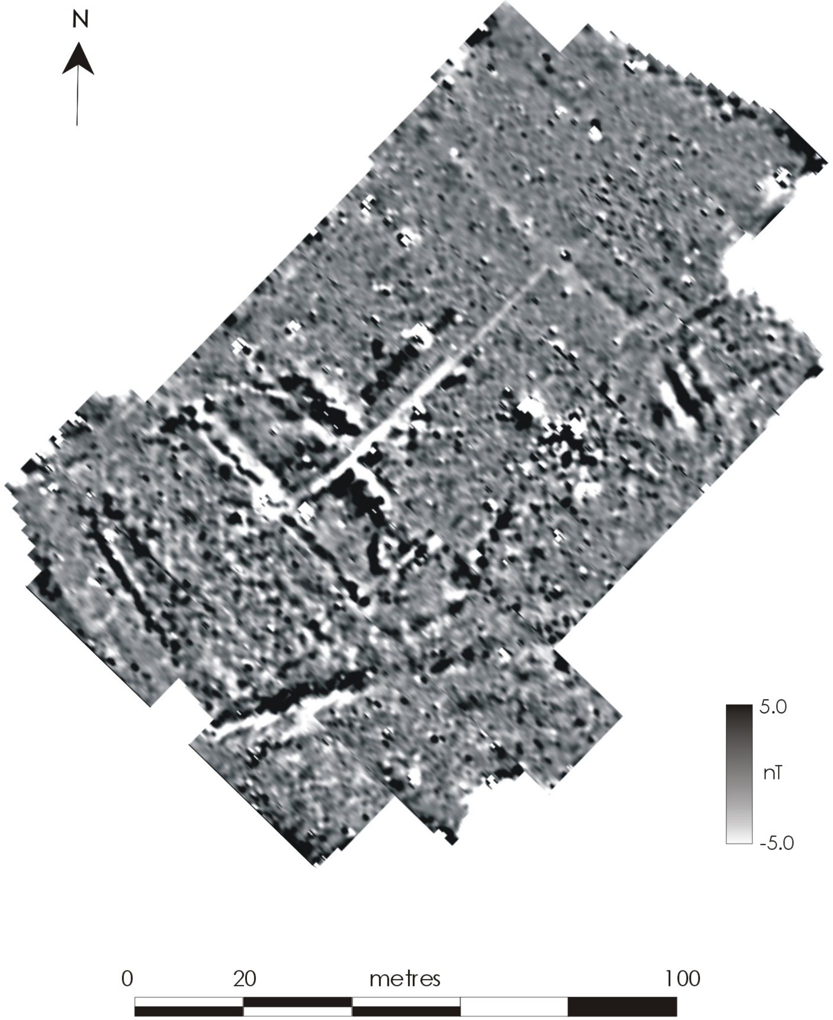

Fig 7: Little Musgrove Farm
highlighted gradiometry results

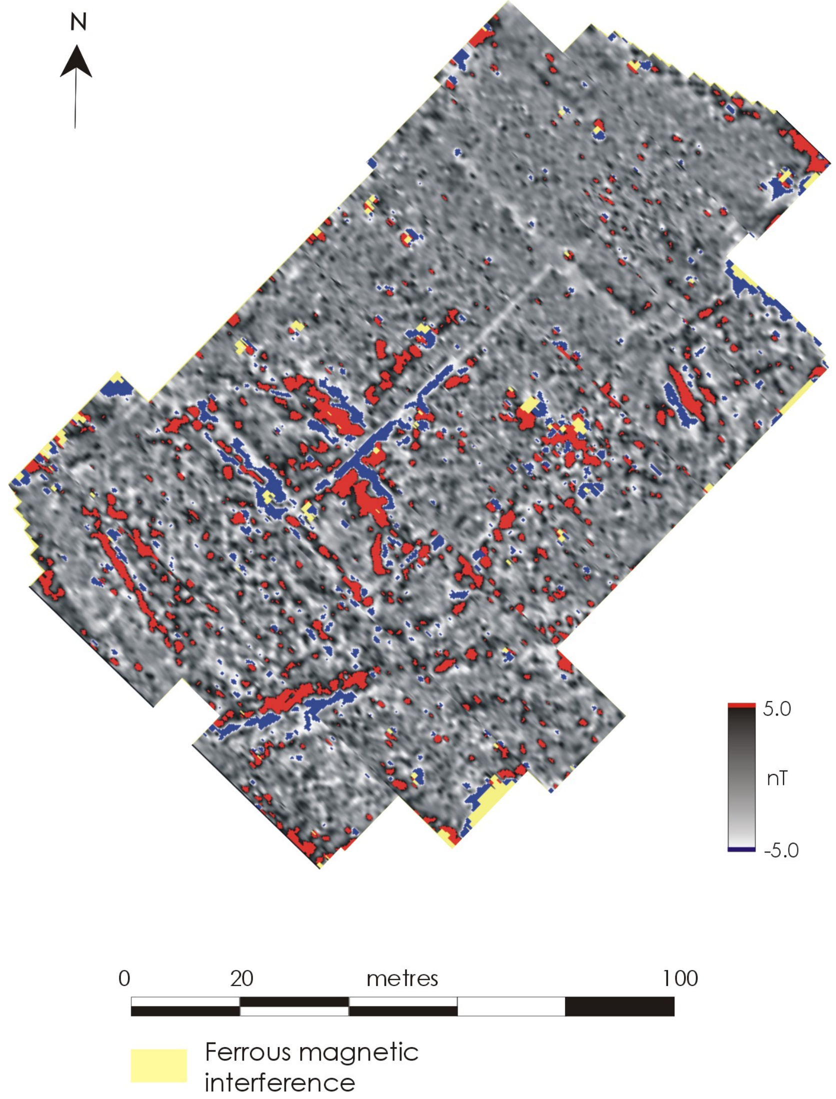

Fig 8: Little Musgrove Farm gradiometry interpretation

