KEDLESTON HALL SOUTH LAWN, DERBYSHIRE

Report on geophysical survey conducted in June 2014

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SUMMARY

- Trent & Peak Archaeology, as part of the York Archaeological Trust was commissioned by ArcHeritage to conduct a geophysical survey on the South Lawn of Kedleston Hall, Derbyshire, centered on NGR SK 31098 40338 at a height of c. 85m OD (Fig. 1).

- The work was carried out between the 2nd and 13th June 2014 following the methodology detailed in the WSI (TPA 2014), in accordance with standard, accepted practices for archaeological geophysical surveys (EH 2008).

- The site is situated on deposits of Mercia Mudstone, with superficial Hodnet Association deposits.

- The site was composed of a single area covering the South Lawn of Kedleston Hall, Derbyshire.

- Geophysical survey demonstrated the presence of potential buried archaeological features, these comprised:

    - Possible remains of the 18th century formal garden.

    - Evidence of former layout of the South Lawn and Pleasure Grounds.

    - Evidence for water-management associated with the current water-features present on the South Lawn.

    - Evidence for water-management associated with now-demolished buildings.

Report on the geophysical survey of the South Lawn at Kedleston Hall, Derbyshire.
NGR SK 31098 40338

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ACKNOWLEDGEMENTS

The Project Manager for the work undertaken was Paul Johnson. The Project advisor was Lee Elliott. The Project Team comprised Tom Hooley, Povilas Cepauskas, and Paul Johnson.

1. INTRODUCTION

1.1. Trent & Peak Archaeology, as part of the York Archaeological Trust was commissioned by ArcHeritage to conduct a geophysical survey on the South Lawn of Kedleston Hall, Derbyshire, centered on NGR SK 31098 40338 at a height of c. 85m OD (Fig. 1).

1.2. The fieldwork was conducted in June of 2014 on an approximately 3 hectare area of land covering the South Lawn of Kedleston Hall, Derbyshire (Fig. 2).

1.3. The site is located on deposits of Mercia Mudstone; Sedimentary Bedrock formed approximately 200–251 million years ago in the Triassic period. The bedrock is overlain by superficial deposits of Hodnet Association (British Geological Survey).

1.4. Topographically the site lays to the south of Kedleston Hall (Derbyshire). The site is on a slight slope down to the south, declining by about 3.6m, to a haha wall which runs alongside the southern edge of the site. The site displays notable localised topographical variation as a result of modern landscaping practices.

1.5. Previous surveys have revealed the presence of buried features under the South Lawn of Kedleston Hall (Schmidt 2010, Malone 2012).

1.6. Following consultation between The National Trust and TPA/ArcHeritage, an approved Written Scheme of Investigation was agreed for earth-resistance survey within the area of the South Lawn.

2. PROJECT BACKGROUND

2.1. Potential Remains

2.1.1. The archaeological potential of the site is considered to be high and comprises the following possible remains, as indicated in reports on previous geophysical surveys (Schmidt 2010, Malone 2012).

- ***Post-Mediaeval***
  The current layout of the hall and grounds was established through the 1758–65 construction and landscaping work of Sir Nathaniel Curzon and his architect Robert Adam. During these works, the area to the south of the hall, the former walled garden, was raised to form a terraced platform and a haha wall installed along its southern edge.
  Known subterranean culverts were noted in 2002 when the ceiling of one collapsed. Archaeological works were conducted (OSA 2003) which confirmed the presence of a tunnel running south-southwest–north-northeast 2.5m below the local ground level.

2.2. Proposed Fieldwork

2.2.1. In order to characterise the potential archaeological remains under the South Lawn of Kedleston Hall, the following fieldwork investigation was proposed:

- Geophysics – Earth-resistance survey across an area totalling c. 3 ha.

3. OBJECTIVES

3.1. The aim of the present work is to enhance the existing understanding of archaeological evidence by attempting to determine the character of any sub-surface remains prior to a programme of trenching to be undertaken by ArcHeritage.

