STRATASCAN

Geophysical Survey Report

Ditton, Widnes, Cheshire

for

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1. SUMMARY OF RESULTS

The geophysical survey undertaken over 49ha of land at Ditton, Cheshire has been successful in locating a number of anomalies of possible archaeological origin. A number of these represent features associated with the site of Lovel's Hall. However, areas of detailed gradiometry based on magnetic susceptibility results have identified a number of cut features that seem to predate Lovel's Hall and may add extra depth to the archaeological record in this area.

2. INTRODUCTION

2.1. Background synopsis

Stratascan were commissioned by Oxford Archaeology North to undertake a geophysical survey of an area outlined for development as a strategic freight park.

2.2. Site location

The site is located at Ditton near Widnes, Cheshire at OS ref. SJ 478 847.

2.3. Description of site

The survey area consists of approximately 49ha of undeveloped agricultural land. The underlying geology is undifferentiated Permian and Triassic sandstones (British Geological Survey Solid Geology Map, Fourth Edition, 2001). The overlying soils are classified as Salop soils which are a type of reddish till. These consist of slowly permeable seasonally waterlogged reddish fine loamy over clayey, fine loamy and clayey soils associated with fine loamy over clayey soils with slowly permeable subsoils and slight seasonal waterlogging (Soil Survey of England and Wales, Sheet 3 Middle and Western England).

2.4. Site history and archaeological potential

Roman and Medieval finds were recovered from the site during the nineteenth century increasing the potential for anomalies of archaeological origin to be found within the geophysical data. The survey area contains the scheduled ancient monument of Lovel's Hall which is believed to date to the mid 14th century (Mike Royden's Local History Pages- Lovel's Hall).

2.5. Survey objectives

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

2.6. Survey methods

The reconnaissance technique of magnetic susceptibility was employed over the survey area. Detailed gradiometry grids were targeted based on the results of this reconnaissance. Both detailed gradiometry and detailed resistance surveys were carried out over the site of Lovel's Hall.

3. METHODOLOGY

3.1. Date of fieldwork

The fieldwork was carried out over 11 days from the 24th April 2006 when the weather was sunny.

3.2. Grid locations

The location of the survey grids has been plotted in Figure 3.

3.3. Description of techniques and equipment configurations

3.3.1 *Magnetic Susceptibility*

Alteration of iron minerals in topsoil through biological activity and burning can enhance the magnetic susceptibility (MS) of that soil. Measuring the MS of a soil can therefore give a measure of past human activity and can be used to target the more intensive and higher resolution techniques of Magnetometry and Resistivity. Measurements of MS were carried out using a field coil which provides a rapid scan and has the benefit of allowing "insitu" readings to be taken.

The equipment used on this contract was an MS2 Magnetic Susceptibility meter manufactured by Bartington Instruments Ltd. A field coil known as an MS2D was used to take field readings. This assessed the top 200mm or so of topsoil. To overcome the problem of ground contact all readings were taken 4 or 5 times and an average taken. All obvious localised "spikes" were ignored.

3.3.2 *Magnetometer*

Although the changes in the magnetic field resulting from differing features in the soil are usually weak, changes as small as 0.2 nanoTesla (nT) in an overall field strength of 48,000nT, can be accurately detected using an appropriate instrument.

The mapping of the anomaly in a systematic manner will allow an estimate of the type of material present beneath the surface. Strong magnetic anomalies will be generated by buried iron-based objects or by kilns or hearths. More subtle anomalies such as pits and ditches can be seen if they contain more humic material which is normally rich in magnetic iron oxides when compared with the subsoil.

To illustrate this point, the cutting and subsequent silting or backfilling of a ditch may result in a larger volume of weakly magnetic material being accumulated in the trench compared to the undisturbed subsoil. A weak magnetic anomaly should therefore appear in plan along the line of the ditch.

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.

3.3.3 *Resistivity*

This method relies on the relative inability of soils (and objects within the soil) to conduct an electrical current which is passed through them. As resistivity is linked to moisture content, and therefore porosity, hard dense features such as rock will give a relatively high resistivity response, while features such as a ditch which retains moisture give a relatively low response.

