



**A MAGNETIC AND RESISTANCE GEOPHYSICAL SURVEY AT  
NEWBURN FORD, NEWCASTLE UPON TYNE  
AUGUST 2004**

**1. PREFACE**

TimeScape Surveys were commissioned by Newburn Country Park (Client) to conduct magnetometry and resistivity geophysical survey at the suspected site of an English Civil War sconce (fig. 1). The purpose of the survey was to attempt to establish the location of one of the English sconces (defensive castramentations) occupied during the battle of Newburn Ford on 28<sup>th</sup> August 1640. In addition it was intended that volunteers attached to the Country Park would gain experience of geophysical survey techniques. This report presents both the results of the survey and some conclusions derived from the geophysical anomalies identified by the survey. Recommendations for further archaeological works are also outlined.



**Figure 1.** General survey area located at the lowest natural crossing point over the River Tyne. The positions of the Scottish and English forces are indicated, although this is speculative rather than established fact.

## 2. INTRODUCTION

The survey area (Figure 1) lies on the south bank of the river Tyne on Ryton Haugh (centred at NGR NZ 163 651) within an area defined as being of Archaeological Importance by virtue of being the location of the Battle of Newburn Ford, fought on 28<sup>th</sup> August 1640. The area currently lies at the junction of the parishes of Newburn, Blaydon and Ryton. Within the precise boundaries of the survey area there are no Scheduled Ancient Monuments, Listed Buildings or sites noted on the Sites and Monuments Register (SMR). However the area lies entirely within the boundaries of the battlefield of Newburn Ford, listed upon the Battlefield Register of English Heritage and within which lie a number of sites noted on the SMR including one of direct relevance to the battle.

Newburn is the first village upstream from Newcastle and its past is reflected in the early Norman church of St Michael and All Angels. Before the line of the Tyne was improved at this location it represented the lowest safest fording point on the river, of crucial importance in terms of the 1640 battle. It is not intended to detail the battle here, but within Appendix 1, an extract from a summary report of the battle is included (Speak 1997).

The exact form of the defensive systems, and indeed their locations, are so far uncertain. It is likely, given the short time available for their construction that the sconces would have been ephemeral in nature, possibly being no more sophisticated than a frontal ditch, with an earthwork, possibly supplemented with gabions or posts. In the intervening time and considering the intensive subsequent land usage, remains, if any, are likely to be slight.

## 3. EVALUATION OBJECTIVES

The archaeological evaluation comprised an initial archaeological assessment and site visit, which was followed by geophysical survey. The geophysical investigation comprised geophysical surveys (magnetometry and resistivity) supplemented by some mapping and limited topographical survey. Evidence was sought for the following: -

- ❖ To determine the nature and extent of any sub-surface archaeological features and determine if possible whether any of the remains of the English defensive system are present.
- ❖ To map features and sub-surface anomalies identified through geophysical prospection and if possible determine previous land usage. This evidence may include the location and nature of such activity together with structures, routeways, field boundaries and pits and ditches.
- ❖ To facilitate the location of trial-trenching (if required) within those areas determined to be archaeologically significant.
- ❖ To supplement the evidence from future targeted fieldwalking and metal detector studies.

- ❖ To produce and submit a suitable archive for the Client and the Sites and Monuments Record.

The purpose of the evaluation is to advise Newburn Country Park on the necessity of preservation of any archaeological deposits *in situ* or any mitigation measures which may be required to record important deposits prior to destruction. Recommendations to this effect will be made in the report for the work.

#### 4. LOCATION OF THE SURVEY AND GEOLOGY

The survey location centred on NZ 163 651 O.D 8.0m was located south-west of Newburn Bridge some 20m from the top of the riverbank and included a maximal area of 1.7ha. Investigation of the 1859 Ordnance Survey map (Fig. 2) indicated that the field boundaries and the general course of the river had changed significantly compared to modern maps (fig. 3). However, in the region of the present northern bridge abutment, using as a datum point St. Michael's and All Angel's Church, an angle of 220° corresponds with the northern access to Newburn Ford as seen on the 1860 O.S. map.

