A GEOPHYSICAL SURVEY AT CROSSGATES, NEAR SCARBOROUGH

REPORT

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A geophysical survey 1989

1.0: SUMMARY

This report describes the results of a geophysical survey of a 20 % sample of land scheduled for development at Crossgates, near Scarborough, North Yorkshire (Figure 1A), and their archaeological implications. Seven areas of differing topography and geology were examined by resistivity survey (Figure 2). The results indicate that the majority of the anomalies interpreted as manmade features lie in the areas of gravel spread to the north-west of the site. The geophysical anomalies have been interpreted within the framework of excavated evidence from the immediate locality, and from the area of the survey itself.

2.0: INTRODUCTION

In March 1989 Birmingham University Field Archaeology Unit (B.U.F.A.U.) were requested by Tussac Estates of Matlock, Derbyshire to undertake a 20% geophysical survey of land at Crossgates, near Scarborough, North Yorkshire, centred on NGR. TA 036830. The area has been periodically ploughed and is now under winter wheat. The site lies at the eastern end of the Vale of Pickering, 4 miles south of Scarborough (Figure 1A), on an area of glacial drift which fringes much of the northern and southern margins of the Vale (Figure 1B).

Evidence of Romano-British and Anglo-Saxon occupation on the site was discovered by small-scale archaeological excavations between 1966 and 1981, (Pye, 1983) and followed the exposure of similar remains during gravel extraction to the north and west of the site, between 1947 and 1965 (Rutter and Duke, 1958: Pye, 1976) (Figure 1C). Proposals to construct a business park in the area have refocussed attention on the proven archaeological importance of the site.

The purpose of the survey was to determine the extent, nature and survival of archaeological deposits, over 20% of the area to be affected by the proposed development. Seven areas were selected for survey to provide an extensive examination of the area subject to development, targetted both at areas of known settlement (Figure 10) (Areas 1,2 and 3), and areas not hitherto sampled by excavation (Areas 4,5,6 and 7) (Figure 2). Areas 1,2 and 3 were located on the gravel terrace to the north-west of the site, both in and immediately outside the area of a known Romano-British enclosure, to determine the extent of features outside the ditched area (Figure 10). Area 4 examined a lowlying area to the south west of the north field. In the south field three areas of higher ground (Areas 5,6 and 7), each on clay subsoil, were selected for survey.

3.0: THE SITE AND ITS SETTING

3.1: Geology and topography.

The survey area comprises two areas of high ground, one across the north west angle of the north field, the other covering most of the south field, separated from each other by a shallow valley aligned north east-south west (Figure 2). This relief was created towards the end of the last glaciation some 10,000-13,000 years ago. The south field and the south-east part of the north field comprise boulder clay deposited by an ice sheet which filled the Vale, whilst the gravel terrace over the north-west of the site was created by glacial meltwaters flowing down the Seamer and Deepdale valleys (Figure 1C). The same meltwaters probably formed the shallow valley which crosses the survey area, within which several individual channels are visible as surface features (Figure 2).

Towards the end of the Ice Age the lower parts of the survey area were probably covered with standing water: research connected with the Seamer Carr archaeological project has established a maximum water level in excess of 27m A.O.D. at Sweetbeck Farm (Cloutman, 1988,10) (Figure 1C). This was the margin of Lake Pickering. As the Vale gradually drained of post-glacial meltwaters some 10,000 years ago, standing water would have given way to reed swamp. The lower parts of the survey area probably remained marshy and unsuitable for agriculture until the 18th-century. Limited auguring suggests a considerable build-up of lacustrine silts above the boulder clay. The 18th-century enclosure of the open fields in this area saw the imposition of man-made drainage, and the cutting of the stream to the east of the two fields drained the lowest parts of the valley (Figure 2).

3.2: Settlement history

Among the earliest traces of human activity in the North of England are

Upper Paleolithic flint assemblages discovered at Seamer Carr and Flixton Carr (Spratt, 1982,10) which suggest visits by hunting parties to the margins of Lake Pickering around 12,000 years ago (Figure 1C). Approximately two thousand years later the same lake margins were being exploited by Mesolithic communities whose camps have been excavated at Seamer Carr and Starr Carr (Spratt, 1982,102).