3.2. The survey results will be used to inform future archaeological work at the site.

4. METHODOLOGY

4.1. Geophysical Survey: Earth-resistance

4.1.1. The decision to use earth-resistance survey on the site was based on its ability to provide relatively precise detail about buried structures and to indicate the presence of both stratigraphically positive and negative sub-soil features without the interference often present in magnetic data as a result of modern disturbance and the presence of ferrous material close to the ground surface (Geoscan Research 1996; Scollar et al. 1990, 362ff).

4.1.2. The results of this method are, however, severely restricted by environmental conditions such as the retention of moisture within the soil (Clark 1990, 27). Details of this survey technique are provided (Appendix B), although other techniques such as magnetometry or GPR could have been applied to the site. Earth-resistance survey represented the best compromise between speed and quality of data retrieval for an investigation of possible structures extending beyond the excavated areas. These had not been recognised in previous geomagnetic survey and so it was desirable to apply a technique measuring different physical properties in order to recover these features.

4.1.3. The earth-resistance survey was undertaken, within the guidelines advocated by English Heritage (David et al. 2008), by a two-person team using a Geoscan Research RM85 Resistance meter in parallel twin-probe configuration. This equipment allowed the survey to be conducted relatively rapidly as the area was free of obstructions. Readings were taken at 0.5 m intervals along traverses of 0.5m spacing walking west. This enabled a sufficiently high density of data for the purposes of archaeological assessment to be collected across the site in the relatively short time allotted for the survey to be completed.

4.1.4. The geophysical survey grids of 30m by 30m were set out using a Leica GS15 RTK GPS system with SmartNet, in the Ordnance Survey National Grid coordinate system. Since the predominant alignments of the expected archaeological remains were known, a slight deviation from north–south orientation for the survey grids was employed as this was able to ensure that any surviving remains would be intersected by the survey traverses at an angle of approximately 30º.

4.1.5. The geophysical survey data were processed in Geoplot 3.0 software to remove any environmental disturbances or variations produced in the course of the survey. Firstly data were manipulated to remove any distorting ‘spikes’ from the survey results. A high-pass filter was then also used to reduce the effect of geological anomalies in the data-set. Low-pass filtering was then used to improve the resolution of larger archaeologically derived anomalies.

4.1.6. The results were exported as greyscale, raster images and inserted into the AutoCAD plan of the site, generated from Ordnance Survey data, for georeferencing and production of a descriptive, vector overlay. The anomalies presented here were identified visually and manually digitised to produce the vectorised plans which are discussed in the results section of this report. The final print-versions of these plans were elaborated and prepared for printing in Adobe Illustrator CS4.

Ground Conditions

4.1.7. Ground conditions for the survey were generally good, the lawn surface provided no significant problems for survey. Garden ornaments and furniture prevented readings being taken in localised areas. The soil-moisture conditions were noted to be extremely arid and prevented survey from being undertaken in some areas as no ground-contact could be attained.

5. RESULTS

(Figures 2-4)

5.1. Earth-resistance Survey

5.1.1. Within the area surveyed, the site exhibited a generally good response to the earth-resistance survey, a high density of geophysical anomalies are observed across the whole area surveyed, and buried features can be clearly discerned against the geological background with very little noise in the dataset. The overall background resistance is high, a result of the arid conditions, any cut features are likely to show against this as areas of relatively low resistance. In contrast, structural remains and voids are likely to present high-resistance signals.

5.1.2. The results are presented below as a greyscale image of the processed data (Fig. 2), and a complementary numbered interpretative plan to which the following description relates (Fig. 3), this description is organised from west to east.

