Archaeological Services
University of Durham

Bamburgh Bowl Hole Anglian Cemetery, Bamburgh, Northumberland

geophysical surveys

on behalf of
Dr Sarah Groves

Report 1587
December 2006

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1. Summary

The project

1.1 This report presents the results of geophysical surveys on the Bowl Hole Anglian Cemetery at Bamburgh, Northumberland. The works comprised both geomagnetic and electrical resistance surveying to inform future excavation strategy.

1.2 The works were commissioned by Dr Sarah Groves and conducted by Archaeological Services in accordance with a Written Scheme of Investigation provided by Archaeological Services (Appendix II).

Results

1.3 Areas of archaeological interest have been identified. A cluster of low resistance anomalies may represent graves and may indicate either that the cemetery was concentrated towards the top of the slope or that burials further down have been eroded away.

2. Project background

Location (Figure 1)

2.1 The study area comprised an area of sand dunes on the southern edge of Bamburgh, Northumberland (NGR: NU 4826 8689). The survey area measures approximately 0.25ha and lies between a woodland area to the south and west and an area of the dunes known as the Bowl Hole to the north and east.

Objective

2.2 The aim of the surveys was to establish the extent of the cemetery and to inform the future excavation strategy.

Dates

2.3 Fieldwork was undertaken between 5th and 6th December 2006. This report was prepared between 11th and 22nd December 2006.

Personnel

2.4 Fieldwork was conducted by Graeme Attwood (Supervisor) and Natalie Swann. This report was prepared by Graeme Attwood with illustrations by Janine Wilson. The Project Manager was Duncan Hale.

Archive/OASIS

2.5 The site code is **BBH06**, for **B**amburgh **B**owl **H**ole 20**06**. The survey archive will be supplied on CD to the client for deposition with the project archive. Archaeological Services is registered with the **O**nline **A**cces**S** to the **I**ndex of archaeological investigation**S** project (OASIS). The OASIS ID number for this project is **archaeol3-**21776.

3. Archaeological and historical background

3.1 A detailed history of Bamburgh has been described by Bateson (1893) while a detailed account of the fortress of Bamburgh can be found in Young (2004).

3.2 The Bowl Hole Cemetery site (Northumberland SMR 5252) was first documented in the 19th century when several cists were revealed in the dunes after a huge storm in the winter of 1816/1817. Excavation of the site is known to have taken place during the 19th and early 20th century, however after this its exact location was lost.

3.3 The Bamburgh Research Project rediscovered the cemetery site in 1997 and has been investigating the burial site ever since, excavating approximately 100 individuals and identifying around another 30 grave cuts. For more information on this project see www.bamburghresearchproject.co.uk./bowl-hole.htm

4. Landuse, topography and geology

4.1 At the time of survey the study area comprised an area of sand dunes in an advanced state of development which was in use as grazing for cattle and contains a single stock fence to south of the survey area. Some excavation has already taken place over several parts of the survey area.

4.2 The survey area undulated at a mean elevation of *c*.9-11m OD.

4.3 Although Bamburgh Castle sits on intrusive basalt rock, the stratigraphy of the Bowl Hole area comprises sands overlying Boulder Clay, which overlies rock of the Carboniferous Limestone Series.

5. Geophysical survey

Standards

5.1 The surveys and reporting were conducted in accordance with English Heritage Research and Professional Services Guideline No.1, *Geophysical survey in archaeological field evaluation* (David 1995); the Institute of Field Archaeologists Technical Paper No.6, *The use of geophysical techniques in archaeological evaluations* (Gaffney, Gater & Ovenden 2002); and the Archaeology Data Service *Geophysical Data in Archaeology: A Guide to Good Practice* (Schmidt 2001).

Technique selection

5.2 Geophysical surveying enables the relatively rapid and non-invasive identification of potential archaeological features and can involve a variety of complementary techniques such as magnetometry, electrical resistivity, ground-penetrating radar and electromagnetic survey. Some techniques are more suitable than others in particular situations, depending on a variety of site-specific factors including the nature of likely targets; depth of likely targets; ground conditions; proximity of buildings, fences or services and the local geology and drift.

5.3 In this instance, given the anticipated depth and nature of targets and the non-igneous nature of the local geology, both geomagnetic and electrical resistance survey techniques were used. The techniques rely on different soil properties to provide complementary data.

