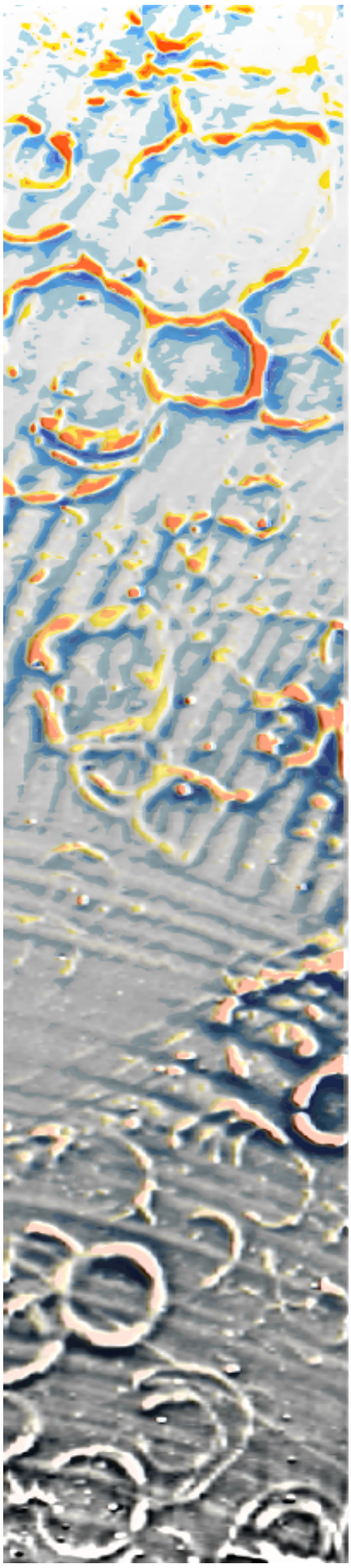

Crane Castle, Illogan, Cornwall

Geophysical Survey Report

Produced for the National Trust

Unlocking Our Coastal Heritage Project

Project code NTC123

July 2013

MJ Roseveare, ACK Roseveare

ArchaeoPhysica Ltd

Kitchener's, Home Farm, Harewood End, Hereford HR2 8JS
Tel. +44 (0) 1989 730 564 www.archaeophysica.com

Non-Technical Summary

A magnetic survey was commissioned by the National Trust to prospect land just inland from Crane Castle for buried structures of archaeological interest, under the aegis of the Unlocking Our Coastal Heritage project.

The site was found to have been heavily ploughed and this combined with the shallow soil has meant that very little was found, either because it is obscured by magnetic striation from ploughing or because little of what may have been present has survived in a magnetically detectable form. There is no magnetic evidence for the postulated anti-glider defences across the site.

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 inland from Crane Castle 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	County
Nearest Settlement	Illogan
Central Co-ordinates	163665, 43835

Approximately 16.6 hectares were surveyed within a single field.

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):

2.1.1 Prehistoric

"The earliest indications of human activity within the survey area are represented by a large lithic scatter recovered across the fields immediately adjacent to the scheduled area. This matches the nature and pattern of prehistoric activity recorded along this part of the coastline. A brief description of each site is given below:

Over a fifteen year period a large lithic scatter was recovered from Raskajeage Downs (sites 3 (SW 6367 4395), 4 (SW 6367 4395) and 6 (SW 638 438)) which included a concentration in a semicircular area approximately 160m in diameter. Three artefacts date from the Upper Palaeolithic, twenty-nine from the Mesolithic, one hundred and ninety four from the Neolithic, and sixty from the Bronze Age. The total assemblage consisted of one hundred and eight primary and secondary flakes of beach flint, five axes (three of greenstone and two of sedimentary rock), one flint hammerstone, two greenstone hammerstones , seventy-eight scrapers, one hundred and eleven blades, seventeen bladelets, four fabricators, three chopping tools, one spokeshave, three microliths, one macehead, forty cores, five knives, eight awls, and five arrowheads (three leaf-shaped, one biface barbed and-tanged and one hollow-based). The majority of the material was made from beach flint but pebble flint accounted for a small percentage of the collection.