5.1.3. The northwestern corner of the survey area shows an amorphous area of high-resistance [1] which covers c. 133m^2. This anomaly should probably be seen as a result of the generally arid conditions under which the survey was conducted. Approximately 4m to the south of this is a probable curvilinear, high-resistance anomaly [2] running broadly northwest–southeast for 8m. Approximately 19m southwest of this, adjacent to the western edge of the survey area is a curvilinear, high-resistance anomaly [3] describing an arc of 22m length. This feature appears to constrain an area of low-resistance [4]. To the southeast of [3] is a linear, high-resistance anomaly [5], which runs for approximately 13.5m in a northeast–southwest direction. Adjacent to this feature is another linear, high-resistance anomaly [6] which runs for c. 11m on a broadly east–west orientation. Approximately 4m to the south of [5] are a pair of high-resistance anomalies [7] which run for 15m and are broadly perpendicular to [5]. The southwestern corner of the survey area demonstrates a 31.5m long linear, high-resistance anomaly [8]. Parallel to this, and located 3m to its south are a pair of high-resistance anomalies [9]. A further high-resistance anomaly [10] may demonstrate the continuation of this feature to the northeast. To the south of [10] and constrained to the west by [9] is a c. 170m^2 area of low-resistance [11].

5.1.4. Approximately 15m to the northeast of [5] is an 11.5m long linear, high-resistance anomaly [12] which may prolong the alignment of that feature. To the southeast of this anomaly is a further high-resistance anomaly [13] running for c. 7m perpendicular to it. Approximately 20m to the southeast of [13] and respecting the same alignment is a complex linear/rectilinear anomaly [14], the long-axis of which extends for c. 28.5m towards the monumental fountain. This anomaly may also indicate a continuation of the linear feature represented by [9]. To the south of [13] and southwest of [14] is a large, amorphous 525m^2 area of high-resistance [15]. To the north of [12] is another area of high-resistance [16], adjacent to the northern edge of the survey area. A small, discrete 16m^2 area of high-resistance [17] is also located adjacent to the northern edge of the survey, directly to the north of [14]. Two parallel, apparently paired high-resistance anomalies [18] and [19] are situated between [14] and [17]. The alignment of these features appears to respect that of [8] and suggests that this alignment may be significant in determining the nature of subsurface features across the area. Immediately to the northeast of these anomalies is an extended-“L-shaped” high-resistance anomaly [20], measuring 26m by 10m. The short axis of this anomaly may be continued by an adjacent high-resistance anomaly [22] located c. 6m to the southeast. The alignment of [9] may also be continued in this area by an 11m long, linear, high-resistance anomaly [21]. To the south of these features are a pair of parallel, linear, high-resistance anomalies [23] and [24] which appear to bracket the fountain which is located at the midpoint between them. An amorphous area of high-resistance [25], is noted to the east of [21]/[22].

5.1.5. The single largest anomaly revealed by the geophysical survey is a 162m long, low-resistance anomaly [26] which extends from the eastern edge of the area surveyed to a point approximately 2/3 the distance to the western extent of the survey. To the north of this feature are three high-resistance anomalies. The westernmost of these, [27], probably represents the aridity of the ground during survey as with [1] and [16]. The central high-resistance anomaly

[28] is broadly linear and parallel to [26]. This feature extends for c. 31m along the northern side of [26]. The final anomaly within this group [29], is a curvilinear, high-resistance anomaly extending for c. 34m. Immediately adjacent to the south of [26], at its eastern end, is a linear, high-resistance anomaly [30], which appears to demonstrate similar characteristics to [28].

5.1.6. To the southeast of the monument to Michael Drayton is a large, c. 26m by 37m rectilinear, high-resistance anomaly [31]. This feature is aligned slightly north of the northeast–southwest alignment predominant in the western part of the survey area. The orientation of [31] should be seen as defining the predominant alignment of anomalies in the eastern part of the area surveyed. Approximately 15m to the northeast of [31] is a group of two high-resistance anomalies [32], which appear to define a linear feature c. 11m long on an east–west orientation. A long, linear alignment of high-resistance anomalies [33], [34] and [35], possibly consistent with the southeastern corner of [31], extend for approximately 51m north-northeastwards across the survey area. This alignment appears to be paralleled adjacent to the southern edge of the survey by the high-resistance anomalies [36], which extend for c. 16m. Approximately 10m to the east of this feature is a curvilinear, high-resistance anomaly [37], measuring approximately 7.5m. Immediately to the north of this feature is a large, curvilinear, high-resistance anomaly [38], measuring approximately 13m by 38m. Approximately 6m to the east of [35] is a linear, high-resistance anomaly [39] which runs broadly east–west and may continue the alignment of [32]. Located between [38] and [39] are a group of high-resistance anomalies [40] which may demonstrate an alignment of features running northwest–southeast, broadly parallel/perpendicular to [31].