5.4 It was anticipated that the gradiometer survey would be most useful for mapping the ditch feature to the west of the excavated area (and other similar features) and for providing an overview of the wider area. However, it was considered that the magnetic susceptibility contrast between the fills of the graves and the surrounding clay would be too weak to distinguish the grave features. A technique which essentially measures soil moisture, such as electrical resistance, would be more effective at detecting these features in this instance. Also, unlike the magnetic data, the resistance data would not be adversely affected by the post-and-wire stock fence which crosses the known part of the cemetery, nor by any ferrous/fired litter which may be present.

Field methods

5.5 A 20m grid was established across the survey area and tied-in to known, mapped Ordnance Survey points using a Trimble Pathfinder Pro XRS global positioning system (GPS) with subsequent RINEX calibration.

5.6 Measurements of vertical geomagnetic field gradient were determined using Bartington Grad601-2 fluxgate gradiometers. A zig-zag traverse scheme was employed and data were logged in 20m grid units. The instrument sensitivity was set to 0.1nT, the sample interval to 0.25m and the traverse interval to 1.0m, thus providing 1600 sample measurements per 20m grid unit.

5.7 Measurements of electrical resistance were determined using a Geoscan RM15D resistance meter with a mobile twin probe separation of 0.5m. A zig-zag traverse scheme was employed and data were logged in 20m grid units. The instrument sensitivity was set to 0.1ohm, the sample interval to 0.25m and the traverse interval to 0.5m, thus providing 3200 sample measurements per 20m grid unit.

5.8 Data were downloaded on-site into a laptop computer for initial processing and storage and subsequently transferred to a desktop computer for processing, interpretation and archiving.

Data processing

5.9 Geoplot v.3 software was used to process the geophysical data and to produce both continuous tone greyscale images and trace plots of the raw (unfiltered) data. The greyscale images and interpretations are presented in Figures 2-6; the trace plots are provided in Appendix I. In the greyscale images, positive magnetic/high resistance anomalies are displayed as dark grey and negative magnetic/low resistance anomalies as light grey. A palette bar relates the greyscale intensities to anomaly values in nanoTesla/ohm.

5.10 The following basic processing functions have been applied to each dataset:

Despike	locates and suppresses random iron spikes in gradiometer data and poor contact resistance spikes in the resistance data.
Interpolate	increases the number of data points in a survey to match sample and traverse intervals. In this instance the data have been interpolated to 0.25 x 0.25m intervals.

5.11 The following functions have been applied to the magnetometer data:

Clip	clips, or limits data to specified maximum or minimum values; to eliminate large noise spikes; also generally makes statistical calculations more realistic.
Zero mean traverse	sets the background mean of each traverse within a grid to zero; for removing striping effects in the traverse direction and removing grid edge discontinuities.

Destagger	corrects for displacement of anomalies caused by alternate zig-zag traverses.

Interpretation: anomaly types

5.12 Colour-coded geophysical interpretation plans are provided for each survey. Three types of geomagnetic anomaly have been distinguished in the data:

positive magnetic	regions of anomalously high or positive magnetic field gradient, which may be associated with high magnetic susceptibility soil-filled structures such as pits and ditches.
negative magnetic	regions of anomalously low or negative magnetic field gradient, which may correspond to features of low magnetic susceptibility such as wall footings and other concentrations of sedimentary rock or voids.
dipolar magnetic	paired positive-negative magnetic anomalies, which typically reflect ferrous or fired materials (including fences and service pipes) and/or fired structures such as kilns or hearths.

5.13 Two types of resistance anomaly have been distinguished in the data:

high resistance	regions of anomalously high resistance, which may reflect foundations, tracks, paths and other concentrations of stone or brick rubble.
low resistance	regions of anomalously low resistance, which may be associated with soil-filled features such as pits and ditches.

Interpretation: features

5.14 A colour-coded archaeological interpretation plan is provided in Figure 6.

5.15 Several areas of positive magnetic anomalies have been detected. These anomalies reflect relative increases in high magnetic susceptibility materials and may represent the remains of soil-filled features or variations within the underlying geology. Some of these anomalies correspond to excavated areas and could reflect variation within the back fill.