Alongside the artefact scatter Bronze Age activity is possibly indicated by a circular earth mound, approx 10m in diameter is visible on air photographs (Site 5). It is possible that it may be a feature associated with the anti-glider defences at this location (Site 7). 3.4 The Iron Age is represented by the remains of the scheduled cliff castle (Site 1 SW 6347 4397). All that now remains of Crane Castle are two lines of defensive banks. The interior of the site, once a minor headland now represented by Crane Islands, has been entirely removed by cliff erosion since the prehistoric period. The rate of erosion may have slowed down in recent times; William Borlase described the site in the 18th century and there appears to be little change to the site since he visited it.

The defences comprise two slightly curving banks (not straight as shown by the OS or Henderson's 1916 plan); the inner bank is massive, up to c.3.5-4m high with a ditch 3m wide and 1.5m deep in front; the

outer bank is slighter and only reaches 2m high with an accompanying ditch 4m wide and 0.7m deep. There is no sign of an entrance; this was presumably in the portion lost to the sea. The banks of the bivallate work appear to be of earth and stone."

2.1.2 Medieval

"During this period we have little evidence as to what was occurring however it is likely that the area was subject to animal grazing as was happening across much of Cornwall's coastal margins. A settlement at Carvannel (c.900m SW of Crane Castle) is first recorded in 1484."

2.1.3 Post-Medieval

"During this period the landscape continues to be managed to varying degrees through agriculture. A disused sub-rectangular enclosure adjoins Crane cliff castle (Site 2). It is constructed of straight lengths of earth bank 0.5m high with a ditch on the outer side. An entrance is likely to have existed on the west side, as the bank does not run to the cliff edge. The form of the bank (with its exterior ditch) shows that it was not intended to enclose livestock but to keep them out. It has been suggested that this feature may be associated in some way with the Basset family's interests in horse racing. Tangye records that Lord de Dunstanville of Tehidy had a 'running horse stable' erected on Reskajeage Down in 1780. It is possible that the enclosure at Crane Castle, although probably later than 18th century, is a paddock or similar feature. The wider area was also known to lie within the 18th century deer park boundary of Tehidy."

2.1.4 20th Century

"A series of oblong pits with associated spoil mounds are visible on air photographs (Site 7). The pits are clearly 'anti-glider' defences, designed to prevent enemy aircraft landing on the plateau at North Cliffs. Several slit trenches and possible buildings associated with the defences are also visible."

2.2 Environment

Superficial 1: 50000 BGS	None recorded
Bedrock 1:50000 BGS	Eifelian to Frasnian Porthtowan Formation - Mudstone and Sandstone (POAN)
Topography	Level
Hydrology	Uncertain, perhaps free draining
Current Land Use	Hay meadow
Historic Land Use	Mixed agricultural
Vegetation Cover	Grass
Sources of Interference	None

