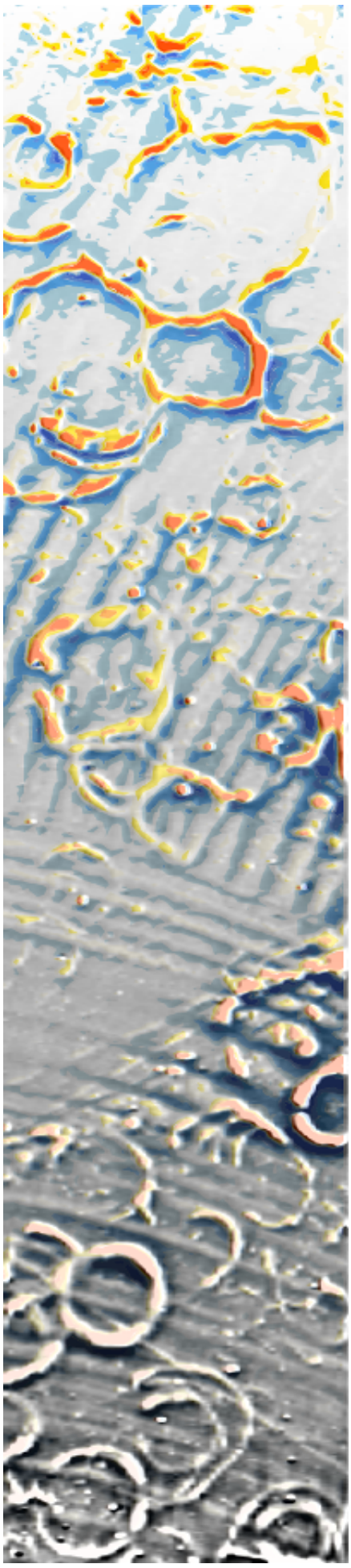

Carne Beacon, Veryan, Cornwall

Geophysical Survey Report

Produced for the National Trust

Unlocking Our Coastal Heritage Project

Project code NTC122

July 2013

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Non-Technical Summary

A magnetic survey was commissioned by the National Trust to prospect an area of land surrounding the mound of Carne Beacon for buried structures of archaeological interest, under the aegis of the Unlocking Our Coastal Heritage project.

The results are striking with three concentric discontinuous rings of ditches found to surround the mound. Various ages of former field and enclosure boundary ditch run towards the mound and illustrate that it has been a focus within the landscape for a long time. A second cairn was found close by, apparently undisturbed.

Digital Data

Item	Sent to	Sent date
CAD – Vector Elements	Jim Parry email	01/08/13

Audit

Version	Author	Checked	Date
Interim	MJR		
Draft Final	MJR, ACKR	ACKR	01/08/13
Final			
Revision			
OASIS			

Table of Contents

1 Introduction

Land surrounding the mound of Carne Beacon was surveyed using ArchaeoPhysica's sledge mounted caesium vapour magnetometer array as part of the National Trust's Unlocking our Coastal Heritage project, to prospect for buried structures of archaeological interest.

1.1 Location

Country	England
County	Cornwall
Nearest Settlement	Veryan
Central Co-ordinates	191263, 38637

Approximately 1.7 hectares was surveyed, filling the corner of the field and wrapping right round the mound.

1.2 Constraints & variations

No constraints were encountered or variations necessary.

2 Context

2.1 Archaeology

The following information is quoted verbatim from the brief (Parry, 2012):

"Carne Beacon is one of the largest Bronze Age barrows in Britain. It has a diameter of 33m and is 5.5m high. There are slight traces of a berm and ditch around the barrow which were recorded in 2001 during the assessment of the scheduling. It sits within a field that is in arable rotation. From the summit it offers extensive views of the surrounding countryside. A public footpath runs past the barrow and it has become popular as a stopping place along the route. It is popularly claimed to be the burial site of King Gerrient of Cornwall 590AD. It is said that he was rowed across Gerrans Bay in a golden boat with silver oars and then buried in the barrow."