Whether the 1859 map represents the route of the ford (and river) of some 220 years earlier is difficult to determine. Certainly some of the north-west sector of the survey area may have been lost due to river improvements. Set against this was the discovery of broad ridge and furrow, with a periodicity of 7-8m, located directly east of the survey area within the grounds of the University boathouse. This ridge and furrow, possibly medieval in origin, extended to within 50m of the southern bridge pier, and, by implication, ground nearby must have been present in 1640.

The geology is complex and has been discussed in detail elsewhere (see Speak; Appendix 1). Of immediate interest to the conduct of the survey is the fact that the area of the survey transect comprised alluvial deposits.

#### 5. METHODOLOGY

The survey was conducted over a period of three days in August 2004 during a period of warm, dry weather conditions, interspersed with some light rain. The grids (fig. 3) were set out parallel to the river using a Leica TC403L EDM, and the grids and other relevant mapping features recorded. The total area surveyed using magnetic and resistance surveys was nominally 1.7 hectares (magnetometry) and 0.7 hectares (resistivity). The setting-out and mapping data collected was superimposed upon Ordnance Survey base maps (fig. 3) at a scale of 1:5000. In common with most O.S. maps of the area some inherent errors were detected and a disparity of *c.* 2m was estimated between the base map and the data recorded by EDM.

A Geoscan FM36 fluxgate gradiometer was used to carry out a magnetometry survey employing 1.0m parallel traverses with 0.5m sample intervals. Automatic logging was

used and log zero drift was recorded at the completion of each grid when the instrument was re-calibrated. Instrument sensitivity was set at 0.1 nT/teslas.

Resistivity survey was employed using a Geoscan RM15 resistivity meter, using 1.0m sample intervals and 1.0m traverses, with a twin-probe electrode separation of 1.0m. 30m survey grids were employed for both geophysical surveys.

The geophysical survey data was computed and analysed using Geoplot 3 data processing software (Geoscan Research). Terramodel and Terravista mapping and digital terrain software (SpectraPrecision Software) was used to process the topographical data.

## **6. SURVEY RESULTS**

### **6.1 General Comments**

It must be stressed at this stage that geophysical survey techniques cannot distinguish between the different phases of archaeological deposits, and can only provide a composite image of all the features within an instrument's operating depth. A more detailed methodology is discussed within the Appendix.

### **6.2 General Geophysical Response and Data Processing**

The English Heritage guidelines on geophysical archaeological field evaluations (David 1995) relating to drift geology of clay and alluvial soils describe the magnetometry response as variable. In this location (and others within Northern England) the technique appeared to provide a satisfactory response (see Plate 1). The resistivity survey was probably completed during a period when conditions, including the net soil moisture deficit, were optimal for the method. These conditions produced acceptable and complementary results when compared to magnetometry survey. Magnetometry, relying as it does upon the clay mineral content of soil, would register rock outcrops as an apparent masonry. This may at times give ambivalent results where geological features approach the surface.

Resistivity (unusually) appeared to recognise some features (e.g. ridge and furrow) which are normally more easily characterised by magnetometry. Using both the resistivity and magnetometry data an anomaly plan was created and significant anomalies were indicated numerically and are referred to within the text. These plans should not be taken as interpretative plans, but rather represent features or anomalies of possible archaeological significance.

In order to fully appreciate the complexities of the site, the results in each instance were represented as grey scale clip plots. Where necessary, despiking or clip function was applied which effectively removes spurious or high amplitude data (i.e. in the case of magnetometry, iron spikes or the effects of ferrous pipelines). Care must be exercised in the application of this procedure so that genuine archaeological responses are not removed. The second stage in this processing procedure used deslope or zero

mean traverse function to eliminate drift problems. This data processing was followed by two essentially cosmetic processing applications, which were interpolation and low pass filter, both of which produce a smoothing effect, but do not enhance the original data.



**Plate 1.** This ditch in lowland Northumberland, possibly of early medieval origin and some 3m wide and 1.5m in depth, gave a positive magnetometry response of c. 5-10 $\eta$  Teslas. The site is not free draining and anaerobic conditions may have contributed to the response (due in part to bacterial action).

A factor associated with uneven ground is the distance from the land surface to the magnetometer. The strength of the magnetic response is proportional to the reciprocal of the distance cubed (i.e.  $1/D^3$ ). It follows that any readings taken upslope with a magnetometer will give a stronger response than those taken downslope. The differential effects of ploughing striations or more particularly vehicle tracks can create the illusionary effect of linear features. An additional factor, which may give erroneous results, is the presence of outcrops of igneous rock. A summary of the suitability of various techniques (magnetometry and resistivity) over differing geological conditions is summarised in the English Heritage Guidelines (David, 1995 Table 9).