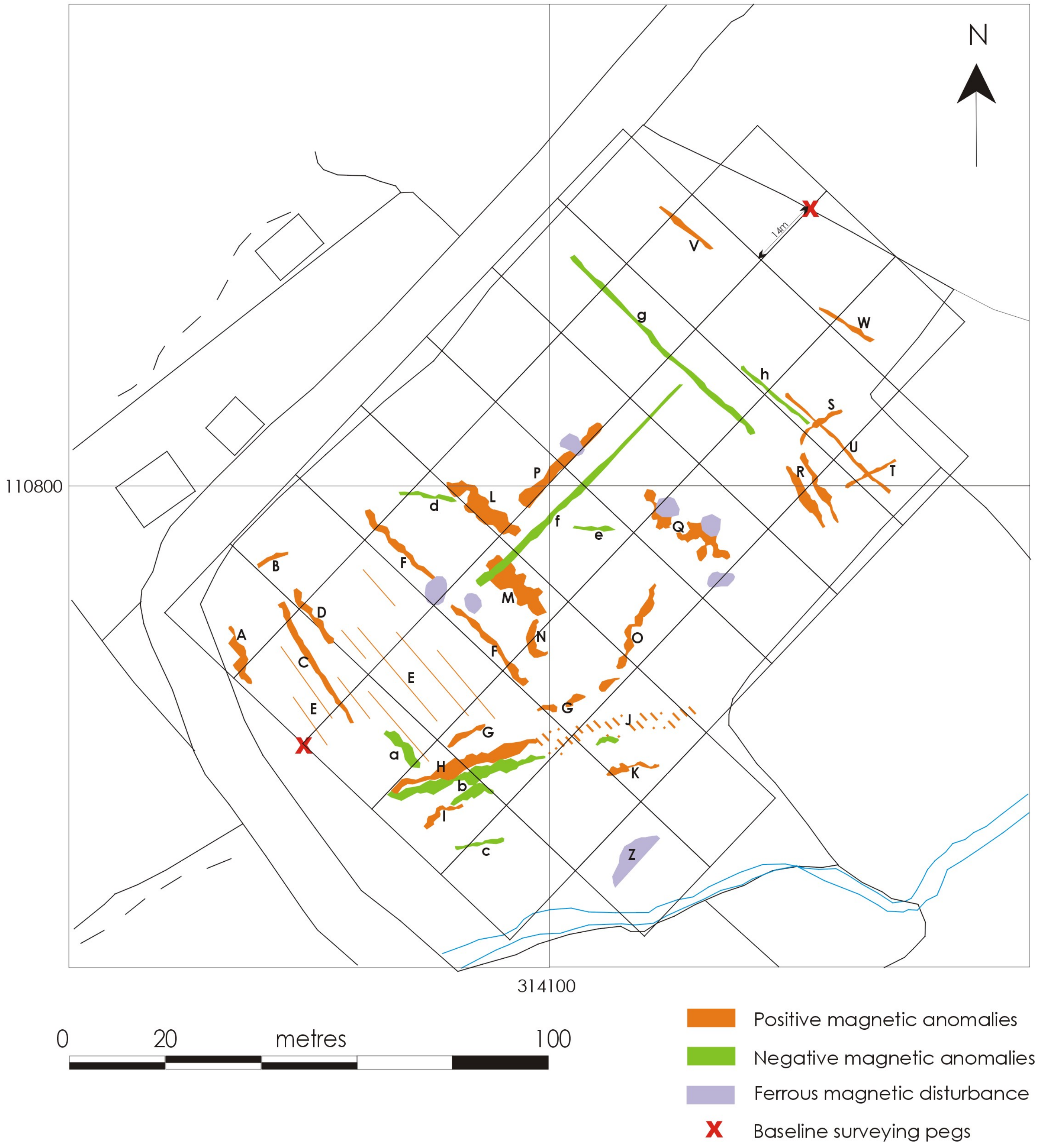

Fig 9: Little Musgrove Farm resistivity survey results

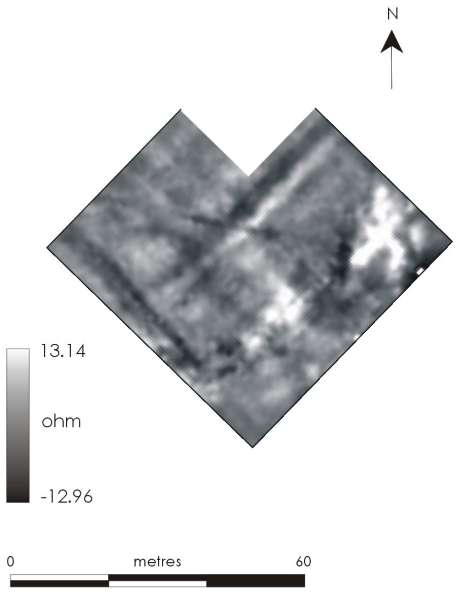

Fig 10: Little Musgrove Farm highlighted resistivity results