5.16 An area of negative magnetic anomalies has been identified; this could reflect geological variation.

5.17 The only other magnetic anomalies detected here are small, discrete dipolar magnetic anomalies. These typically reflect items of near-surface ferrous and/or fired debris, such as fence wire and brick fragments, however, they could also reflect ferrous items within graves. The effect of the wire stock fence is evident along the southern edge of the magnetic survey.

5.18 Areas of anomalously high resistance data are evident across the survey area and correspond to the higher peaks of the sand dunes. Smaller high resistance anomalies are also evident, which could reflect stone features of archaeological significance, possibly stone-lined graves.

5.19 A broad arc of high resistance in the area of previous excavations does not correspond to known archaeological features there and must reflect variation either within the underlying deposits or the excavation backfill.

5.20 Small low resistance anomalies have been identified, which may reflect the presence of soil-filled features such as graves. There is a concentration of these anomalies in the north-western part of the survey. This largely corresponds, although not exclusively, to the excavated part of the cemetery. The anomalies are all towards the woodland side of the survey area, further up the slope, suggesting that the lower part of the slope may not have been used.

6. Conclusions

6.1 Both magnetic and resistance surveys have been carried out on the cemetery site at The Bowl Hole, Bamburgh.

6.2 Areas of archaeological interest have been identified. A cluster of low resistance anomalies may represent graves and may indicate either that the cemetery was concentrated towards the top of the slope or that burials further down have been eroded away.

7. Sources

Bateson, E 1893 *A History of Northumberland Volume 1: The Parish of Bamburgh with the Chapelry of Belford*, A. Reid, Newcastle upon Tyne

David, A, 1995 *Geophysical survey in archaeological field evaluation*, Research and Professional Services Guideline **1**, English Heritage

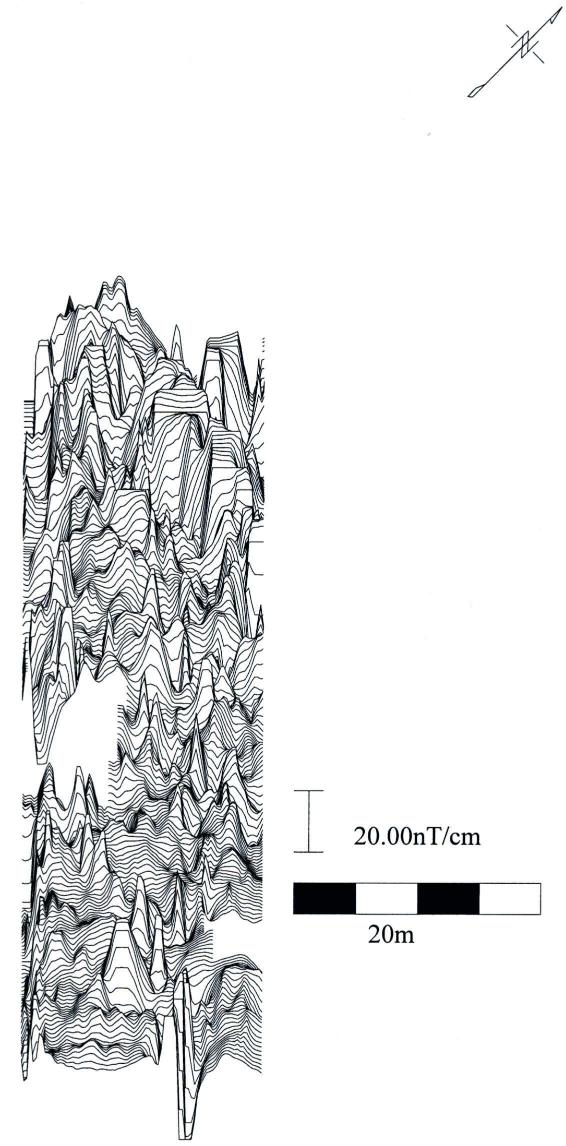
Gaffney, C, Gater, J, & Ovenden, S, 2002 *The use of geophysical techniques in archaeological evaluations*, Technical Paper **6**, Institute of Field Archaeologists

Schmidt, A, 2001 *Geophysical Data in Archaeology: A Guide to Good Practice*, Archaeology Data Service, Arts and Humanities Data Service