Flint artifacts of the Neolithic and Bronze Age were revealed as a result of excavations in the Crossgates gravel pits, (Rutter and Duke, 1958, 62) and Late Neolithic pottery has been recovered from Manham Hill, (Spratt, 1982,254), indicating the location of a settlement some 4,000 years old. This evidence is paralleled by discoveries during the Seamer Carr project, which revealed prehistoric occupation on the nearby Hopper Hill and Rabbit Hill (Figure 1C).

Discoveries made in the survey area and in the adjoining gravel quarries comprise the main evidence for Romano-British and Anglo-Saxon settlement in the Seamer district. The earliest Romano-British feature is a sub-rectangular enclosure of the 1st Century AD. It was mostly destroyed by the quarry, but part still survives in the north-west corner of the survey area (Figure 10). The exact function of this enclosure has not been established by the small-scale excavations so far conducted. Originally interpreted as a small fort connected with the Roman advance into the North in 71 AD (Rutter and Duke, 1958,62-63), it has since been re-interpreted by Ramm (1978,77) as a farm or stock enclosure, similar in form to other earthworks in the region. However, the site posesses more formidable ditches than other comprable enclosures which, together with the discovery of a sword suggests a military connection.

Following abandonment of the enclosure the area continued to be occupied into the 4th Century. Several huts have been excavated in the gravel quarries and a possible field boundary ditch has beeen uncovered in the present survey area (Pye, 1983), (Figure 10). Later settlement in the 6th Century is evidenced by several open-air hearths and sunken-floor huts, which were uncovered in piecemeal fashion by the gravel quarrying.

Later Anglo-Saxon and Medieval settlement was probably located on or around the present day villages of Seamer, Irton and Cayton (Figure 1C). The survey area, and much of the surrounding terrain would have been part of the open fields attached to these villages. Crossing the south field is a shallow ditch aligned north-south, which may have marked a division within the medieval field system (Figure 2: Figure 10).

4.0: THE METHODOLOGY

4.1: Geophysics and archaeology

The main role of geophysical survey in archaeology lies in the rapid examination of large areas to pinpoint areas of human activity that may merit further archaeological investigation. In this instance a resistivity survey was considered to be the most appropriate technique of examination, given the ground conditions and nature of the features anticipated. Resisitivity surveying involves applying a small electrical current into the ground via metal electrodes, and measurement of the soil's resistance to the flow of electricity (Tite, 1972). Soils vary considerably in resistivity, depending on their content and wetness and thus detailed and accurate measurements of variation in ground resistance from place to place can detect quite subtle changes (anomalies) in the near subsurface which may be due to natural processes or manmade features, such as walls, ditches and pits. Water-retentive materials such as clay are of notably low resistivity, whilst stone walls and floors have a higher resistivity, due to their low water content which impedes the flow of electricity. Resistivity survey can be particularly successful on a well-drained subsoil such as the gravel that covers the north west part of the site, and in the recognition of features such as ditches, rough stone floors and pits. The technique cannot distinguish between differing soils of similar resistivity, and climatic conditions may cause the anomalies to reverse or disappear.

An alternative geophysical technique, using a magnetometer measures subtle variations in the soil's magnetic field intensity, and is at its best locating features that have acquired thermoremanent magnetism as a result of heating, such as hearths. The depth of investigation of this instrument is shallower than that of of the resistivity equipment employed, and may not have penetrated beneath the deep topsoil in the north west part of the survey area. Natural variations in the magnetic field within the boulder clay which covers the majority of the site could mask any manmade features located here.

All Geophysical methods of examination provide only an indirect method of site investigation. They are incapable of the same precision and complexity in interpretation as a direct method of examination such as excavation. Such a survey cannot be seen as an alternative to excavation, but as a preliminary stage in site evaluation.

4.2: Field techniques

An Atlas Copco SAS 300 Terrameter was used in conjunction with 0.5m and 1m dimension 4-electrode square arrays. The square array comprises a frame in which all four electrodes are positioned at the corners of a square. A 5 mA current from the terrameter was injected into the ground through two of the electrodes, the potential difference, or ground resistivity, being measured in Ohm Metres across the second pair. The effective depth of investigation depends on ground conditions, and the separation of the electrodes: around 0.25m for the 0.5m array, and 0.45m for the 1m array (Edwards, 1977).