5.1.7. The southeastern corner of the survey area exhibits a large (c. 188m^2), amorphous area of high-resistance [41]. Directly to the south of this is another, smaller amorphous area of high-resistance [42]. To the east of this latter anomaly are two aligned, linear, high-resistance anomalies [43] and [44] which extend for a total of 44m in a northeast–southwest direction. Immediately to the north of [43] is an amorphous high-resistance anomaly [45]. Immediately adjacent to the southeastern corner of the survey area, bounded to the northwest by [43] and [44] are two linear, high-resistance anomalies [46] and [47]. The former of these is approximately 10.5m long and runs on an alignment approximately perpendicular to that of [33], [34] and [35]. The second of these two linear anomalies [47], runs for approximately 14m on a broadly east–west alignment. Adjacent to the area of high-resistance [41], is a curvilinear low-resistance band [48] with runs for approximately 17m. Approximately 4.5m to the east of [48] is a high-resistance macula [49] covering an area of 39m^2. The final feature observed is a long, irregular, high-resistance anomaly [50] which extends for approximately 30m in a broadly east–west direction.

6. DISCUSSION

6.1. Earth-resistance Survey

6.1.1. As a result of the small area surveyed, landscape-scale features could not be easily recognised within the dataset. However, smaller-scale features were recognisable within the survey area. The ground-conditions were only partially conducive to the earth-resistance survey, however reasonably clear results were obtained from the majority of the area intended for survey. Likely archaeological features were represented by both high- and low-resistance anomalies, being therefore strongly suggestive of voids (tunnels/culverts), structures consisting of masonry or brick walls, and/or possible spreads of demolition debris. The overall character of the geophysical anomalies revealed by the survey strongly suggests the presence of substantial remains within the area surveyed.

6.1.2. The group of features [38], [39], [43], [44], [47] and [50] may represent the remains of earlier, formal, garden features dating to the 18th century and which are shown on the map of 1758.

6.1.3. Feature [26] almost certainly represents the line of a former path across the lawns, leading towards the Pleasure Grounds to the west of the area surveyed.

6.1.4. The features [31], [33] – [35] probably represent subterranean features which may be associated with the management of the South Lawn or the drainage of water/waste from the buildings to the north.

6.1.5. The features [38] and [46] may also represent the remains of a former underground outlet, possibly that from the ice-house located to the east of the current loggia.

6.1.6. Features [9], [14], [21], [23] and [24] show subsurface features, possibly related to water-management systems associated with the fountain located in the centre of the sunken area of the South Lawn near the small summer-house at its southern edge.

6.1.7. The features [5] – [8], [12], [13], [18] and [19] appear to also represent buried features which again may relate to water management in some way.

7. CONCLUSION

7.1. Geophysical survey demonstrated the presence of potential buried archaeological features.

These comprised:

- Possible remains of the 18th century formal garden.
- Evidence of former layout of the South Lawn and Pleasure Grounds.
- Evidence for water-management associated with the current water-features present on the South Lawn.
- Evidence for water-management associated with now-demolished buildings.

7.2. The distribution of geophysical anomalies across the areas surveyed should probably be seen as representative of the presence of archaeological features within the survey area and no significant biases in survival/detection of these remains appear to be present within the dataset.

8. BIBLIOGRAPHY

David, et al. (2008) *Geophysical Survey in Archaeological Field Evaluation*. English Heritage

Gaffney, C., Gater, J. & Ovendon, S. 1991. *The Use of Geophysical Survey Techniques in Archaeological Evaluations*. Institute of Field Archaeologists Technical Paper No. 9.