2.2 Environment

Superficial 1: 50000 BGS	None recorded
Bedrock 1:50000 BGS	Eifelian to Givetian Carne Formation Sandstone (CRNE)
Topography	Level
Hydrology	Presumed to be free draining
Current Land Use	Pasture
Historic Land Use	Mixed agricultural
Vegetation Cover	Grass
Sources of Interference	Wire fencing, especially round the mound

Soils derived from Devonian sandstone in this area can be expected to exhibit a fairly high natural susceptibility, although not universally so, hence there is a reasonable chance of being able to detect and map buried structures that are rock cut or contain relict topsoil.

3 Methodology

3.1 Survey

3.1.1 Technical equipment

Measured variable	Magnetic flux density / nT
Instrument	Array of Geometrics G858 Magmapper caesium magnetometers
Configuration	Non-gradiometric transverse array (4 sensors, ATV towed)
Sensitivity	0.03 nT @ 10 Hz (manufacturer's specification)
QA Procedure	Continuous observation
Spatial resolution	1.0m between lines, 0.3m mean along line interval

3.1.2 Monitoring & quality assessment

The system continuously displays all incoming data as well as line speed and spatial data resolution per acquisition channel during survey. Rest mode system noise is therefore easy to inspect simply by pausing during survey, and the continuous display makes monitoring for quality intrinsic to the process of undertaking a survey. Rest mode test results (static test) are available from the system.

3.2 Data processing

3.2.1 Procedure

All data processing is minimised and limited to what is essential for the class of data being collected, e.g. reduction of orientation effects, suppression of single point defects (drop-outs or spikes) etc. The processing stream for this data is as follows:

Process	**Software**	**Parameters**
Measurement & GNSS receiver data alignment	Proprietary	
Temporal reduction, regional field suppression	Proprietary	60s median highpass
Gridding	Surfer	Kriging, 0.25m x 0.25m
Smoothing	Surfer	Gaussian lowpass 3x3 data
Imaging and presentation	Manifold GIS	

The initial processing uses proprietary software developed in conjunction with the multisensor acquisition system. Gridded data is ported as data surfaces (not images) into Manifold GIS for final imaging and detailed analysis. Specialist analysis is undertaken using proprietary software.

General information on processes commonly applied to data can be found in standard text books and also in the 2008 English Heritage Guidelines "Geophysical Survey in Archaeological Field Evaluation" at http://www.helm.org.uk/upload/pdf/Geophysical_LoRes.pdf.

ArchaeoPhysica uses more advanced processing for magnetic data using potential field techniques standard to near-surface geophysics. Details of these can be found in Blakely, 1996, "Potential Theory in Gravity and Magnetic Applications", Cambridge University Press.

All archived data includes process metadata.

3.3 Interpretation framework

3.3.1 Resources

Numerous sources are used in the interpretive process which takes into account shallow geological

conditions, past and present land use, drainage, weather before and during survey, topography and any previous knowledge about the site and the surrounding area. Old Ordnance Survey mapping is consulted and also older sources if available.

3.3.2 Magnetic

Interpretative logic is based on structural class and examples are given below. For example a linear field or gradient enhancement defining an enclosed or semi-enclosed shape is likely to be a ditch fill, if there is no evidence for accumulation of susceptible material against a non-magnetic structure. Weakly dipolar discrete anomalies of small size are likely to have shallow non-ferrous sources and are therefore likely to be pits. Larger ones of the same class could also be pits or locally-deeper topsoil but if strongly magnetic could also be hearths. Strongly dipolar discrete anomalies are in all cases likely to be ferrous or similarly magnetic debris, although small repeatedly heated and in-situ hearths can produce similar anomalies. Reduced field strength (or gradient) linear anomalies without pronounced dipolar form are likely to be caused by relatively low susceptibility materials, e.g. masonry walls, stony banks or stony or sandy ditch fills.