Measurements of resistivity were obtained by inserting the four basal electrodes of the array securely into the ground. Readings were obtained at 1m intervals, along contiguous grid lines. The point of measurement for each array was in the centre of the four electrodes.

Selective auguring of the areas chosen for investigation enabled the choice of the correct array to penetrate beneath the archaeologically sterile modern overburden, and allowed direct comparison between the resistivity values recorded and the physical characteristics of the deposits thus encountered.

4.3: Processing of data

Readings of apparent resistivity were logged onto an IBM-compatible micro-computer. A graphics package (Whizplot) was employed to provide on-screen interpretation of this data and the illustrations for this report, in the form of dot-density plots. These computer generated plots highlight the areas of anomalies, which are represented by darker shading in the case of areas of higher resistivity, and lighter shading in areas of lower than average resistivity. The dot density plots in this report emphasise the areas of higher resistivity by use of a logarithmic, rather than arithmetic progression in shading. Some of the interpretative plots use inverse shading to highlight areas of low resistivity, where appropriate.

After recognition and definition, anomalies may be interpreted as either natural or manmade features. Study of the surrounding topography and the results of auger boring are relevant, along with the anomalies spatial characteristics: its shape, sharpness of outline, and by comparision with the resistivity of the surrounding areas, including other anomalies and any distinct pattern of resistivity within the anomaly itself.

5.0: THE RESULTS

5.1: Introduction

The survey was effected during a two-week period marked by heavy showers and prolonged periods of rain and snow. Accordingly, data from different areas cannot be closely correlated but the broad pattern of anomalies from individual areas is evident. These conditions of unusually high rainfall can impede the location of features as current flow is concentrated at the surface, (Tite, 1972).

The dot-density plots have been chosen to give maximum definition of the data from individual 25m squares and consequent changes in shading between squares should be disregarded. Slight distortion of data occurs along the lines of the measuring grid and single point anomalies should be disregarded.

5.2: Area 1 (Figure 2: Figure 3)

Area 1 covers the summit, and part of the east slope of the gravel terrace in the north west of the survey area (Figure 2). It also encompasses the area containing most of the archaeological features recognised during earlier trial excavations. An area of 50m by 50m was investigated using a 1m array.

Readings of background resistivity in this area fell largely within the range 60-110 Ohm Metres. Slightly higher readings were noted in the better-drained area of natural slope to the south west. On the flatter ground in the remainder of the area a group of anomalies, maintaining both higher and lower values than the background may be distinguished. A linear band of low resistivity values, 1A up to 5m in width, crosses the area on an approximate west-east alignment. Pockets of similar low values are evident in the north west, 1B. An interrupted linear anomaly of values in excess of 110 Ohm Metres follows the alignment of 1A to the south but is of notably more irregular outline, 1C. Other patterns visible on the plot derive from machine error.

5.3: Areas 2 and 3 (Figure 2: Figures 4 and 5)

Areas 2 and 3 are located 10m to the south of area 1, on the southern slope of the gravel terrace in the north west of the site (Figure 2). A 1m array was employed in area 2 and a 0.5m array in area 3, where the topsoil is shallower. Therefore, although the areas are contiguous the results have been obtained at different depths of investigation and are therefore not comprable. Area 2 measured 25m by 50m and area 3 50m by 50m.

Only a limited range of background resistivity values is recorded in area 2; between 75-110 Ohm Metres. Soil background resistivity appears to decrease towards the eastern edge of the area, down the natural slope. A poorly defined area of low resistivity, 2A, is visible in the west of the area, containing values around 50-75 Ohm Metres. Adjoining 2A is an area of high resistivity containing values in the range 110-160 Ohm Metres, forming an arc to the east of 2A.

The background values of resistivity recorded in area 3 are broadly consistent with the pattern recorded in area 2 to the north (and at a different depth). The values recorded decrease down the slope eastwards towards the area of the boulder clay, from approximately 250 to 150 Ohm Metres. Within the western area a lower order anomaly may be distinguished, 3A, measuring 4m by 6m and containing values 25% lower than the surrounding area.