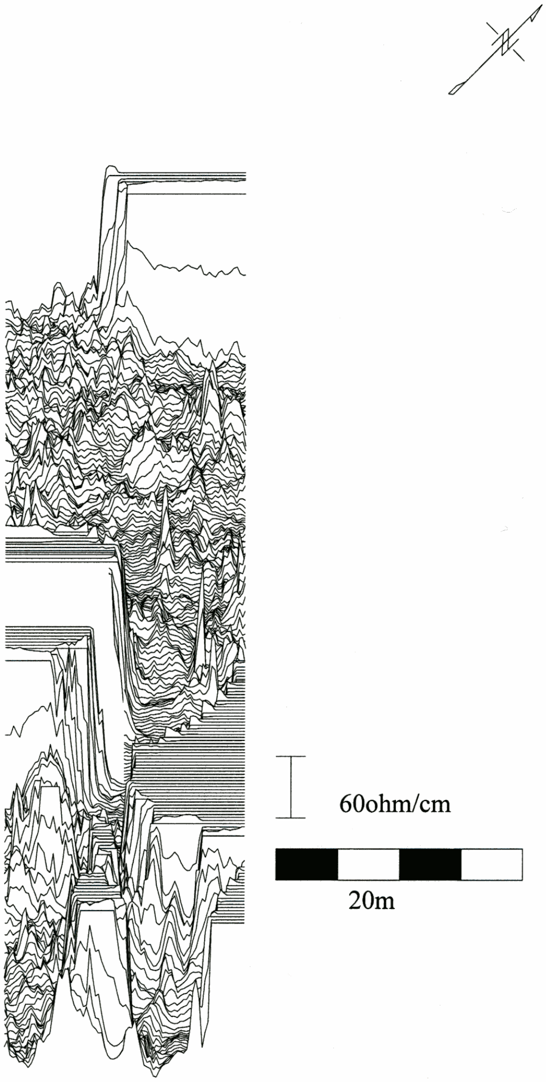
Young, G, 2003 *Bamburgh Castle: The archaeology of the fortress of Bamburgh AD 500 to AD 1500*, Bamburgh Research Project

Appendix I: Trace plots of geophysical data

Magnetometer survey



Electrical Resistance Survey



Appendix II: Written Scheme of Investigation

Quotation ref. **DH 06.278rev1**
28th November 2006

Bamburgh Bowl Hole Anglian Cemetery, Northumberland
Fee proposal and methods statement for geophysical surveys
On behalf of:

Dr Sarah Groves

Department of Archaeology, Durham University

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1. Introduction

1.1 Dr Groves has requested a quotation for geophysical surveys on land known as the Bowl Hole, south-east of Bamburgh Castle in Northumberland. The surveys would form part of an ongoing research project into the early medieval cemetery at the site. Recent excavations have identified about 100 graves; many of these have been excavated and some were found to be lined with stone. The depth of the graves varies from very near-surface to over 1m.

1.2 The principal aims of the geophysical surveys would be to establish the extent of the cemetery and to inform future excavation strategy. A substantial ditch has previously been identified and partially excavated to the west of the known graves; this could define one edge of the cemetery, although its spatial and chronological relationships to the graves are currently uncertain.

1.3 This document comprises our proposals for provision of the survey and reporting services.

2. Capability statement

Archaeological Services

2.1 Our service is geared towards both research and commercial projects and we have an established record of working with English Heritage, Historic Scotland, CADW, Ministry of Defence, Highways Agency, The National Trust, National Park Authorities, County and City Councils and many private corporations, developers, architects and environmental consultants. Archaeological Services have considerable experience in managing and conducting projects of any scale, and have successfully completed over 1,500 projects during the last twelve years.

2.2 We incorporate a range of in-house specialist services and laboratories, which are regularly employed by other archaeological and environmental contractors. Geophysical surveying is one such service.

Geophysical Survey Services

2.3 Our Geophysical Survey Services department undertakes geophysical surveys for both academic researchers and commercial clients throughout the UK and abroad. We have conducted numerous large programmes of geophysical survey in recent years, including several for proposed road improvements, flood alleviation schemes and large housing developments. The largest of these recent schemes has entailed the detailed survey of 225ha along the A1 road between Dishforth and Barton in North Yorkshire.