3.4 Standards & guidance

All work was conducted in accordance with the following standards and guidance:

- David et al, "Geophysical Survey in Archaeological Field Evaluation", English Heritage, 2008.
- "Standard and Guidance for Archaeological Field Evaluation", Institute for Archaeologists, 2008.

In addition, all work is undertaken in accordance with the high professional standards and technical competence expected by the Geological Society of London and the European Association of Geoscientists and Engineers.

All personnel are experienced surveyors trained to use the equipment in accordance with the manufacturer's expectations. All aspects of the work are monitored and directed by fully qualified professional geophysicists.

4 Catalogue

Label	Anomaly Type	Feature Type	Description	Easting	Northing
1	Strong linear enhanced dipolar	Fill - Ditch	As with all the ditch fills associated with the mound (so [2], [3] [4] and [5]) this is very strongly magnetic (> 50 nT) and given the lesser strength of anomalies associated with former field boundaries etc. it is probable that the fills contain material that has been heated. This might suggest the site has not always been a simple barrow and has been a focus for other activities. Perhaps the mound has also been a beacon? The apparently discontinuous nature of the ditches is also puzzling. This anomaly, with [3], implies an arc up to 80m diameter defined by a ditch approximately 2m wide	191261.7	38682.8
2	Strong linear enhanced dipolar	Fill - Ditch	See [1]. This circuit is more continuous than the outermost one but is again absent from the west side of the monument. The ditch (approximately 2m wide) defines an area of 60m diameter	191289.1	38665.9
3	Strong linear enhanced dipolar	Fill - Ditch	Part of the outermost circuit of ditches. See [1]	191308.1	38654.0
4	Strong linear enhanced dipolar	Fill - Ditch	Part of the outermost circuit of ditches? See [1]	191228.3	38647.0
5	Strong linear enhanced dipolar	Fill - Ditch	The innermost circuit of ditch, apparently continuous and of about 20m diameter. It lays just outside the present fence	191264.8	38620.3
6	Area enhanced field	Fill - Ditch?	Possible boundary ditch, although broad (up to 2.5m wide) and not obviously part of a former field system and more magnetic than the ridge and furrow cultivation that is parallel to it. See also [7] which seems to continue the feature westwards	191303.1	38610.3
7	Area enhanced field	Fill - Ditch?	See [6] which appears to be the same feature east of ring ditch [2]. Here it is more obviously parallel to ridge and furrow cultivation and hence perhaps a medieval feature?	191221.8	38635.7
8	Area variable field	Structure	A possible ring ditch of about 17m diameter encloses an area of reduced magnetic field strength typical of stony or sandy soil. It is possible that this is a low cairn, perhaps a satellite structure to the mound and ditches	191234.9	38595.6

9	Linear enhanced dipolar	Fill - Ditch	This ditch fill, with [10], suggests that either a field boundary once extended north from the sharp bend in the lane or perhaps that the lane itself once passed across the monument although there is no sign of the west side or surfacing material if so	191254.3	38584.5
10	Linear enhanced dipolar	Fill - Ditch	See [9]	191244.8	38609.5
11	Area variable field	Fills / structure - Ditches?	With the corner of the field, that looks to be the result of a combination of different field systems and selected removal of boundaries, there is weak linear anomaly that seems to define a rectangular area measuring approximately 16m x 24m	191187.3	38561.9
12	Linear enhanced dipolar	Fill - Ditch	This appears to be the northern ditch of a Cornish hedge, however, it has a different character to the southern ditch and therefore these may be of different dates or past treatment. It is possible that this is an older feature later made into a Cornish hedge, hence having possible enclosure [13] associated with it	191226.1	38671.8
13	Linear enhanced dipolar	Fill - Ditch?	A small enclosure may be attached to the south side of [12], aligned parallel to it and about 7m wide	191201.1	38669.5
14	Area enhanced field	Disturbance? / natural?	Uncertain cause, a natural soil structure is possible but this could also be an area of soil with increased magnetic susceptibility, e.g. through heating and cooling, and hence perhaps a midden or similar deposit	191217.8	38695.3
15	Linear reduced field	Structure?	At only about 0.5m wide this seems likely to be a buried service, e.g. a drainage pipe or culvert. It appears to skim past the upstanding part of the monument, continuing southeast as [16]	191237.3	38682.2
16	Linear reduced field	Structure?	See [15]	191268.2	38584.9