The effect upon magnetometry of the Cheviot Massif is well documented and similar effects have also been observed close to the Whin Sill (Biggins *et al*, 1999). What is less easy to distinguish are the effects of relatively small glacial erratic boulder, such as andesite. The response from a football-sized boulder of andesite is identical to that measured from a large pit 1-2m in diameter. The effects of rocky outcrops can produce an effect with magnetometry which is superficially similar to features such as

roads or cobbles (see Plate 2). In this instance the absence of clay minerals gives a negative reading on the magnetometer.



**Plate 2.** This cobbled area, on a suspected Roman site, gave a slight negative response in a magnetometry survey. However, its location was only confirmed by complementary resistivity survey. Even so, until excavation was conducted, the amorphous and slight response could not be categorically identified as a feature of archaeological origin.

Magnetometry results were plotted as an overview using a grey scale clip plot superimposed upon an Ordnance Survey base map at a scale of 1:2500 (fig. 4). As a comparison the resistance survey was plotted as an overview at a scale of 1:2500 (fig. 5).

### 6.3 Magnetic Survey – Results and Interpretation (figs. 6 - 9)

Magnetic grey scale clip plots were plotted at a scale of 1:2000 (fig. 6). Relief plots (fig. 7) using different sun angles of  $0^\circ$  were useful in showing positive anomalies (possible ditches) in particular, although other sun angles were consulted in creating the anomaly plan. A trace plot, which enables the intensity of various responses to be readily visualised, was produced (figs. 8). This clipped variant, at  $\pm 20$  nteslas, enabled less intense responses to be observed without being saturated by the relatively few higher readings.

From these different methods of viewing the data a magnetometry anomaly plan (fig. 9) was constructed at a scale of 1:2500 to enable direct comparison with the grey scale plot.



**Plate 3.** Field drains comprising trenches filled with stone on marginal grazing land in Northumberland. The response detected from the magnetometry survey gave a slight linear negative reading, superficially similar to a masonry foundation. On the same site natural rock outcrops gave a more robust negative signal. Ceramic field drains give a much more intensive response and are usually recognisable as such.

Given that the land has been used for arable purposes the presence of ferrous material (i.e. horseshoes, ploughshares etc.) is likely to give distinct bipolar response. The effect of even levelled ridge and furrow is well known. Superficially these anomalies appeared to produce small rectangular or sub-rectangular entities. However, the effects of medieval cross ridge and furrow can produce anomalies with such a morphology, especially if later ploughing activities have obscured or removed some of the evidence. The apparent strength of the responses (compare to Plate 1) may be misleading and could be caused by natural processes which are explained in the next paragraph.

At this point it should be pointed out that features such as ditches and pits concentrate the effects of an accumulation of specific and non-specific anthropogenic material. Fermentation (REDOX reactions) in which soils subjected to a seasonal cycle of reducing (winter) followed by oxidising (summer) conditions demonstrate an enhanced topsoil magnetic susceptibility which may be responsible for some anomalies. Waterlogged soils can significantly enhance the magnetic response, possibly disproportionately relative to size. This process may well be (micro) biologically moderated and may cause bacterial magnetism in which abundant soil bacteria may lead to the enhancement of magnetic susceptibility through a number of mechanisms. One mechanism alters the pH/Eh of the soil environment and the other, anaerobic respiration, utilises  $\text{Fe}^{2+}$  as an electron acceptor. Both of these mechanisms may contribute to topsoil magnetic susceptibility, but tend to vary according to local soil conditions.

At first sight the magnetometry results gave the impression of an extremely disturbed and magnetically active survey area, particularly around the periphery of the field. Interpretation of this data was complicated by what is obviously a palimpsest of features, some of which are probably modern in origin. The very substantial anomalous band (1) close to the southern field boundary is probably derived from a gas main associated with the gas valve compound located to the west of the survey area (fig. 9).

Other areas of non-significant disturbance include a strip of made ground (or infill) leading towards one of the pylons (2). Parallel to this, and closer to the road are the typical white/black striations of a substantial pipe (3). The grids adjacent to the pylons are very markedly affected by the magnetic effects of these steel structures and were not surveyed. Even so the effects were detected some 20-30m distant.