2.4 The service is managed by Duncan Hale BA AIFA (Project Manager), an expert in works of this type, who has conducted over 550 geophysical survey projects during the past fifteen years across the UK, Ireland and Egypt. Many of the projects have been undertaken in the north of England, with some projects involving over 100 separate surveys. Duncan is assisted by Graeme Attwood, Lorne Elliott BSc and Natalie Swann BA, all of whom have been conducting surveys of this type for Archaeological Services in recent years. These project leaders are supported by qualified, experienced members of Archaeological Services staff using state-of-the-art field instruments and software; several additional members of our field team are specifically trained in geophysical survey techniques, data processing and interpretation.

2.5 The majority of our surveys have involved the use of fluxgate gradiometers (magnetic) and/or electrical resistance meters (resistivity). We also have experience of electromagnetic surveys using EM31 meters, ground-penetrating radar (GPR) surveys and electrical resistivity profiling.

2.6 All our geophysical work is carried out in accordance with English Heritage Research and Professional Services Guideline No.1, *Geophysical survey in archaeological field evaluation* (David 1995); the Institute of Field Archaeologists Paper No.6, *The use of geophysical techniques in archaeological evaluations* (Gaffney *et al*. 2002); and the Archaeology Data Service *Geophysical Data in Archaeology: A Guide to Good Practice* (Schmidt 2001).

2.7 Recent examples of large geophysical survey projects include:

- 2004-06 A1 Dishforth to Barton, N Yorks, 225ha
- 2006 Potland Burn, Northumberland, 110ha
- 2006 Dallington Grange, Northampton, 100ha
- 2006 Wilburton, Cambridgeshire, 85ha
- 2006 Swindon, Wiltshire, 45ha
- 2006 Seghill, Northumberland, 30ha
- 2006 Steads Burn, Northumberland, 30ha
- 2005 Innsworth, Gloucester, 75ha
- 2005 Harlow, Essex, 40ha
- 2004-05 Northallerton FAS, North Yorkshire, 90ha

2.8 Some of our surveys are published and all are available as reports in Sites and Monuments Records (SMR) and through OASIS (the Online AccesS to the Index of archaeological investigationS project).

3. Timetable

3.1 The fieldwork can be undertaken at any time, though data collection and quality would be improved once the vegetation has died down a little. It is anticipated that the surveys would be completed over a two-day period.

3.2 The survey report will be supplied within 15 working days of completion of fieldwork. An alternative timescale can be arranged.

4. Methods statement

Technique selection

4.1 Geophysical surveying enables the relatively rapid and non-invasive identification of potential archaeological features and can involve a variety of complementary techniques such as magnetometry, electrical resistivity, ground-penetrating radar and electromagnetic survey. Some techniques are more suitable than others in particular situations, depending on a variety of site-specific factors including the nature of likely targets; depth of likely targets; ground conditions; proximity of buildings, fences or services and the local geology and drift.

4.2 Although Bamburgh Castle sits on intrusive basalt rock, the stratigraphy of the Bowl Hole area comprises sands overlying Boulder Clay, which overlies rock of the Carboniferous Limestone Series. In this instance, given the anticipated depth and nature of targets and the non-igneous nature of the local geology, both geomagnetic and electrical resistance survey techniques will be employed. The techniques rely on different soil properties to provide complementary data.

4.3 It is anticipated that the gradiometer survey will be most useful for mapping the ditch feature to the west of the excavated area (and other similar features) and for providing an overview of the wider area. However, the magnetic susceptibility contrast between the fills of the graves and the surrounding clay is likely to be too weak to distinguish the grave features. A technique which essentially measures soil moisture, such as electrical resistance, may be more effective at detecting these features in this instance. Also, unlike the magnetic data, the resistance data will not be adversely affected by the post-and-wire stock fence which crosses the known part of the cemetery, nor by any ferrous/fired litter which may be present.

Fieldwork

4.4 It is anticipated that 0.5ha will be surveyed geomagnetically and that up to 0.25ha will be surveyed using the resistance technique. A 20m grid will be established across the study area and tied-in to known points.