5 Discussion

5.1 Introduction

The sections below first discuss the geophysical context within which the results need to be considered and then specific features or anomalies of particular interest. Not all will be discussed here and the reader is advised to consult the catalogue (ibid) in conjunction with the graphical elements of this report.

5.2 Principles

In general, topsoil is more magnetic than subsoil which can be slightly more magnetic than parent geology, whether sands, gravels or clays, however, there are exceptions to this. The reasons for this are natural and are due to biological processes in the topsoil that change iron between various oxidation states, each differently magnetic. Where there is an accumulation of topsoil or where topsoil has been incorporated into other features, a greater magnetic susceptibility will result.

Within landscapes soil tends to accumulate in negative features like pits and ditches and will include soil particles with thermo-remanent magnetization (TRM) through exposure to heat if there is settlement or industry nearby. In addition, particles slowly settling out of stationary water will attempt to align with the ambient magnetic field at the time, creating a deposit with depositional remanent magnetization (DRM).

As a consequence, magnetic survey is nearly always more a case of mapping accumulated magnetic soils than structures which would not be detected unless magnetic in their own right, e.g. built of brick or tile. As a prospecting tool it is thus indirect. Fortunately, the mechanisms outlined above are commonplace and favoured by human activity and it is nearly always the case that cut features will alter in some way the local magnetic field.

5.2.1 Instrumentation

The use of the magnetic sensors in non-gradiometric (vertical) configuration avoids measurement sensitisation to the shallowest region of the soil, allowing deeper structures, whether natural or otherwise to be imaged within the sensitivity of the instrumentation. However, this does remove suppression of ambient noise and temporal trends which have to be suppressed later during processing. When compared to vertical gradiometers in archaeological use, there is no significant reduction in lateral resolution when using non-gradiometric sensor arrays and the inability of gradiometers to detect laminar structures is completely avoided.

Caesium instrumentation has a greater sensitivity than fluxgate instruments, however, at the 10 Hz sampling rate used here this increase in sensitivity is limited to about one order of magnitude.

The array system is designed to be non-magnetic and to contribute virtually nothing to the magnetic measurement, whether through direct interference or through motion noise. There is, however, some limited contribution from the towing ATV.

5.3 Character & principal results

5.3.1 Geology

The bedrock geology is Devonian sandstone and in common with many Devonian rocks it is capable of supporting natural magnetic enhancement of the soils. Features like field boundary ditches tend to be clearly defined simply by increased depth of topsoil above them or relict topsoil within them. Over some rock types weathering of the rock itself may also be increasing the natural magnetic susceptibility of the soil.

Here the usual slightly mottled background texture of sandstone is evident and it is possible that the soil is quite thin. If so, it would have provided a ready source of stone for the cairn beneath the mound and also

other structures. These are unlikely to be directly detectable by magnetic survey unless then displace more magnetic materials. It also seems likely that some at least of the ditches are partly rock-cut.

Overall the natural magnetic susceptibility of the soil appears to be sufficient to allow the detection and reliable mapping of most soil-filled structures.

