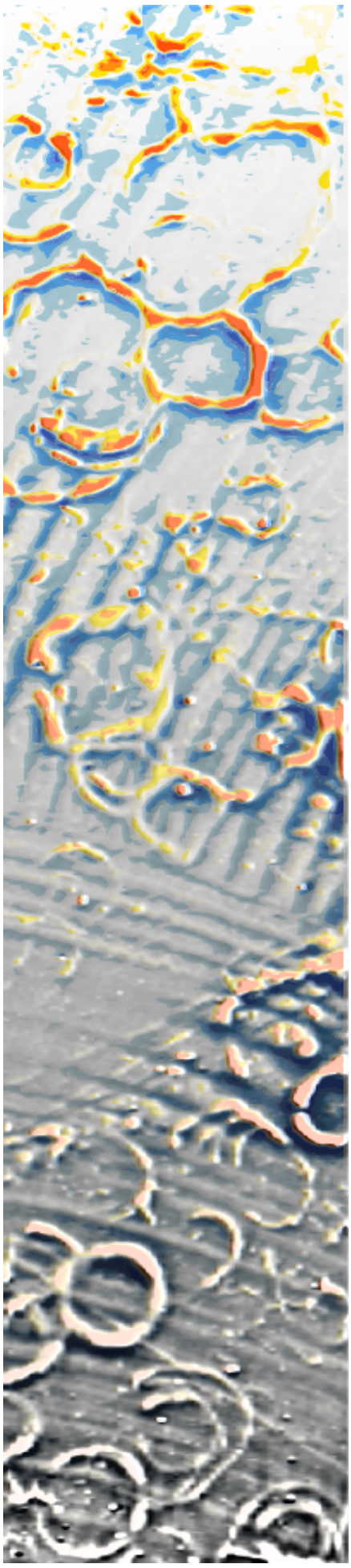

Land near Ingham, Suffolk

Geophysical Survey Report

Produced for CgMs Consulting

Project code NIS131, Suffolk HER ING 032

October 2013

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Non-Technical Summary

A magnetic survey was commissioned by CgMs Consulting to prospect land near Ingham in Suffolk for buried structures of archaeological interest in advance of a proposed photovoltaic power plant.

Apart from perhaps three short possible ditch fills nothing of interest was found although two former gravel quarries were located and mapped.

This project has OASIS ID archaeop1-163773;

Digital Data

Item	Sent to	Sent date
CAD – Vector Elements	Will Bedford & Rob Bourn	24th September 2013
CAD – Vector Elements 2nd batch	Will Bedford & Rob Bourn	29th October 2013

Audit

Version	Author	Checked	Date
Interim	MJR	MJR	24th September 2013
Draft Final (first survey)	MJR	MJR	25th September 2013
Draft Final (second survey)	RF	ACKR	29th October 2013
Final	MJR, RF	MJR	7th November 2013
Revision			
OASIS	MJR	MJR	7th November 2013

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1 Introduction

Land near Ingham in Suffolk was surveyed to prospect for buried structures of archaeological interest, the land being subject to a proposal to construct a photovoltaic power plant.

1.1 Location

Country	England
County	Suffolk
Nearest Settlement	Ingham
Central Co-ordinates	584910, 271750

Approximately 21 hectares were surveyed across two fields, the northern left as stubble and the central one fallow (re-seeded oil seed rape). The area to the south was surveyed later, following the beet harvest, bringing the total to 53 hectares.

1.2 Constraints & variations

The area was completely surveyed apart from some particularly rutted and soft areas in the south.

2 Context

2.1 Archaeology

Prehistoric and Roman material and sites have been found nearby but nothing is known within the survey area (Bedford, 2013).

2.2 Environment

Superficial 1: 50000 BGS	Cover Sand (CSD) (part) and Lowestoft Formation – Diamicton till (LOFT) (part)
Bedrock 1:50000 BGS	Lewes Nodular Chalk Formation, Seaford Chalk Formation, Newhaven Chalk Formation And Culver Chalk Formation (LCCK)
Topography	Gentle slope downhill to south
Hydrology	Free draining apart from low-lying areas in the southern part
Current Land Use	Arable
Historic Land Use	Arable
Vegetation Cover	Stubble (northern field), fallow - reseeded oil seed rape (central field), none (southern field)
Sources of Interference	None apart from overhead cables around two sides of one field

The geological basis of the site is magnetically fairly complex as it depends upon the location of two very different superficial deposits, coversand (CVS) and the Lowestoft Formation till (LOFT). The former is unlikely to support significant natural magnetic susceptibility and hence anomaly strengths from buried structures of archaeological interest are likely to be weak. In contrast the till could promote enhancement of susceptibility and the clay decomposition product of chalk can benefit magnetic survey. It is possible that magnetic geological (glacial) erratics may be present in the till. If at any location these deposits are thin and the chalk therefore close to the surface a relatively high magnetic contrast may be evident where features are cut into the chalk itself.