The resistance meter used was an RM15 manufactured by Geoscan Research incorporating a mobile Twin Probe Array. The Twin Probes are separated by 0.5m and the associated remote probes were positioned approximately 15m outside the grid. The instrument uses an automatic data logger which permits the data to be recorded as the survey progresses for later downloading to a computer for processing and presentation.

Though the values being logged are actually resistances in ohms they are directly proportional to resistivity (ohm-metres) as the same probe configuration was used through-out.

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

3.4.1 *Sampling Interval*

Magnetic susceptibility
The magnetic susceptibility survey was carried out on a 20m grid with readings being taken at the node points.

Magnetometer
Readings were taken at 0.25m centres along traverses 1m apart. This equates to 3600 sampling points in a full 30m x 30m grid. All traverses are surveyed in a “parallel” rather than “zigzag” mode to avoid heading error.

Resistivity
Readings were taken at 1.0m centres along traverses 1.0m apart. This equates to 900 sampling points in a full 30m x 30 grid. All traverses were surveyed in a “zigzag” mode.

3.4.2 *Depth of scan and resolution*

Magnetic Susceptibility
The MS2D coil assesses the average MS of the soil within a hemisphere of radius 200mm. This equates to a volume of some 0.016m^3 and maximum depth of 200mm. As readings are only at 20m centres this results in a very coarse resolution but adequate to pick up trends in MS variations.

Magnetometer
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.

Resistivity
The 0.5m probe spacing of a twin probe array has a typical depth of penetration of 0.5m to 1.0m. The collection of data at 1m centres with a 0.5m probe spacing provides an appropriate methodology balancing cost and time with resolution.

3.4.3 *Data capture*

Magnetic susceptibility
The readings are logged manually on site, and then transferred to the office where they are entered into a computer and colour *Surfer* plots are produced.

Magnetometer and Resistance
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*

Magnetic susceptibility
No processing of the data has been undertaken.

Magnetometer
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 magnetometer data used in this report:

Zero mean grid	*Threshold = 0.25 std. dev.*
Zero mean traverse	*Last mean square fit = off*
Despike	*X radius = 1 Y radius = 1*
	Threshold = 3 std. dev.
	Spike replacement = mean

Resistivity
The processing was carried out using specialist software known as *Geoplot 3* and involved the 'despiking' of high contact resistance readings and the passing of the data though a high pass filter. This has the effect of removing the larger variations in the data often associated with geological features. The net effect is aimed at enhancing the archaeological or man-made anomalies contained in the data.

The following schedule shows the processing carried out on the processed resistance plots.

Despike	*X radius = 1*
	Y radius = 1
	Spike replacement
Low pass filter	*X radius = 10*
	Y radius = 1
	Weighting = Gaussian
Cut and Combine	

3.5.2 *Presentation of results and interpretation*

Magnetic susceptibility
The presentation of the data for this site involves a colour plot of the field measurements overlain onto a site plan (see Figure 2).

Magnetometer
The presentation of the data for each area involves a print-out of the raw data both as grey scale (Figures 5, 10, 15, 20, 25 and 30) and trace plots (Figures 6, 7, 11, 12, 16, 17, 21, 22, 26, 27, 31 and 32), together with a grey scale plot of the processed data (Figures 8, 13, 18, 23, 28 and 33). Magnetic anomalies have been identified and plotted onto the 'Abstraction and Interpretation of Anomalies' drawings for the site (Figures 9, 14, 19, 24, 29 and 34).

Resistivity
The presentation of the data for the site involves a print-out of the raw data as a grey scale plot (Figure 35), together with a grey scale plot of the processed data (Figure 36). Anomalies have been identified and plotted onto the ‘Abstraction and Interpretation of Anomalies’ drawing (Figure 37).

4. RESULTS

4.1. Magnetic Susceptibility

Areas of high and low magnetic susceptibility have been identified within the reconnaissance data. Detailed survey grids were positioned over areas of high magnetic susceptibility in order to investigate these areas of enhancement. Survey grids were also positioned over areas of low susceptibility to act as a control.

