ISAP NEWS

The newsletter of the International Society for Archaeological Prospection

Issue 15, April 2008

Contents

Editor's Note

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Welcome to the 15th issue of ISAP News. Please read on for yet another great selection of articles. My thanks go once again to all the contributors.

Don't forget, any member is welcome to send a contribution for inclusion and it would be great to hear from those who haven't submitted a piece before.

Any item for ISAP News 16 should be sent to me by 16th July 2008.

Polarity: The Example of Porticus Octaviae in Rome, Italy

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The focus of this article is to make GPR users aware of the fact that polarity could be diagnostic in interpretation (see Figures 1 and 2).

Usually, this issue prompts a number of questions and comments: the most common is how does one know what is positive and what is negative?

A reference is needed since data alone can be ambiguous. The first arrival direct wave is commonly used as a reference - unfortunately this can be misleading. Noggin Plus 1GHz data obtained from a marble building preservation project illustrate the problem.

The complex of *Porticus Octaviae*, in the area corresponding to the ancient Jewish ghetto in Rome, was rebuilt by Augustus, in the place of the most ancient *Porticus Metelli*, between 27 and 23 B.C. and it was dedicated to the sister Octavia. It was damaged by the fire in 80 and then again in 191 A.D., then it was rebuilt by Settimius Severus in the 203 A.D..

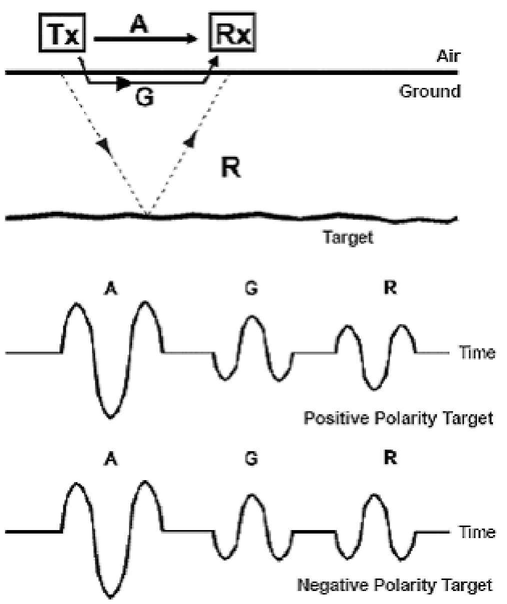
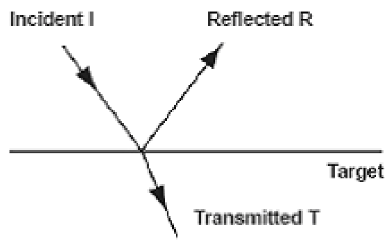


Figure 1: When GPR measurements are made, at least three events will normally be observed: the direct air wave A, the direct ground wave G and a reflected signal R. Two idealized radar traces displayed here show the polarity of the wavelets.

It was a tetraporch of 119 x 132 m, with a nave and two side aisles that included *Iuno Regina* and *Iovis Stator* temples, the *Curia* and two libraries, one Greek and the other Latin. Until today the complex has suffered a series of intense transformations and rapid changes, invalidating its statics and its conservation with fractures and lesions.



Reflection coefficient

$$R = \frac{Z_{target} - Z_{ground}}{Z_{target} + Z_{ground}}$$

For a dielectric target

$$R = \frac{\sqrt{K_{target}} - \sqrt{K}}{\sqrt{K_{target}} + \sqrt{K}}$$

Special case of metal target

$$Z_{target} = 0, \ R = -1$$

Figure 2: When a signal is incident on a target, the reflected signal polarity is dictated by the change in impedance between the target and the host ground.

For all the acquisition has been used the bistatic GPR Noggin Plus, equipped with 1 GHz antennas, using a temporal window of 30ns and a stacking of 4 and a step mode technique to obtain a constant sampling of 5 cm. We have been collected an horizontal profile of approximately 14 m both in perpendicular and in parallel broadside.

The velocity analysis is equal to 0.10 m/ns; based on this parameter the thickness of the architrave is 80-90 cm.