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 (6 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	0.3s lowpass then 5.0s highpass filters
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	Texture	Natural	The low susceptibility contrast evident here would be more typical of the coversands (CSD) than the Diamicton Till (LCCK), in contrast with the 1:50,000 BGS mapping and the soil lacks the flint evident further south	584988.3	272043.8
2	Texture	Natural	In contrast with [1] the more variable texture here could be Diamicton Till which is a mixture of flint, chalk, sand and gravel. Flint gravel is evident in the soil here and further south	584791.5	272068.4
3	Texture	Natural and cultivation?	As for [2] but here there is a suggestion of north-south aligned linear anomalies typical of former cultivation, e.g. ridge and furrow	584799.4	271895.8
4	Strong variable dipolar (group)	Debris	A number of strong magnetic anomalies and three in particular are typical of buried items of ferrous debris, perhaps within a fill within a former hollow?	584936.0	271895.4
5	Strong variable dipolar (group)	Debris	In some places (see also [6] and [9]) there is a band of strongly magnetic debris along the edge of the cultivated area, likely to be ferrous debris that has accumulated after clearance, although there is a lot of it. Could this be evidence of material being brought onto site, e.g. soil or rubble?	584798.6	271833.5
6	Strong variable dipolar (group)	Debris	See [5]	584933.6	271737.4
7	Texture	Natural and debris	Although the same geological context as [2], i.e most likely the Till, here the data is dominated by strong dipolar responses typical of small items of ferrous, brick or tile debris. This may have been spread from fills [10] and [11] but a more likely explanation is that it is material spread from elsewhere	584953.0	271537.4
8	Strong variable dipolar (group)	Debris	An isolated scatter of small items of debris, probably a concentration of what is apparent across the whole field	585056.6	271592.5
9	Strong variable dipolar (group)	Debris	See [5]	584883.6	271582.6
10	Strong dipolar (group)	Debris / ferrous items	See also [11]. A concentration of very strong anomalies typical of large ferrous items are present within the fill of a former gravel quarry	584961.4	271393.7
11	Strong dipolar (group)	Debris / ferrous items	See [10]	585033.6	271390.9

12	Strong variable dipolar (group)	Debris	A spread of debris south of the former gravel quarry becomes concentrated in a wide band along the southern edge of the survey which appears to the former location of a bund or tip	584977.6	271321.9
13	Linear enhanced dipolar	Fill? - Ditch?	Uncertain interpretation	585042.4	271500.0
14	Linear enhanced dipolar	Fill? - Ditch?	Uncertain interpretation	585023.8	271479.3
15	Linear enhanced dipolar	Fill - Ditch?	A possible narrow (1.5m?) ditch fill	585053.5	271491.4
16	Linear weak enhanced	Fill - Ditch	A possible drainage ditch	584638.8	271158.8
17	Linear weak enhanced	Fill - Ditch	As [16]	584938.4	270941.7
18	Linear enhanced	Fill - Ditch	A possible old field boundary running W-E across the field	584656.1	271240.0
19	Area enhanced	Natural	Area at the break of slope thought to be magnetically enhanced by natural accumulation	584494.4	271300.6

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

Clear variations in the background texture exist that will directly relate to different superficial geologies, specifically the cover sand and till. The sand appears to be most evident in the northeast corner [1] where magnetic variation is minimal and characterised by small-sized linear anomalies trending northwest to southeast. Further west this variation is replaced by larger ones [2] that could still be due to sand (or rather soil filled depressions within this) but are more likely to represent increasing quantities of other material, presumably as overlying sand thins. The material beneath will be either the chalk or the till. Further south

the till is evident [7] and although the magnetic texture is similar to the northwest area [2] there is a scatter of strong dipoles across the field. These may be magnetic stones in the till (in the Lowestoft Formation derived from northern England and Scotland) or could be ferrous debris spread through the soil.