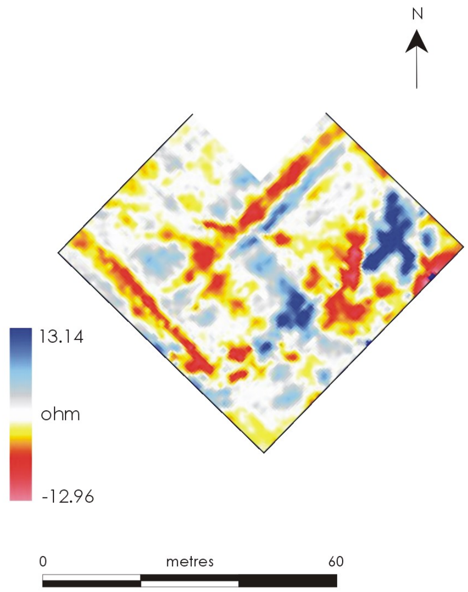

Fig 11: Little Musgrove Farm resistivity interpretation

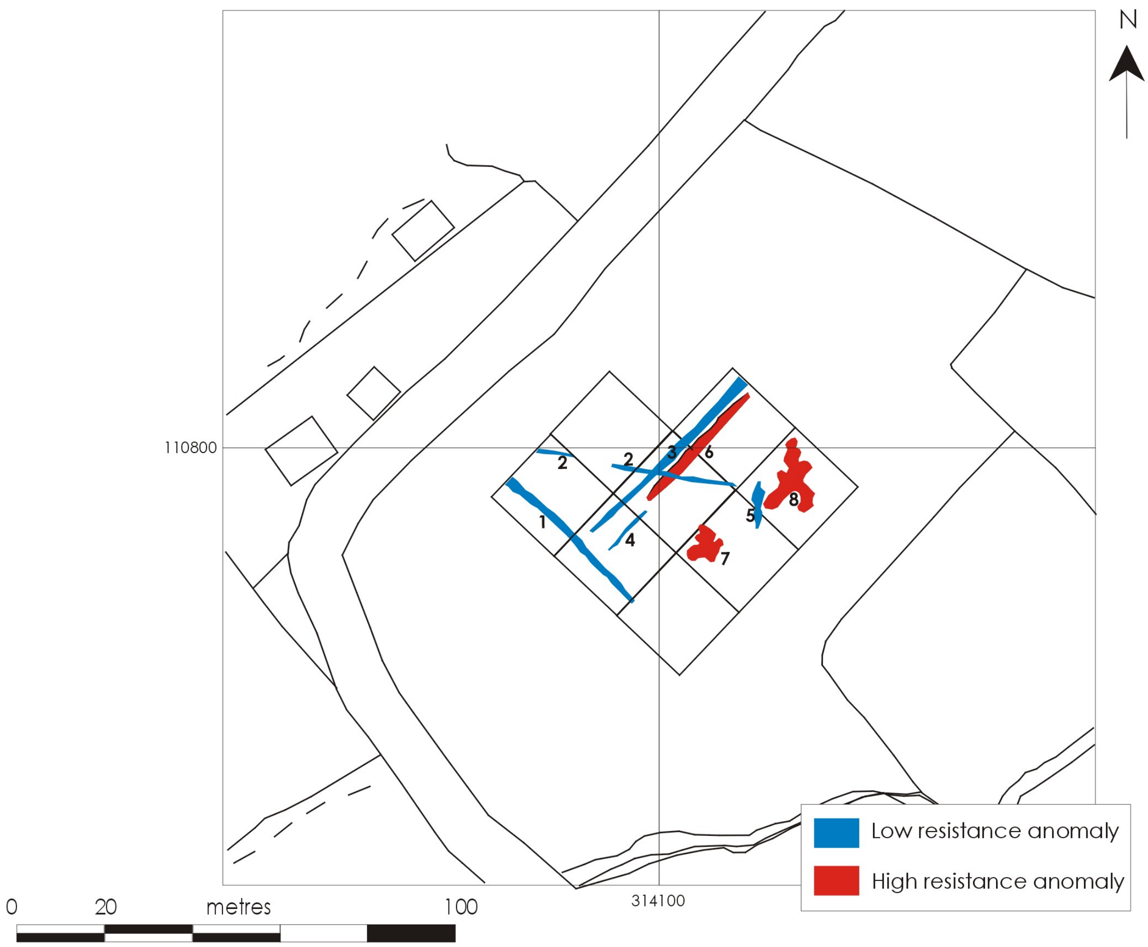