4.5 Measurements of vertical geomagnetic field gradient will be determined using Geoscan FM36/256 or Bartington Grad601-2 fluxgate gradiometers. Measurements of electrical resistance will be determined using a Geoscan RM15D meter. A zig-zag traverse scheme will be employed and data logged in 20m grid units.

4.6 For the magnetic survey, the instrument sensitivity will be set to 0.1nT, the sample interval to 0.25m and the traverse interval to 0.5m, thus providing 3,200 sample measurements per 20m grid unit.

4.7 For the resistance survey, a mobile probe separation of 0.5m will be used to measure resistance at a theoretical depth of 0.75m. The instrument sensitivity will be set to 0.1ohm, the sample interval to 0.25m and the traverse interval to 0.5m, thus providing 3,200 measurements per 20m grid unit.

4.8 This sampling interval would be appropriate for detecting small/narrow features such as graves.

4.9 Data will be downloaded on-site into a laptop computer for verification, initial processing and storage and subsequently transferred to a desktop computer for further processing, interpretation and archiving. Geoplot v3 software will be used to process and interpolate the data to form gridded arrays of regularly-spaced values at 0.25m intervals and to produce continuous-tone greyscale images and trace plots of the raw data.

Reporting

4.10 The greyscales will be presented by importing the images directly into digital plans of the area, to be supplied by the project. A palette bar relating the greyscale/trace intensities to anomaly values in nanoTesla/ohms will be included with each image. Other types of plots may also be provided, if they aid presentation or interpretation.

4.11 Colour-coded geophysical and archaeological interpretation plans will be provided. The survey report will also include a detailed discussion and interpretation, explaining the likely nature of the anomalies, along with their implications. Modern services and other potential hazards will be clearly distinguished. CAD drawing files, bitmap image files and data files can be supplied on request.

4.12 The report will be prepared suitable for submission to the Bamburgh Bowl Hole Project, the county SMR and OASIS.

4.13 The report will be based on the following format:

1. Executive summary
    - 1.1 The project
    - 1.2 Results
    - 1.3 Recommendations
2. Project background
    - 2.1 Location
    - 2.2 Objective
    - 2.3 Dates
    - 2.4 Personnel
    - 2.5 Acknowledgements
    - 2.6 Archive
3. Archaeological and historical background
4. Landuse, topography and geology

5. Geophysical survey
    5.1 Technique selection
    5.2 Field methods
    5.3 Data processing
    5.4 Interpretation: anomaly types
    5.5 Interpretation: features
6. Discussion
7. References

Archive

4.14 A survey archive will be produced on CD containing copies of the report, raw data files and metadata. This will be supplied to the Bamburgh Bowl Hole Project for deposition with the project archive in due course.

5. Insurance details

5.1 Durham University is a member of UM Association Limited and maintains the following covers provided by ACE Insurance SA-NV:

Employer's liability	£25,000,000	Certificate no. 42UKA09609/050
Public & products liability	£25,000,000	Certificate no. UM050/00
Professional indemnity	£ 5,000,000	Certificate no. UM050/00
Contractor's 'all risks'	£ 1,000,000	Certificate no. UM050/00

6. Safety, Health & Environmental Management

6.1 Archaeological Services abides by the 1974 Health and Safety Act and its subsequent amendments. We also follow the guidelines within *Health and Safety in Field Archaeology* (Standing Conference of Archaeological Unit Managers 2002, 4th edition), and the University of Durham's *Code of Practice for Safety in Fieldwork* (University & Colleges Employers Association 1995). All works comply with CDM regulations. Risk Assessment and COSHH forms are completed before any works commence. All staff receive an appropriate Health and Safety Induction Talk before being allowed on site, which includes provision for working with plant. Each team member signs the Risk Assessment at the end of the induction. Archaeological Services provides all personnel members with appropriate safety clothing and equipment, including mobile telephones, and ensures that qualified First Aiders and are present at all times during work. All field personnel receive Manual Handling training.

6.2 Archaeological Services is committed to ensuring that all personnel pass the CITB Construction Skills Health and Safety Test and subsequently become CSCS card-carriers (Construction Skills Certification Scheme).

7. Copyright

7.1 Copyright in this document rests with Archaeological Services Durham University. Copyright of project reports also rests with Archaeological Services Durham University unless specific arrangements are made for its assignment elsewhere.

8. Quotation

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