5.3.2 Land use

The southern and western parts of the survey have evidence for ridge and furrow or lazy bed style cultivation, potentially constrained by the sites of two former Cornish hedges (e.g. [12]). The mound has clearly been a past focus for the laying out of fields with three Cornish hedges meeting at it but also two potentially older boundaries [6] and [7]. All the Cornish hedges were laid out after the outer two ditch circuits [1], [2] and [3] had disappeared as they pas right across them.

Further changes in the landscape are evident as the loss of what seems to have been a small close in the southwest corner, containing [11] and possibly also a re-alignment of the lane from [9] and [10] passing the mound. The former enclosure forms an odd angle with the road and this might hint at further alterations to the landscape just outside the area surveyed.

5.3.3 Archaeology

Two principal groups of anomalies are evident, the multiply ringed barrow itself and a smaller satellite cairn [8] to the southwest. The barrow appears to have one continuous ring ditch [5] of about 40m diameter, surrounded by two discontinuous rings [2], [1], [3] and [4] with diameters of approximately 60m and 80m. Of these the outermost is the least continuous and indeed is only visible as arcs around the eastern and northern sides. The middle ring is continuous apart from a large gap on the east side.

These gaps are of course an absence of magnetic anomaly and not necessarily an absence of feature and because these anomalies are about four times larger than other fills of the site (e.g. former field boundary ditches) the magnetics of these features is complex. It seems likely that the magnetic susceptibility of their fills has been artificially enhanced, e.g. by the incorporation of quantities of heated soil. Given that cremation burials have been found within the periphery of the mound (G. Kirkham, *pers. comm.*) it seems likely that material from these is within the ditches. Whether this has occurred as primary deposition or as a result of later robbing of soil from the mound to fill the ditches is not known.

The second structure, cairn [8] is smaller (about 18m in diameter) and seems to comprise a narrow ditch around an area of reduced magnetic field strength. This has been interpreted as likely to be caused by stones or sandy soil and the former would be typical of the base of a flat or robbed cairn. There is no sign of central or associated structures.

It is possible that the Cornish hedge of which [12] is part may have evolved from an earlier and more strongly magnetic structure. Although not as magnetic as the barrow ditches, [12] is still locally strongly magnetised and it is revealing that it is more so than the southern ditch of the same Cornish hedge. The implication is that the ditch marked by [12] has been exposed to magnetic material perhaps from the mound. If so this might lend credibility to there having been an attempt in the past to fill in ditches using material from the mound.

The significance of possible enclosure [13] against the south side of [12] is uncertain. It overlies the southern ditch of the Cornish hedge yet is not as magnetic at the northern, hence contains a different type of fill.

It seems likely that small and non-magnetic structures of archaeological interest may survive between the features detected by this survey.

5.4 Conclusions

It seems likely that there are further significant structures nearby and especially considering the focus that mound has evidently received in the past. The clarity of the data is good and there is a clear distinction

evident between soils with natural and artificial susceptibilities, so there is diagnostic data available.

The large number of structures found within this small survey would suggest that further magnetic survey in this area is likely to reveal much information.

5.5 Caveats

Geophysical survey is a systematic measurement of some physical property related to the earth. There are numerous sources of disturbance of this property, some due to archaeological features, some due to the measuring method, and others that relate to the environment in which the measurement is made. No disturbance, or 'anomaly', is capable of providing an unambiguous and comprehensive description of a feature, in particular in archaeological contexts where there are a myriad of factors involved.

The measured anomaly is generated by the presence or absence of certain materials within a feature, not by the feature itself. Not all archaeological features produce disturbances that can be detected by a particular instrument or methodology. For this reason, the absence of an anomaly must never be taken to mean the absence of an archaeological feature. The best surveys are those which use a variety of techniques over the same ground at resolutions adequate for the detection of a range of different features.

Where the specification is by a third party ArchaeoPhysica will always endeavour to produce the best possible result within any imposed constraints and any perceived failure of the specification remains the responsibility of that third party.

Where third party sources are used in interpretation or analysis ArchaeoPhysica will endeavour to verify their accuracy within reasonable limits but responsibility for any errors or omissions remains with the originator.