Fig 12: Burnsome Forde gradiometry survey results

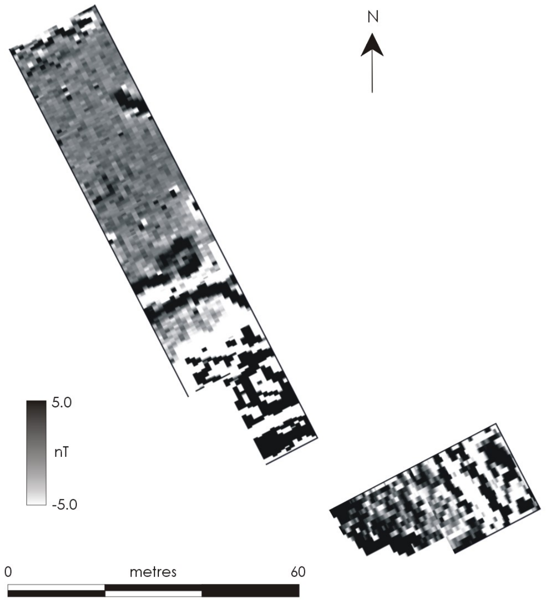

Fig 13: Burnsome Forde highlighted gradiometry results

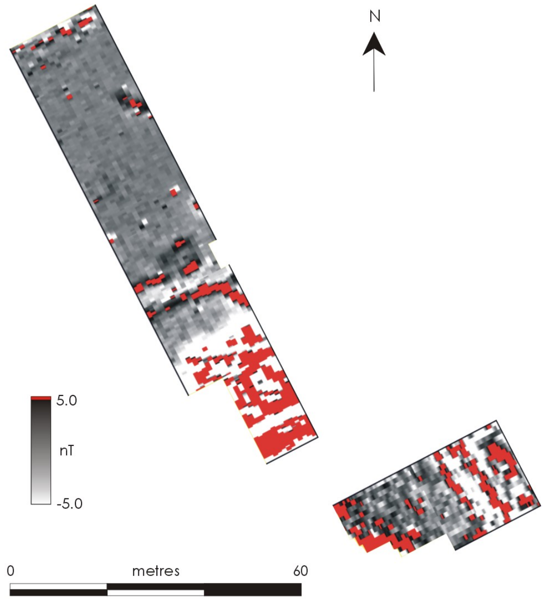