4.2. Detailed Magnetometry

4.2.1 *Area 1*

The gradiometer survey undertaken over Area 1 indicates that the high magnetic susceptibility readings were caused by 'made ground.' The high magnitude of the values in this area masks any archaeological features that may be present beneath this modern activity.

4.2.2 *Areas 2 and 6*

A positive linear anomaly bisects Area 2 running approximately east to west. This anomaly represents a cut feature of possible archaeological origin. Another positive linear anomaly of possible archaeological origin can be noted in the south eastern limits of this survey area. A discrete positive anomaly indicating a possible pit is also observed near this anomaly. Other positive linear anomalies are evident running northeast to southwest across this survey area. These indicate agricultural activity on the site in the form of ridge and furrow. An area of magnetic debris seen in the northeast of Area 2 provides evidence of ground disturbance.

A number of positive linear anomalies indicating cut features of possible archaeological origin can be noted in the southwestern limits of Area 6. A positive area anomaly is evident to the northeast of this area. This anomaly is likely to represent a cut feature and may be of an archaeological nature. An area of disturbance of unknown origin is evident to the northwest of this survey area.

4.2.3 *Areas 3 and 4*

The data collected from Area 3 is dominated by positive linear anomalies representing ridge and furrow. Areas of disturbance within this area have been caused by the close proximity of ferrous objects.

Positive linear anomalies can be noted in the southwestern limits of Area 4. These represent cut features of possible archaeological origin. Three discrete positive anomalies are evident spread across this area. These have been interpreted as pits and may be of an archaeological nature. Positive linear anomalies of an agricultural nature are evident running northeast to southwest through this survey area. Three bipolar anomalies, representing buried ferrous objects, are located in the centre of this survey area along with areas of magnetic disturbance.

4.2.4 *Areas 5 and 7*

The data in Area 5 is dominated by magnetic disturbance, probably caused by the demolition and or construction of buildings in the area. Positive linear anomalies representing agricultural activity can be noted to the east of this survey area.

Two positive linear anomalies join in Area 7 to form a right-angled feature. These anomalies represent a cut feature and may indicate the partial survival of a prehistoric enclosure. Further investigation is required in order to ascertain the nature of this anomaly. In close proximity to this ditch feature is a discrete positive anomaly. This has been interpreted as a pit of possible archaeological origin. An area of magnetic enhancement is evident to the western limits which may represent an area that has been exposed to burning.

4.2.4 *Area 8*

The ditches related to Lovel's Hall are represented in the gradiometer data as positive linear anomalies. Negative linear anomalies can also be noted relating to the former earthwork banks of the hall site. However, these are less prominent in the data compared with the positive anomalies.

A set of positive linear anomalies can be noted to the northwest of this survey area. These anomalies represent a set of parallel ditches that seem to relate to part of an enclosure (Image 1). A further set of parallel ditches, perhaps suggesting an avenue, extends from the enclosure towards the site of Lovel's Hall. Further investigation is required in order to fully understand the date and function of this feature.

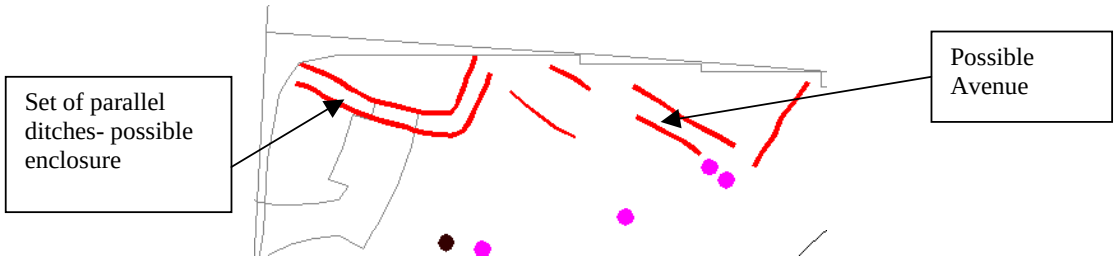


Image 1: Area 8. Set of parallel positive linear anomalies

Other positive linear anomalies are evident within this survey area, some of which may relate to defensive features of the Hall. Further investigation would be required in order to understand the dates of these ditches.