A public right of way crosses the field leading towards Newburn Bridge. This path is not shown 1859 O.S. map, but does connect with an extant farm track, shown on both that and the modern map. The magnetic survey detected the track across the survey transect as a diffuse linear anomaly (4). Rights of way such as this often precede Acts of Enclosure boundaries and may indicate a path to an unknown fording point.

Set across this path were a number of possible pits (5) arranged as a prominent curvilinear arc subtending some 15m. It is possible that these pits may continue, initially towards the north and then west. Alternatively, a slight curvilinear positive anomaly (possible ditch) may form part of this complex. Whether this indicates a true ditch or a former palaeochannel is uncertain.

A large number of small circular bipolar responses together with less intense positive anomalies (innominate) were present over much of the transect, but appeared to be more prevalent north of the public footpath. In fields subject to constant intensive arable production, small bipolar responses tend to indicate spurious ferrous material, such as horse shoes, ploughshares and large bolts. On the possible site of a battle the response from an iron cannon ball would give a bipolar response. Lead or stone balls will not affect the magnetic response. The less intense positive responses may still indicate a small ferrous metal source, or ceramic materials such as bricks or genuine pits. It must be said that this field did not show much surface evidence of bricks or tiles. The effect of particularly the bipolar responses can be seen on the trace plot (fig. 8) as iron 'spikes', although the curvilinear feature (5) is well-represented.

#### **6.4 Resistance Survey - Results and Interpretation (figs. 10 - 13)**

##### **General Observations**

The resistivity results proved to be complementary to the magnetometry confirming the impression of an extremely disturbed survey area, which has seen significant relatively modern modification of the landscape.

In order to place the resistance anomalies in context they have been superimposed upon an Ordnance Survey base map, which shows their relationship with other topographical features (fig. 5). Resistivity results were also plotted as reverse palette

grey scale plots (fig. 9) at a scale of 1:2000. The relief plots (fig. 10), different sun angles and created a shade effect which can emphasise some features, particularly those with linear characteristics. The trace plot (fig. 11) enhances certain linear (and other) features, which can be observed as subtle, but distinct positive peaks and troughs on the trace (scale 1:2000). From these different methods of viewing the data a magnetometry anomaly plan (fig. 12) was constructed at a scale of 1:2500 to enable direct comparison with the grey scale plot. The anomaly plans, for resistance and magnetic survey, were also superimposed upon an O.S. database to present the data as an overview with the correct spatial alignment plan (fig. 13). This figure also indicated the composite anomaly plan for both geophysical survey methods.

What is immediately evident on the resistance survey is the distinctive parallel ploughing marks (fig. 10). The ridge appears as a white high resistance band, whilst the more moist furrow as a darker lower resistance band. The periodicity of 6-7m possibly may indicate medieval ridge and furrow, although later episodes of ridge and furrow are known to be found in the early 19<sup>th</sup> century (Bailey 1810). It is unusual, but not unknown, for resistance survey to indicate this feature more strongly than magnetic survey although exceptions do occur (see e.g. Biggins 2001). The recent modern ploughing striations, set upon the same alignment, but much narrower and less intense can just be seen on the magnetic survey (fig. 6 and particularly fig 7; sun angle 90°).

An amorphous high resistance area (7) was detected towards the western edge of the survey sector, but had no distinguishing morphological characteristics. A more intense low resistance linear feature (8), appeared to follow the track of a furrow, but then curved towards the south at its western terminus. This was located in lower ground and may merely indicate the path of least opposition for natural field drainage.

A more intense double parallel band of high resistance was noted (9). This was evident during the survey because of the increased difficulty in inserting the mobile probes and also presented as a slight ridge. This feature may represent a farm track and field boundary indicated on the 1859 O.S. map and now removed. Crossing this boundary was a short section of very high resistance response (10). This feature also crossed the present right of way track, which paradoxically showed as a linear low resistance anomaly (11). The short section of high resistance anomaly (10) also corresponded to the distinctive curvilinear line of 'pits' (5) detected by the magnetic survey. The significance of this conformity will be discussed later.

A broad, but diffuse linear high resistance anomaly (12) cut across the ridge and furrow on an approximate north south alignment. It is not known if this feature had any archaeological significance.