Fig 14: Burnsome Forde interpretation

Fig 15: Little Musgrove Farm NMP transcriptions with gradiometry results overlay

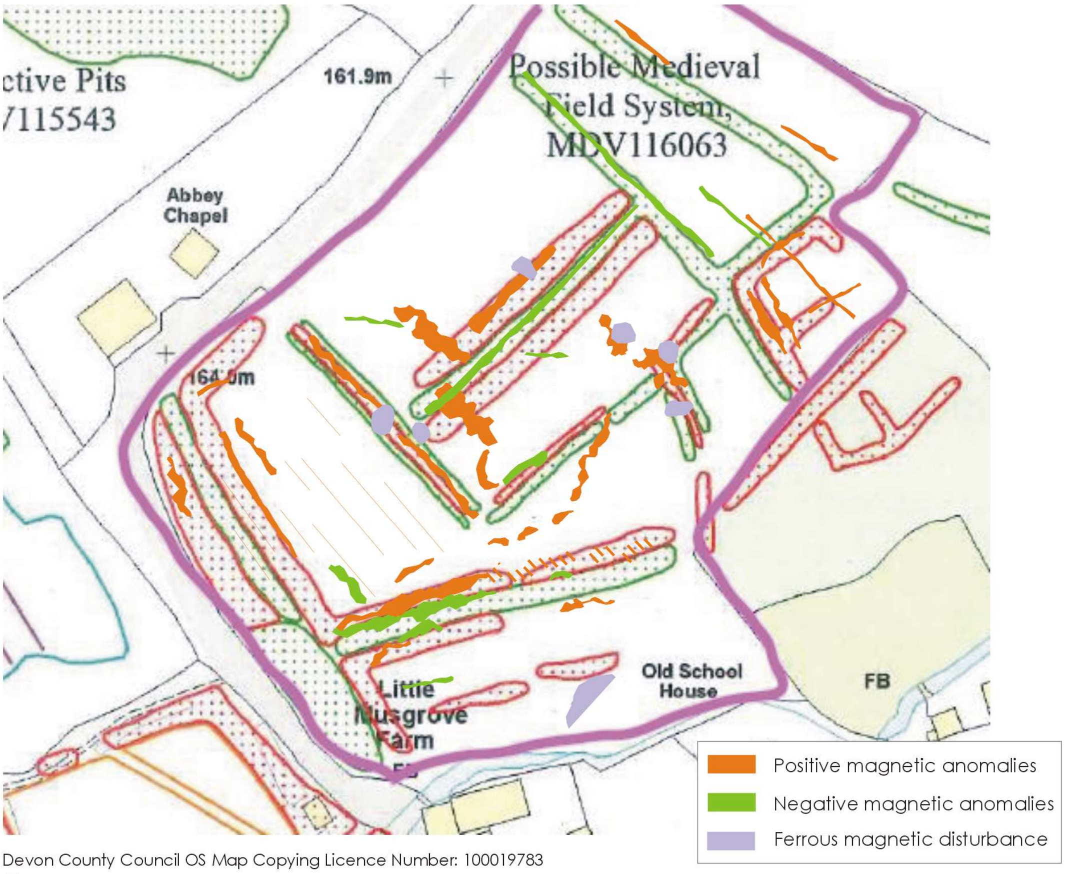

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