5.4: Areas 4 and 6 (Figure 2: Figures 6 and 7)

Area 4 comprises a rectanglular block 25m by 100m along the eastern edge of the north field, within a flat low-lying area (Figure 2). Between area 4 and the road lies a band of stone rubble, probably derived from the recent re-alignment of the road. A 0.5mm square array was used here.

Little variation of resistivity was recorded in this area, the values represented being in the range between 25-50 Ohm Metres, indicating the presence of clay. A slight increase in values is noted towards the south of the area, which correlates with an increased quantity of stone visible in the surface of the ploughsoil.

Area 6 is a block 25m by 150m, 30m inside the eastern boundary of the south field (Figure 2), in an area of badly drained land holding standing water on the surface at the time of the survey. A 1m square array was employed to penetrate beneath the ploughsoil.

The resistivity values recorded fell within a narrow range of predominantly low values, from 30-50 Ohm Metres. A slight increse in measurements was noted towards the south of the area but patches of higher resistivity seem to be randomly distributed and may result from machine error.

5.5: Area 5 (Figure 2: Figure 8)

Area 5 comprised a block of 25m by 75m in the north west of the south field, occupying a slight hollow within higher ground on boulder clay (Figure 2:). A 1m array was employed here.

A small range of background values was recorded, varying from 20-40 Ohm metres. Within this background a trend of values increasing to the north was noted. 5A is an anomaly of resisitivity up to 20% higher than the surrounding area, in the form of collar of sub-circular shape containing two areas of lower resistivity, 5B and 5C. The pattern of the sub-circular anomaly 5A seems repeated to the west (5D), which only partly falls within the survey area, and may be conjoined with the first, close to a roughly circular area of higher resistivity. These anomalies may be manmade.

5.6: Area 7 (Figure 2: Figure 9)

An area 25m by 100m was investigated close to the southern site boundary using a 0.5m m square array (Figure 2). Topographically, the area is dominated by a naturally formed platform to the south, with ground sloping gently away on the other three sides.

Only a small range of resistivity values was recorded from 40-100 Ohn Metres; the lower values within the platform area and slightly higher readings on the surrounding slopes.

Anomaly 7A is a linear band of values up to 50% lower than surrounding values, and located in the position of a shallow surface ditch aligned north-south (Figure 2). Anomaly 7B is sub-circular in shape, with values upto 25% higher than the surrounding area. These anomalies may be manmade.

6.0: DISCUSSION

6.1: Area 1 (Figure 3)

This area encompasses the locations of previous archaeological excavations: because of this recent disturbance the pattern of anomalies revealed requires care in interpretation. These anomalies may represent manmade features; the lower order anomaly 1A may be caused by the fills of negative features such as ditches and the area of higher resisitivity anomaly 1C, represent upcast from a ditch.

In contrast to the evidence from areas 2 and 3 (to the south), the background values appear to increase markedly to the west; possibly due to a localised area of gravel concentration.

6.2: Areas 2 and 3 (Figures 4 and 5)

The pattern of background resistivity correlates with a decrease in the depth of the gravels, towards the junction with the boulder clay: lower values may be caused by the more free draining area on the slope (Figure 2). Anomaly 2A may be an area of a more water-retentive material, such as a silt, surrounded by soil of notably higher resistivity than the natural gravel base. This may be interpreted as a naturally derived variation in the depth of the localised gravel deposit. None of the noted anomalies need be interpreted as of manmade origin.

In area 3 a marked distinction can be drawn between the west sector, containing material of markedly higher resisitivity, and the eastern area on the slope, where the square array may have contacted boulder clay. A low order anomaly within the western area, 3A, may be a manmade feature despite its irregular shape and a slight concentration of material of higher resistivity around feature 3A may support this interpretation.

6.3: Areas 4 and 6 (Figures 6 and 7)

Both areas extend close to the recently formed eastern boundary of the site. The broad pattern of readings indicates the prescence of a homogenous deposit of boulder clay seen during limited auguring. The presence of clay is confirmed by the standing water on this part of the site and the clay turned over by the plough visible on the surface. The irregular areas of higher resistivity may be patches of stones within the boulder clay. No archaeological features were noted in areas 4 and 6.