Malone, S. 2012. *Kedleston Hall Pleasure Grounds geophysical survey*. APS Report Number 96/12.

OSA. 2003. *Kedleston Hall, Derbyshire. Report on a controlled watching brief*. OSA report No. OSA03WB31.

Schmidt, A. 2010. *Kedleston Hall, Derbyshire. Final Geophysical Survey Report*. University of Bradford, Archaeological Sciences: GP03-01e.

Scollar et al. (1990) *Archaeological Prospecting and Remote Sensing*. Cambridge: Cambridge University Press.

Cartographic references

BGS British Geological Survey: England and Wales (online) Solid and Drift Geology: 1: 50,000

OS Ordnance Survey 1: 50,000 Landranger Map

Ordnance Survey Maps: All editions 1859-1992

Appendix A: Details of Survey Strategy
Date of Survey: 2nd–13th June 2014
Site: KHG – Kedleston Hall, South Lawn (Derbyshire)
Region: Derbyshire
Grid Reference: NGR SK 31098 40338
Surveyor: Trent and Peak Archaeology
Personnel: Paul Johnson, Tom Hooley, Povilas Cepauskas
Geology: Mercia Mudstone/Hodnet Association
Survey Type 1: Earth-resistance
Approximate area: 3 hectares
Grid size: 30m
Traverse Interval: 0.5m
Reading Interval: 0.5m
Instrument: Geoscan Research RM85
Resolution: 0.1Ω
Traverse mode: Zig-zag

Appendix B: Geophysical Prospection Methods

Earth-resistance Survey

Resistivity survey is based on the ability of sub-surface materials to conduct an electrical current passed through them. Differences in the structural and chemical make-up of soils affect the degree of resistance to an electrical current (Clark 1990, 27).
The technique involves the passing of an electrical current through a pair of probes into the earth in order to measure variations in resistance over the survey area. Resistance is measured in ohms (Ω), whereas resistivity, the resistance in a given volume of earth, is measured in ohm-metres (Ωm).

Four probes are generally utilised for electrical profiling (Gaffney et al. 1991, 2), two mobile and two remote probes. Earth-resistance survey can be undertaken using a number of different probe arrays; twin probe, Wenner, Double-Dipole, Schlumberger and Square arrays.

Twin Electrode Configuration:

This array represents the most popular configuration used in British archaeology (Clark 1990; Gaffney et al. 1991, 2), usually undertaken with a 0.5m separation between mobile probes. Details of survey methodology are dealt with elsewhere (Geoscan Research 1996) and so will not be discussed here. The twin probe array configuration utilises two probes on a mobile frame, with two remote probes located at a distance from the mobile frame of least 30 times the separation between the mobile probes.

Alterations can be made to suit different conditions. For extremely dry soils, a range of 0.1mA can be used. If the background resistance is lower than 100Ω, then a gain of x10 should be used. If the background resistance is lower than 10Ω, then a gain of x100 can be used. In urban situations, it may be necessary to alter the range and gain of the instrument to 10mA and x1 respectively.

A number of factors may affect the interpretation of twin probe survey results, including the nature and depth of structures, soil type, terrain and localised climatic conditions. The response to non-archaeological features may lead to a misinterpretation of the results, or the masking of archaeological anomalies. A twin probe array of 0.5m will rarely recognise features below a depth of 0.75m (Gaffney et al 1991). More substantial features may register up to a depth of 1m.

With twin probe arrays of between 0.25m and 2m, procedures are similar to those for the 0.5m twin probe array. However, the distance at which the remote probes are located must for 1-2m twin arrays be greater than that for 0.5m.

Although changes in the moisture content of the soil, as well as variations in temperature, can affect the form of anomalies present in resistivity survey results, in general, higher resistance features are interpreted as structures which have a limited moisture content, for example walls, mounds, voids, rubble filled pits, and paved or cobbled areas. Lower resistance anomalies usually represent buried ditches, foundation trenches, pits and gullies.

FIGURES