The data in Figure 3 show the response from the marble block structure. The direct wave, a reflection from a marble-air interface (positive polarity) and scattering from two metallic tie-rod (negative polarity) are visible on a selected superimposed trace.

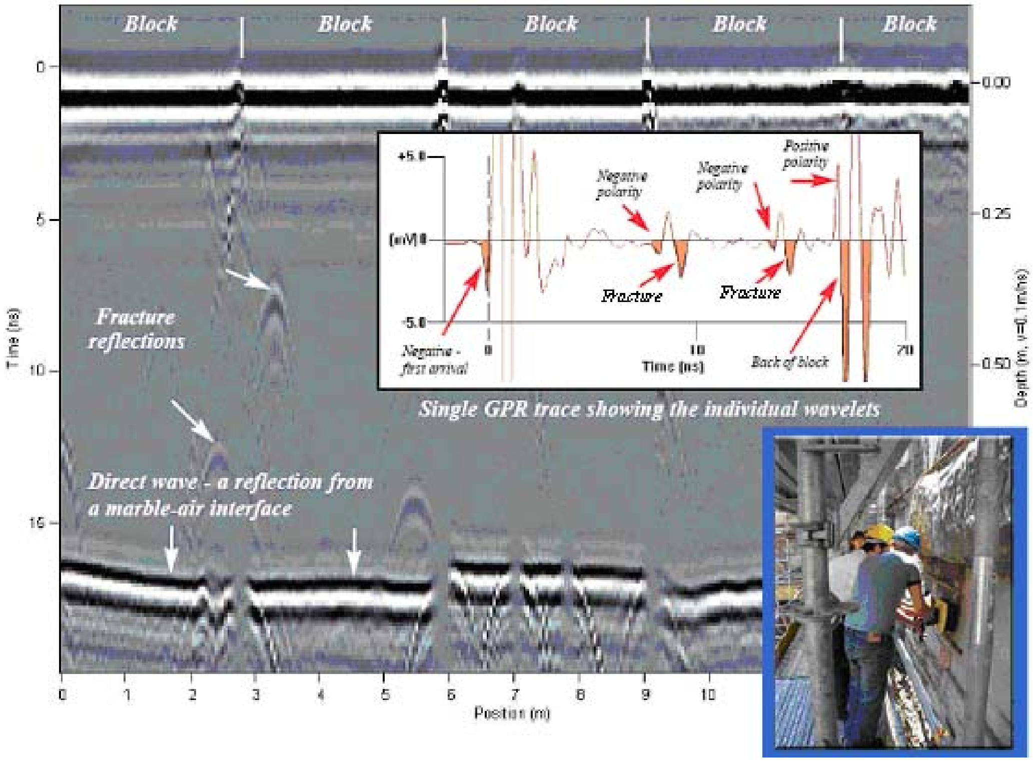


Figure 3: Noggin Plus 1GHz data from a marble architrave. The superimposed trace shows the wavelets from two fractures and the marble-air interface.

This example reinforces the need to be systematic when determining signal polarity. Many users assume the first arrival indicates positive polarity. This is not necessarily true. With shielded antennas tightly coupled to the ground, the first visible arrival can be the direct ground wave since the direct airwave may be eliminated by antenna shielding.

Since the direct ground wave is actually negative polarity, assuming it to be the positive reference polarity will result in incorrect polarity assignments. In order to use polarity, GPR users need to establish standard operational procedures.

The best way to confirm polarity is to measure the system response over a known target. For systems with separately moveable antennas, make sure that the antenna orientation remains the same while surveying.

In summary, polarity can provide diagnostic information but practice and care must be used to exploit it.

Initial Findings Using Comparative Magnetic Datasets

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Introduction

The Landscape Research Centre (LRC) is fortunate in having access to a number of reference sites in the Vale of Pickering (North Yokshire, England) which can be used to test the returns from different geophysical instruments. One of these is site 106, a field currently under permanent pasture, which has not been ploughed for at least 10 years. The area of 5.6 Ha has now been surveyed by 3 different magnetometers; a Bartington Grad 601-2 dual fluxgate gradiometer, a Foerster Ferex 4.032 DLG (using a 4 probe fluxgate gradiometer array), and by the English Heritage geophysics team using a Scintrex SM-4 caesium vapour magnetometer (employing 4 specially modified sensors). The magnetic surveys carried out by the LRC on this site have been supported by the Aggregates Levy Sustainability Fund.