## 7. SUMMARY, DISCUSSION AND CONCLUSIONS

It is evident when both the resistivity and magnetometry survey are viewed together that the results are complementary, with some data being corroborated. Without the application of both geophysical survey methods it is unlikely that some of the anomalies would have been recognised and would not have been placed in context.

Some of the anomalies appear to be relatively modern (post-19<sup>th</sup> century) in origin, comprising in the main a series of ferrous and other pipes.

The results do not unambiguously show the presence of a defensive sconce which would have housed an English gun battery and a supporting body of troops. Hurriedly erected defensive works would not have stood the test of time, particularly on a field which has been subjected to intense agricultural activity.

The geophysical results and map analysis do indicate that it is possible that the land in the immediate area of the survey itself may have been extant at the time of the battle and remained relatively unaltered during the intervening time. If this is the case, the anomalies identified in the magnetic survey (5) and co-located corroborating evidence from the resistance survey (10), may indicate a defensive structure perhaps comprising a number of posts, possibly with an additional embankment. These features describe an arc set across a public footpath, which may have been an access route to a ford. If that is the case it would seem sensible to cover by fire this approach route and associated fording point.

Although the battlefield emplacements according to the SMR place the western sconce some 200m towards the south, this area is now largely covered by a modern factory. A prominent small earthwork, located south of the engineering works at 1620 6483, upon investigation, was thought to comprise shale, rather than the expected earthen bank, and should now be considered suspect as a possible sconce.

Many smaller anomalies were detected, possibly pits etc., which were not specifically identified or labelled. However, most did not have any characteristics or distribution pattern which could identify them as archaeologically significant. It should be noted that recent work by English Heritage has concluded by that up to 70% of non-specific anomalies detected by geophysical survey may be archaeologically significant (Dr. A. David - pers. comm.).

## 8. RECOMMENDATIONS

As part of the overall project design additional fieldwork was to be completed after the geophysical survey had been conducted. This follows a pattern recommended in an English Heritage publication of English Civil War battlefield archaeology (Harrington 2004). Although the surveys were far from conclusive this additional fieldwork may provide additional supportive information. It is therefore recommended that the following fieldwork be conducted.

- ❖ Intensive fieldwalking be conducted over the entire area of the field in which the survey was conducted where magnetometry and resistivity survey have indicated possible defensive features. Finds within this area should be accurately plotted using an EDM total station or GPS, and should be supervised by an experienced archaeologist.
- ❖ The fieldwalking project should be followed by survey with a team of trained metal detectorists. As with the fieldwalking this should be supervised by an

experienced archaeologist. Finds within this area should also be accurately plotted using an EDM total station or GPS.

- ❖ When the results are collated, it may be decided that excavation may be appropriate at any location identified by geophysical survey or artefact concentrations identified by fieldwalking and metal detecting. This work should not be conducted without consultation with the County Archaeologist.
- ❖ Within the wider sphere of the battlefield more work may be considered appropriate (e.g. fieldwalking). Maximal use of volunteers may be utilised in projects of this nature.
- ❖ The Client and the County Archaeologist, depending on the results, may also consider some form of publication (rather than 'grey' literature) may be appropriate, and even negative results may prove important. The report should include previous work (e.g. Speak 1997), shown as an appendix in this report.

## **9. PROJECT ARCHIVE**

Four appropriately bound hard (paper) copy of the complete document archive together with copy disks of any electromagnetically stored or processed data will be deposited with the Client and one with Tyne And Wear Sites and Monuments Records.

## **10. PUBLICITY, CONFIDENTIALITY AND COPYRIGHT**

- 10.1 Any publicity will be handled by the Client.
- 10.2 TimeScope Surveys will retain copyright of all documentary and photographic material under the Copyright Designs and Patent Act, 1988, although they will grant an exclusive licence to English Heritage in respect of this work.

## **11. STATEMENT OF INDEMNITY**

All statements and opinions presented in this report arising from the programme of investigation are offered in good faith and compiled according to professional standards. No responsibility can be accepted by the author of the report for any errors of fact or opinion resulting from data supplied by any third party, or for loss or other consequence arising from decisions or actions made upon the basis of facts or opinions expressed in any such report(s), howsoever such facts and opinions may have been derived.

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