At a break of slope, a weak linear feature [19] is probably the result of an accumulation of magnetically enhanced topsoil.

5.3.2 Land use

Anomalies [10] and [11] are strong and likely due to metal items within the fill of former quarry, possibly as a source of gravel for the nearby RAF base (landowner, *pers. comm.*). The aerial photograph used for this project reveals that the land has only recently been restored to agricultural use.

A slight depression in the northern field marks the site of sand or gravel pit and is likely to be associated with the scatter of debris [4].

There are indications of a former field boundary [18], however there is no evidence for variations in past land use. There are weak signs [3] of possible cultivation in the northern field. Linear features [16] and [17] could represent field drains, leading towards the topography on the site.

There is evidence in several places for the clearance of magnetic debris to field margins, possibly indicative of materials being brought onto site in soil and subsequently removed? It is possible that some of these are magnetic glacial erratics and this might explain the apparent association between the areas of glacial till and the concentrations of debris at the field margins.

5.3.3 Archaeology

Two short lengths of narrow (<1m) wide anomaly [13] and [14] might suggest the presence of a ditch fill but this identification is only tentative.

A possible ditch fill [15] extends for about 15m at an angle to the present field boundary. It might extend further southwest for perhaps up to 60m length. There is nothing to suggest a function for this.

5.4 Conclusions

The result can be summarised as the following list of points:

- there are few convincing signs of structures of archaeological interest;
- there is a sign of a former field boundary and only weak evidence for ridge and furrow cultivation;
- magnetic susceptibility is low in places, presumably due to the cover sands. In these areas it is possible that buried fills may not present a detectable magnetic anomaly, however, given the lack of structures elsewhere in the site this might not be a significant issue;
- the extent of the quarry in the southern field is now known and its fill contains metal objects.

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

Bedford, 2013, "Cultural Heritage Assessment – Land North of Ingham Suffolk", CgMs Consulting, unpublished, ref. WB/15575

6 Appendices

6.1 Project metadata

Project Name	Land near Ingham, Suffolk
Project Code	NIS131
Client	CgMs Consulting
Fieldwork Dates	18th - 19th September & 15th - 16th October 2013
Field Personnel	ACK Roseveare, MJ Roseveare
Data Processing Personnel	ACK Roseveare
Reporting Personnel	MJ Roseveare, ACK Roseveare, R Fry
Draft Report Date	25th September 2013 (updated 29th October 2013)
Final Report Date	7th November 2013

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.

6.5 OASIS ID: archaeop1-163773

Project details	
Project name	Land near Ingham Suffolk - NIS131
Short description of the project	Non-gradiometric caesium vapour magnetic survey in advance of proposed development
Project dates	Start: 18-09-2013 End: 29-10-2013
Previous/future work	No / Not known
Any associated project reference codes	ING 032 - HER event no.
Type of project	Field evaluation
Site status	None
Current Land use	Cultivated Land 3 - Operations to a depth more than 0.25m
Monument type	UNASSIGNED Uncertain
Significant Finds	N/A None
Methods & techniques	"Geophysical Survey"
Development type	Not recorded
Prompt	Direction from Local Planning Authority - PPS
Position in the planning process	Not known / Not recorded
Solid geology (other)	Lewes Nodular Chalk Formation, Seaford Chalk Formation, Newhaven Chalk Formation, Culver Chalk
Drift geology	GLACIAL SAND AND GRAVEL
Drift geology (other)	HEAD
Techniques	Magnetometry
Project location	
Country	England
Site location	SUFFOLK ST EDMUNDSBURY INGHAM Ingham
Study area	53.00 Hectares
Site coordinates	TL 8468 7152 52 0 52 18 37 N 000 42 34 E Point
Lat/Long Datum	Position derived from charts
Project creators	
Name of Organisation	ArchaeoPhysica Ltd
Project brief originator	Local Authority Archaeologist and/or Planning Authority/advisory body
Project design originator	ArchaeoPhysica Ltd
Project director/manager	M. Roseveare
Project supervisor	M. Roseveare
Type of sponsor/funding body	Developer
Project archives	
Physical Archive Exists?	No
Digital Archive recipient	ArchaeoPhysica Ltd

Digital Archive ID	NIS131
Digital Contents	"Survey"
Digital Media available	"GIS","Geophysics","Survey","Text"
Paper Archive Exists?	No
Entered by	MJ Roseveare (m.roseveare@archaeophysica.com)
Entered on	7 November 2013