Part of the site has also been surveyed by 2 resitivity meters; a small area by the LRC in the north-west corner using a Geoscan Research RM15 resistance meter, and most of the northern two-thirds of the field by Geocarta using the Automatic Resistivity Profiling (ARP) machine. We hope to present a comparison of these two datasets with the magnetic data in a future issue of the ISAP newsletter.

Results

It is intended to publish the results of these surveys in more detail in an article for Archaeological Prospection, but we present some of our preliminary findings here.

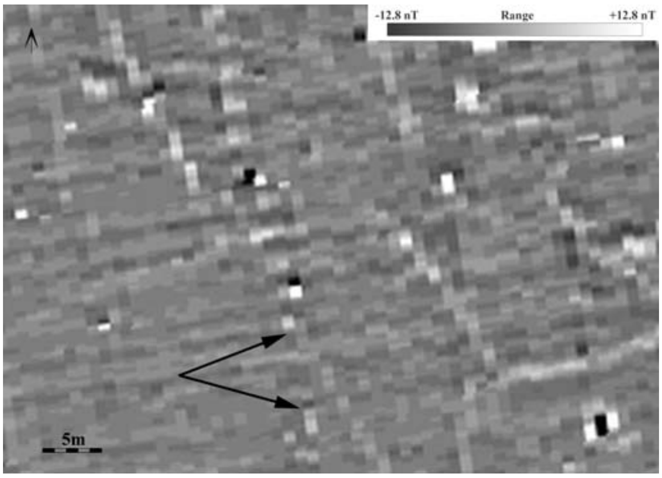

Figure 1 Area 1 Bartington Grad 601-2 data (resolution 0.25 x 1m traverse)

The Bartington data was collected at a spatial resolution of 0.25 along 1m traverses, with the machine set to a 0.1 nT sensitivity.

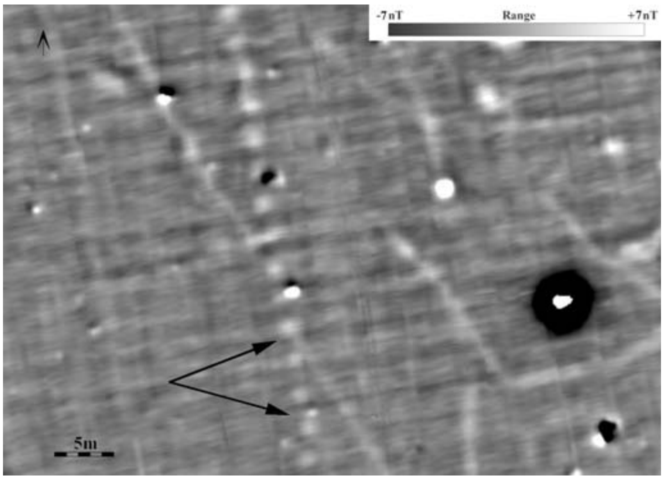

Figure 2 Area 1 Foerster Ferex 4.032 data (resolution 0.1 x 0.5m traverse)

The Foerster data was collected at a spatial resolution of 0.1 along 0.5m traverses, with the machine nominally providing a 0.2 to 0.3 nT sensitivity.

The linear anomalies extending across the area in a roughly east-west alignment are the remains of the final ploughing event.

The arrows in Figure 1 show the line of a pit alignment at a point where the lower resolution survey indicated that no pits were present. While it is possible for pit alignments to have gaps or entrances, this interpretation could not be justified from the initial survey data alone. The higher resolution survey (Figure 2) confirmed that the pit alignment is continuous, with three further pits detected. While a number of linear anomalies can be seen in the initial survey, they are much more clearly defined in the higher resolution data. The new, very strong anomaly in the south-western area of Figure 2 was a sheep feeder which was too heavy to move by hand.

Conclusion

The initial conclusion from the magnetic surveys of site 106 is that it is neither the type of magnetometer used nor the sensitivity of the machine that is most relevant to archaeological feature detection; rather it is the spatial resolution at which the data is collected. A total of 393 archaeological anomalies were interpreted from the surveys, of which 311 (79.2%) were detected by the initial Bartington survey and an additional 82 (20.8%) were detected by the higher resolution surveys. The increased definition also allowed for a greater degree of confidence in initial anomaly interpretation as being of archaeological origin.