The Devonian bedrock is likely to support sufficient natural susceptibility enhancement to allow the detection of features cut into the bedrock or with fills containing former 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	40s median highpass filter
Gridding	Surfer	Kriging, 0.25m x 0.25m
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	Cropmark	Natural?	A broad band of lighter cereals occupies the southwest end of the field and is probably due to natural causes, however, it could also indicate an area once within a different field and subject to different land use practices	163419.9	43695.5
2	Cropmark	Natural / disturbed ground	A band (13m wide) of lighter cereals suggests disturbed ground. Anti-glider defences have been suggested within this field, but whether this is the same anomaly is uncertain. There is no associated magnetic evidence	163558.0	43762.2
3	Linear dipolar enhanced	Fill - Ditch?	A narrow (< 1.5m) probable ditch fill, perhaps continuing further east but virtually undetectable against strong magnetic striation from modern agriculture	163402.4	43722.5
4	Area enhanced	Fill? - Ditch?	Uncertain, anomaly not easily detectable against variations from natural and agricultural sources. See also [3]	163422.3	43661.0
5	Area enhanced	Fill? - Ditch?	See [4]; this could be part of the same complex	163487.7	43676.5
6	Area enhanced (sample)	Cultivation?	Uncertain, but one of several repeating cultivation features across the field with the same alignment. It is possible that these are what have been interpreted as anti-glider trenches in the past	163545.7	43719.7
7	Area enhanced	Fill - ditch / headland?	A broad (4 - 5m) and relatively clear magnetic anomaly of uncertain origin but probably not natural: characteristic of a fill, e.g. a broad ditch-like structure	163567.1	43680.4
8	Linear reduced	Fill / structure?	This reduced field linear anomaly, less than 2m wide, appears to be associated with [7] although it is not exactly parallel. It would be typical of a band of stony or sandy ground and in this context perhaps the remains of the surface of a path or road?	163573.5	43629.6
9	Area enhanced	Fill? - Ditch?	Very weak and also poorly defined anomalies appear to mark some sort of enclosure although this is not certain	163800.5	43788.4
10	Area enhanced	Fill? - Ditch?	See [9]	163784.6	43739.2

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 soil possesses significant natural magnetic susceptibility as would be expected of those formed over the Devonian meta-mudstone and meta-sandstone present here. It seems likely to be fairly shallow and with ploughing to have perhaps brought quantities of the rock into the soil, both increasing the amount of weathered material in the soil (which might increase the magnetic susceptibility in some circumstances) and perhaps also leaving permanent soil-filled scars in the rock. Either way, multiple episodes of ploughing and in different directions have created a strong magnetic texture.

The one definite deep-cut feature is a former Cornish hedge crossing the site and the fill of this is strongly magnetic, the anomaly being a few times stronger than those due to cultivation.

5.3.2 Land use

The land has been intensively cultivated in modern times, deeply ploughed, perhaps repeatedly. The only evidence for former land use is therefore fragmentary and limited to the ditches of the Cornish hedge that crossed the centre of the field (also aligned with the western edge of the enclosure on the headland) and the two linear structures [7] and [8] of uncertain form and function.

Given the latter's approximate alignment with the road, especially at the west end, it is possible that they represent former land divisions or perhaps former courses of the road.

5.3.3 Archaeology

There is little of archaeological interest in the data, apart from a possible ditch fill [3] of unknown function and two possible structures or sites of structures [9] and [10]. These latter are so weakly magnetic as to be virtually undetectable against the striation from ploughing and might not be real, or could be more extensive than apparent in the data.

There is no sign of the anti-glider defences said, from aerial photographic evidence, to cross the western part of the site. Given the clarity of the ditches of the former Cornish hedge, this is perhaps surprising.

5.4 Conclusions

The lack of anomalies as magnetic as the fills of the ditches of the former Cornish hedge might suggest there to be a paucity of similar, possibly rock cut, features at the site. If so, then anything of archaeological interest was presumably wholly contained within the soil and hence is likely to have been damaged or eroded away by modern agricultural activity. Weakly magnetic anomalies like [9] and [10] might therefore represent the spread remains of features that don't physically survive.

Overall, and given experience of other sites with similar environmental contexts, there appears to be little of archaeological interest surviving at this site.

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: Crane Castle Promontory Fort, Illogan, Cornwall – Brief for Geophysical Survey", the National Trust, unpublished

5.7 Acknowledgements

Jim Parry, National Trust Archaeologist, and the National Trust wardens are thanked for their help and support throughout the survey.

6 Appendices

6.1 Project metadata

Project Name	Crane Castle, Illogan
Project Code	NTC123
Client	The National Trust
Fieldwork Dates	16th July 2013
Field Personnel	D Rouse, R Vine
Data Processing Personnel	A Roseveare
Reporting Personnel	MJ Roseveare, A Roseveare
Draft Report Date	31st July 2013
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.