Any recommendations are made based upon the skills and experience of staff at ArchaeoPhysica and the information available to them at the time. ArchaeoPhysica is not responsible for the manner in which these may or may not be carried out, nor for any matters arising from the same.

5.6 Bibliography

Parry, 2012, "Unlocking Our Coastal Heritage Project: Carne Beacon and Veryan Castle, nr Veryan, The Roseland, Cornwall - Brief for Geophysical Survey" National Trust, unpublished

5.7 Acknowledgements

Jim Parry, National Trust Archaeologist, the farmer and the local National Trust rangers and wardens for arranging access.

6 Appendices

6.1 Project metadata

Project Name	Carne Beacon, Veryan, Cornwall
Project Code	NTC122
Client	The National Trust
Fieldwork Dates	17/07/13
Field Personnel	D Rouse, R Vine
Data Processing Personnel	ACK Roseveare
Reporting Personnel	MJ Roseveare, ACK Roseveare
Draft Report Date	31/07/13
Final Report Date	

6.2 Qualifications & experience

All work is undertaken by qualified and experienced geophysicists who have specialised in the detection and mapping of near surface structures in archaeology and other disciplines using a wide variety of techniques. There is always a geophysicist qualified to post-graduate level on site during fieldwork and all processing and interpretation is undertaken under the direct influence of either the same individual or someone of similar qualifications and experience.

ArchaeoPhysica meets with ease the requirements of English Heritage in their 2008 Guidance "Geophysical Survey in Archaeological Field Evaluation" section 2.8 entitled "Competence of survey personnel". The company is one of the most experienced in European archaeological prospection and is a key professional player. It only employs people with recognised geoscience qualifications and capable of becoming Fellows of the Geological Society of London, the Chartered UK body for geophysicists and geologists.

6.3 Safety

Safety procedures follow the recommendations of the International Association of Geophysical Contractors (IAGC).

Principal personnel have passed the Rescue Emergency Care – Emergency First Aid course and CSCS cards are being sought for those members of staff currently without them.

All personnel are issued with appropriate PPE and receive training in its use. On all sites health and safety management is performed by the Project Geophysicist under supervision by the Operations Manager.

Health and safety policy documentation is reviewed every 12 months, or sooner if there is a change in UK legislation, a reported breach of such legislation, a reported Incident or Near Miss, or changes to ArchaeoPhysica's activities. Anne Roseveare, Operations Manager, has overall responsibility for conducting this review and ensuring documentation is maintained.

We are happy to confirm that ArchaeoPhysica has suffered no reportable accidents since its inception in 1998.

6.4 Archiving

ArchaeoPhysica maintains an archive for all its projects, access to which is permitted for research purposes. Copyright and intellectual property rights are retained by ArchaeoPhysica on all material it has produced, the client having full licence to use such material as benefits their project.

Archive formation is in the spirit of Schmidt, A., 2001, "Geophysical Data in Archaeology: A Guide to Good Practice", ADS.

Access is by appointment only. Some content is restricted and not available to third parties. There is no automatic right of access to this archive by members of the public. Some material retains commercial value and a charge may be made for its use. An administrative charge may be made for some enquiries, depending upon the exact nature of the request.

The archive contains all survey and project data, communications, field notes, reports and other related material including copies of third party data (e.g. CAD mapping, etc.) in digital form. Many are in proprietary formats while report components are available in PDF format.

In addition, there are paper elements to some project archives, usually provided by the client. Nearly all elements of the archive that are generated by ArchaeoPhysica are digital.

It is the client's responsibility to ensure that reports are distributed to all parties with a necessary interest in the project, e.g. local government offices, including the HER where present. ArchaeoPhysica reserves the right to display data from projects on its website and in other marketing or research publications, usually with the consent of the client. Information that might locate the project is normally removed unless otherwise authorised by the client.