Admittedly, it may be the case that a 20% increase in anomaly detection will not occur in less magnetically active areas; however, the “new” anomalies found by the higher resolution surveys tended to be weakly magnetic in strength, and were predominantly smaller features (i.e. pits, small funerary monuments and slighter enclosure ditches). The implication is that a similar increase in anomaly detection could be expected in other areas using a higher survey resolution.

While the fact that higher resolution surveys detect more magnetic anomalies will not come as a surprise to many geophysical practitioners, it has ramifications for the commercial geophysical sector, where the de facto standard for magnetic surveying is currently 0.25m along tracks using 1m traverses. While increasing the along track resolution alone will see only slight benefits, increasing the traverse resolution as well allows interpretation confidence levels to be raised significantly. Up to now, the trade-off has been survey resolution against collection time, particularly where 1 or 2 probe systems are used. However, with the current move towards multiple probe arrays combined with RTK GPS systems to guide the machines, it is likely that higher resolution surveys will become the norm within the next decade, particularly if the initial cost of the survey equipment decreases.

Towed Magnetic Data for Archaeological Prospection Within a Sand and Gravel Mineral Deposit

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Christopher Leech, Geomatrix Earth Science Ltd, Leighton Buzzard, UK
Ian A. Hill, University of Leicester, Leicester, UK
Neil Linford, English Heritage, Portsmouth, UK

Introduction

Magnetic surveys have been popular within the discipline of archaeological prospection for many years. With advances in instrumentation, the ability to detect the very small resolution anomalies often associated with archaeological remains is now easily achieved. In sand and gravel environments the high level of magnetic variation in the substrate, can sometimes lead to the small archaeological anomalies becoming undetectable. In order to detect small amplitude variations in the archaeomagnetic response from historical artefacts or structures, the area needs to be adequately sampled in order to prevent aliasing of the data. This often leads to very detailed surveys with common line spacing of 0.5 or 1m, carefully controlled by pre-defined grids. It can take many hours for one operator to complete coverage of a large area in this detailed manner even when aided by an array of magnetic sensors mounted on a hand pulled cart.

Figure 1: The GEEP (Geophysical Exploration Equipment Platform).

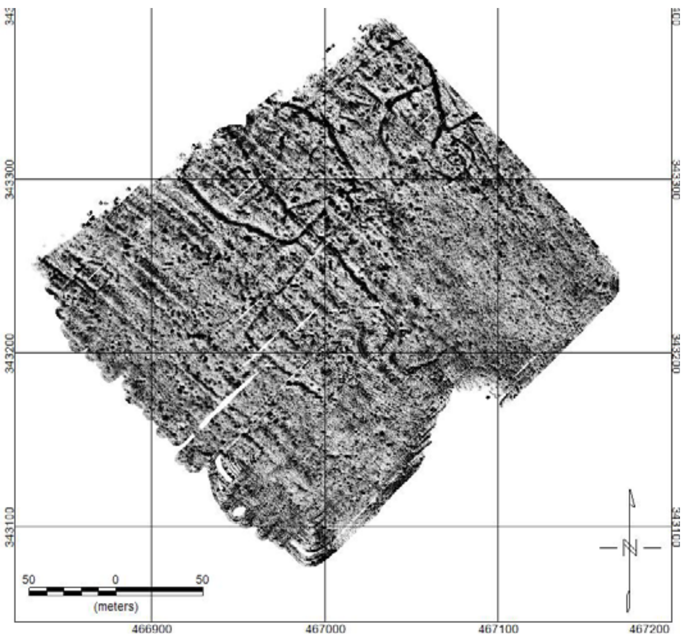

Figure 2: Shelford site GEEP magnetometer survey. Grey scale used in this figure black = -3.8nT, white = +3nT above the background field.