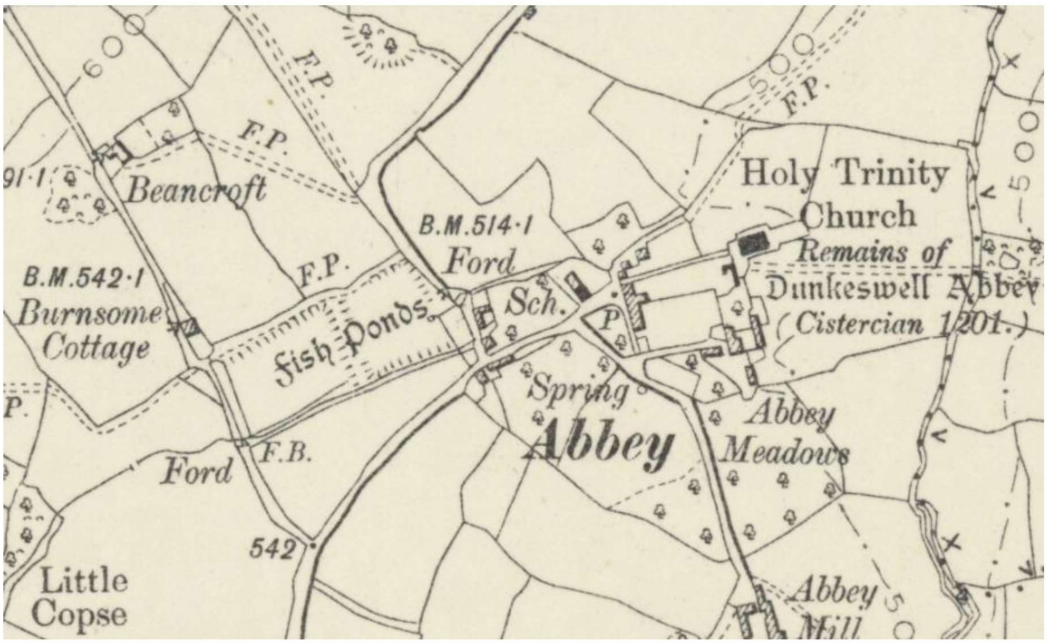
Fig 16: 1905 Ordnance Survey map



Https://maps.nls.uk/os/6inch-england-and-wales/

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