A number of discrete positive anomalies can be noted within and around the site of Lovel's Hall. These anomalies may indicate pits of archaeological origin.

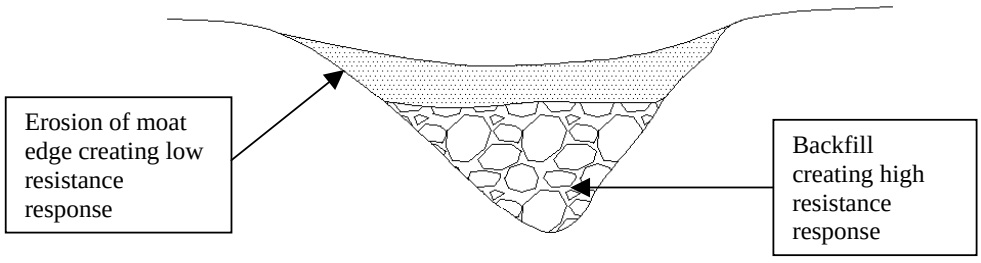
Positive linear anomalies representing agricultural activity are evident in this area. The two alignments of these agricultural marks may suggest separate phases of activity.

A modern pipe is evident cutting through the site of Lovel's Hall from north to south. The service's response within the data suggests that the pipe is made of plastic with regularly spaced ferrous joins. Another service is evident to the far west of Area 8 along with a possible land drain.

A large number of bipolar anomalies can be noted within this survey area. These represent buried ferrous objects and are likely to have a modern origin.

4.3. Detailed Resistivity

The data collected during the resistance survey is dominated by area anomalies. The ditch related to the hall is represented in the data by a high resistance area anomaly flanked by two low resistance area anomalies. This type of response is caused by the backfilling of the moat and erosion of the moat edges.



High resistance area anomalies are evident within the site of Lovel's Hall. These may relate to sub surface rubble or areas of compacted earth. Low resistance areas within the site of Lovel's Hall may represent the robbing out of former walls. A number of high resistance linear anomalies can be noted to the southwest of Lovel's Hall. These may indicate the presence of structural remains.

5. CONCLUSION

The geophysical survey undertaken at Ditton, Cheshire was successful in locating a number of anomalies of possible archaeological origin.

The reconnaissance survey highlighted a number of areas of enhanced magnetic susceptibility. These areas were then targeted with detailed gradiometry. The areas with the most archaeological potential, outside of Lovel's Hall are Areas 7, 6, 4 and 2. These areas all contain positive linear anomalies representing cut features of possible archaeological origin. In Area 7 two of these anomalies combine to create a right-angled feature which may indicate partial evidence for an enclosure of some sort. A similar feature can be noted in Area 8 where a set of parallel right-angled anomalies seems to suggest the presence of an enclosure in this area. Further investigation is required in order to ascertain a date for these features.

The site of Lovel's Hall is represented within the gradiometer data as positive linear anomalies indicating the cut of the moat. A number of other positive linear anomalies are evident in close proximity to the site of Lovel's Hall. Further investigation may ascertain as to whether these ditches relate to the defence of the Hall or if they had a different function or date entirely.

Discrete positive anomalies are evident within and around the site of Lovel's Hall. These anomalies have been interpreted as pits of possible archaeological origin.

The detailed resistance survey undertaken over the site of Lovel's Hall was dominated by area anomalies. High resistance anomalies correspond with positive linear anomalies in the gradiometer data. This indicates that the moat has been backfilled, possibly using the rubble from the Hall. Areas of high resistance within the earthworks indicate areas of possible structural remains or compacted earth. A number of high resistance linear anomalies represent the presence of possible structural remains to the southwest of the Hall site