Site of Investigation

Shelford is a small village in Nottinghamshire, UK. It is the site of a former medieval priory and manor house situated south of the River Trent. The site lies above a sand and gravel mineral deposit which sits on top of a mudstone unit. The sand and gravel is of varied composition and exists at a depth no deeper than 10m as shown by a 2D resistivity survey carried out as part of the FASTRAC project (A Whole-site First-assessment Toolkit for combined Mineral Resource and Archaeological assessment in Sand and Gravel deposits - PN 5366).

All data collected was in accordance with this project funded by the Aggregates Levy Sustainability Fund (ALSF) administered by English Heritage. The area of interest in this report comes from magnetometer surveys conducted over a grass field approximately 6 hectares.

Methodology

The survey was conducted using a Geophysical Exploration Equipment Platform (GEEP). The platform was equipped with six caesium magnetometer sensors giving a 0.6m line coverage across the site (figure 1.0).

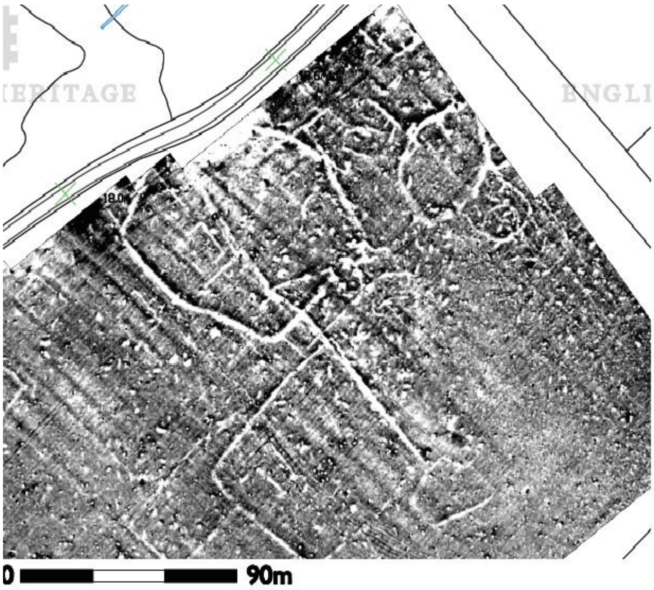

Figure 3: Extract from the English Heritage caesium magnetometer survey conducted at Shelford for comparison with the GEEP data set. Grey scale used in this figure black = -3nT, white = +3nT above the background field. © Crown copyright. All rights reserved English Heritage 100019088 2007.

A differential GPS system was also mounted to provide positional information and the magnetic signal was monitored at a separate logging station allowing real-time QC of the data. The GEEP was towed across the site at 6km/hour allowing data over the 6 hectare site to be acquired in just 3.5 hours. English Heritage also conducted a survey across the same site using a hand pushed cart equipped with 4 modified caesium magnetometers at a line spacing of 0.5m. Data acquisition for this walked survey was achieved in 15 hours per 6 hectares.

Results and Conclusions

A number of significant features can be identified from both datasets (figure 2 and figure 3) including a series of enclosures and the presence of the ridge and furrow farming technique. The GEEP dataset (figure 2) has a slightly increased level of noise when compared to the walked survey (figure 3) and the polarity of the anomalies is reversed due to differences in base level chosen in the removal of the magnetic base station results. It can be clearly seen that a towed vehicle magnetometer array can be used to achieved rapid coverage of a large site while sill retaining good data quality when compared to the walked array.

Discovering Prehistoric Settlement in Warwickshire, UK

A.C.K. Roseveare and M.J. Roseveare, ArchaeoPhysica Ltd, UK a.roseveare@archaeophysica.co.uk

Angie Bolton, Senior Finds Liaison Officer for the Portable Antiquities Scheme (PAS) in Warwickshire, contacted us with a request for geophysical survey. The site in question was located by systematic metal detecting and fieldwalking by a local enthusiast who recorded the location of 450 sherds of Bronze Age and Iron Age Pottery as well as a quern stone and ceramic loom weight fragments, a cast copper alloy Bronze Age razor and a possible palstave fragment. These finds were thought to indicate a late Bronze Age to early Iron Age midden site, of which only one other is known in the county (under excavation by Kate Waddington, Cardiff University). However, nothing was known of the archaeological features that these finds must have been associated with…

We decided to tackle the site with a combination of our DGPS-tracked system and detailed magnetic survey, drawing on our almost 10 years of experience with caesium magnetometry. The Geometrics G858 was configured as a dualchannel magnetometer on a cart (sensors approximately 0.3m above the surface) to guarantee a stable low-noise platform. Data was collected at 10Hz, giving sampling intervals of 1.0m x approx. 0.15m as a compromise between detail and speed.