6.4: Area 5 (Figure 8)

The small gradual decrease in resistivity to the north correlates with the gentle slope in that direction being better drained. As in the adjoining areas 4, 6 and 7 the underlying boulder clay exibits little variation in the pattern of resistivity.

The anomalies 5A and 5D may be interpreted both by their form and dimensions as sub-circular manmade features, possibly circular huts.

6.5: Area 7 (Figure 9)

Strong correlation is exhibited between the resistivity values recorded and the surface topography. Higher readings are obtained on the better-drained slopes, indicating the presence of silts with higher resistivity compared to the natural clay exposed by erosion at the top of the slope. Anomaly 7B is not well defined but may represent a ditch running down the slope. The linear anomaly 7A corresponds to the shallow ditch visible as a surface feature throughout the length of the south field (Figure 2); its fill may comprise material of low resistivity which divides an area containing higher values.

7.0: IMPLICATIONS AND RECOMMENDATIONS

7.1.1: The Gravel Terrace (Figure 10, Zone1)

The geophysical sample of the gravel terrace (Zone 1) has located anomalies outlining the Roman ditched enclosure encountered in earlier excavations in Area 1. Excavations outside the enclosure have confirmed the spread of Romano-British settlement down the gravel slope to the south, to which the geophysical survey has added a sub-circular anomaly in Area 3. This may represent the clay floor of a circular hut similar to those discovered in the gravel quarry.

The previous trial excavations in this field, coupled with the geophysical evidence, has confirmed that this terrace contains the last remaining part of an important, multi-period archaeological site destroyed by the gravel quarrying to the west and north. Although archaeological remains were recorded as they were revealed by the quarrying, such ad hoc recovery methods prevented all but the most basic interpretation and reconstruction of the site's layout, function and development. It is nevertheless evident that this is one of the few known instances of an Anglo-Saxon settlement re-occupying an earlier Romano-British site, and is therefore of considerable interest. The remaining area of gravel terrace presents the last opportunity to obtain a proper control sample of the site and thus assess the implications of the earlier discoveries.

7.1.2: Recommendation

The remains in Zone 1 are of sufficient importance to warrant their preservation in situ if at all possible. Should the planned development preclude this option then provision for the recovery of the archaeological data to the highest possible standards (preservation by record) must be a high priority. This could be achieved through the application of a relatively extensive programme of controlled archaeological excavation/recording within the framework of an appropriate sampling strategy and in advance of the development timetable.

7.2.1: The Boulder Clay (Figure 10, Zones 2 and 3)

The geophysical sample of the boulder clay suggests a division between the low-lying and sloping areas (Zone 3), where archaeological features are almost certainly absent, and the level tops of the hillocks (Zone 2) where some evidence was forthcoming. This could well be an accurate reflection of the settlement pattern, with occupation limited to the higher ground because of poor drainage and waterlogging on the lower slopes and valley floor. The discovery of possible prehistoric pottery fragments and a flint core on the surface of Area 5 hints at the possibility of settlement in this area. Similar hilltops were occupied in the prehistoric period at Manham Hill and Hopper Hill.

These high boulder clay clay areas (Zone 2) have never been systematically examined by modern archaeological methods before, although similar locations in the neighbourhood have yielded prehistoric remains. The geophysical sample suggests the existence of settlement evidence in Area 5 and of man-made features in Area 7. Agricultural activity in these areas of thin topsoil has probably eroded the remains somewhat as evidenced by pottery fragments found on the surface, but this hypothesis should be tested by excavation.

There is at present no geophysical or other evidence to suggest the location of archaeological features in Zone 3, being probably the least favourable settlement locations.

7.2.2: Recommendation

Development proposals involving substantial disturbance to Zone 2, particularly in the vicinity of Area 5, should be preceded by a limited programme of archaeological investigation involving excavation sampling of geophysical anomalies and their wider context. Further archaeological monitoring of these areas may be desirable in the preliminary stages of site development, for which access agreements will be required.

In Zone 3 no further archaeological response appears to be justified although the sampling programme proposed for Zone 2 might be extended here to a limited extent to confirm the hypothesis proposed above. The monitoring programme for Zone 2 might also be applied in Zone 3.

8.0: ACKNOWLEDGEMENTS

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