Figure 1 shows an overview of the magnetic survey, overlaid by the contoured finds density. The magnetic data is plotted as a greyscale black -10 nT to white +10 nT. Finds density is plotted as contoured counts per square metre as green 0.02 to red 0.12.

We find that use of a base station magnetometer and subtraction of its data from the survey is essential to preserve the basic characteristics of the data for analysis and further processing. Apart from a small amount of spike suppression and heading correction no further processing is necessary to provide a seamless sheet of total field data. Established principles of potential field-based processing are then used to separate the regional, deep and shallow components for further study. A simulated vertical gradient can also produced depending upon the needs of the data. We have used this methodology for several years across a wide range of soil and archaeological feature types and found it to be a reliable approach.

It isn't often that a completely unknown site provides such a wealth of information; we were all pleasantly surprised by what the data showed. It is clear now why the artefacts were located here – a busy multiphase settlement with round huts, enclosures and pits. The data background is relatively uniform due to the magnetic characteristics of the underlying Lias geology and there is a weak overprint of medieval ridge and furrow cultivation, which interestingly shares the alignment of the northern settlement boundary. The full interpretation of the data will take some time and further research at the site is expected. A 0.5m line separation would reveal significantly more, especially the post settings and narrow gullies which are likely to exist in various places and future work will examine this possibility.

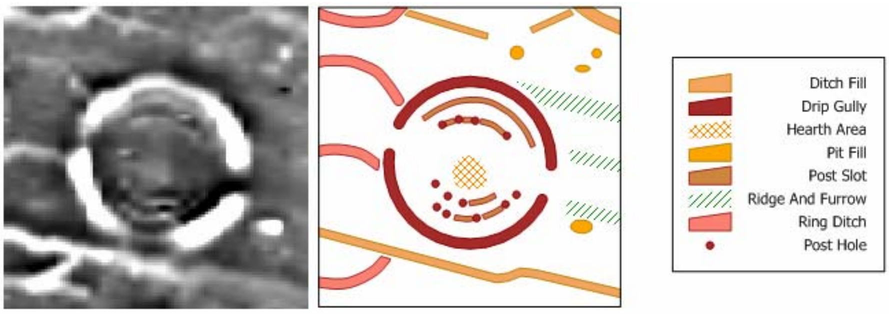

Figure 2 details the characteristic features of the round huts that have been discovered; a significant amount of internal detail is apparent even with the 1m line separation. The drip gully has a 16.5m diameter.

Angie Bolton of the Portable Antiquities Scheme (www.finds.org.uk) is thanked for her unstinting encouragement throughout the survey. This project was funded by the PAS and the finder.

Waddington, K. 2007 'Pins, Pixies and Thick Dark Earth' *British Archaeology*, July/August 2007

Conference, Seminar and Course Announcements

EIGG Geophysical Equipment Exhibition

Geophysical Test Site, Oadby, Leicester, UK, 4 May 2008

Stimulating
Near-Surface
Geophysics

The EIGG will be hosting the latest in its series of out door geophysical field equipment demonstrations at the EIGG/Leicester University test site on 8th May from 10:00 to 16:00

Full details can be found at:
http://www2.le.ac.uk/Members/iah/eiggex2008

Or download a flyer at:
http://www2.le.ac.uk/Members/iah/eiggex2008/resolveuid/89a38fbd70ed042d3f61bf9746dc0869

Or please contact the undersigned.

Representatives of major geophysical instrument vendors will be present demonstrating their latest innovations. You will have the chance to see how instruments perform in true field conditions and get hands on experience of their use.

Attendance is free! You can come and go as you please and stay for as long, (or as short) as you want.

Chris Leech
chris@geomatrix.co.uk

Inaugural short course in Conflict Archaeology

Cranfield University, Shrivenham, Swindon, UK, 12th – 16th May 2008

Exploring new avenues in the multi-disciplined approach to Conflict Archaeology and looking out from the battlefield to see combat in context this course is intended for all those interested in Conflict Archaeology. Ranging in scope from Prehistoric warfare through to the archaeology of modern, total warfare the course will be applicable to archaeologists, military personnel, scientists, and heritage managers, as well as those with a general interest in this rapidly developing field.

It will include hands-on sessions as well as formal lectures.

Topics that will be covered in the course include:

- Battlefield Tour
- Live firing on the ranges
- Unique access to expertise and facilities of the Defence Academy of United Kingdom
- Wide overview with many expert speakers

Key note speaker: Professor Richard Holmes

Web link: www.cranfield.ac.uk/forensics click on 'news and events' this will take you to the course brochure and provisional timetable.

AARG 2008

University of Ljubljana, Slovenia, 9 - 11 September 2008

* CALL FOR PAPERS *

International aerial archaeology conference

AARG 2008 LJUBLJANA

9 - 11 September 2008

Hosted by the

Department of Archaeology, Faculty of Arts
University of Ljubljana

Proposals for sessions, papers and posters are invited

The following sessions have been proposed, for which offers of papers are welcome:
Aerial Archaeology in the Mediterranean; New Projects; Postgraduate research;
Airborne Thematic Mapping/Airborne Laser Scanning;
An archaeology of natural places … from the air;
Aerial photography in context – recording landscape and urban areas

11 September Conference Day 3
Field Trip

Note: session titles are provisional and all papers and session proposals are welcome.
Oral papers should usually be 20 minutes duration, and equal weighting is given to poster presentations.

Closing date for abstracts is 31st May 2008.

Address for conference correspondence:
Dave Cowley
RCAHMS
16 Bernard Terrace
Edinburgh, EH8 9NX
Scotland
Email dave.cowley@rcahms.gov.uk

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STUDENT/YOUNG RESEARCHERS BURSARIES FOR AARG 2008

These are to support bona fide students and young researchers who are interested in aerial archaeology and wish to attend the conference. Anyone wishing to apply should contact Dave Cowley (RCAHMS, 16 Bernard Terrace, Edinburgh, EH8 9NX, Scotland or by email) with the following information:

Their interests in archaeology and aerial archaeology; place of study; the name and contact details of a supervisor or employer who can provide a reference; an estimate of their travel costs to attend.

Closing date for applications is 31st May 2008.

Aerial Archaeology Research Group website: http://aarg.univie.ac.at/

Four funded Studentships: MSc in Archaeological Prospection: Shallow Geophysics

University of Bradford, UK, September 2008

UNIVERSITY OF BRADFORD

MAKING KNOWLEDGE WORK

This one-year taught Masters course provides training in the underlying principles and applications of archaeological prospection techniques, with particular emphasis on geophysical survey (e.g. magnetic, earth resistance, ground penetrating radar). In addition to gaining a formal qualification in this discipline, the long-established course offers an ideal opportunity to acquire in-depth understanding of fundamental issues related to instrument usage, data processing and archaeological data interpretation.

The University's *Division of Archaeological, Geographical and Environmental Sciences*, is ideally equipped to deliver the course with a large number of geophysical instruments for student use, excellent teaching facilities and academic staff who are experts in the field (including Armin Schmidt, Chris Gaffney and Cathy Batt).

The University offers **four** prestigious NERC **studentships** for the next course, which will start in September 2008. For UK students the awards comprise of university fees, a maintenance grant of £8,280 and research expenses. Additionally, EU students are eligible if they have been resident in the UK for three years - if this is not the case the award will still be available to cover their course fees. Unfortunately, these studentships are not available to non-EU students.

Archaeological Prospection can also be studied at MPhil and PhD level. Individual research topics can be tailored to the applicants' interests and funding applications, for example to the AHRC, are supported by dedicated staff.

For further details please consult http://www.bradford.ac.uk/archsci/depart/pgrad/arcpros/ and email the course manager, Dr Armin Schmidt (A.Schmidt@Bradford.ac.uk), or telephone ++44 - (0)1274 - 23 5534. Applications may be discussed with the course manager in advance of a formal submission.

“Recent Work in Archaeological Geophysics” and “Geoscientific Equipment and Techniques at Crime Scenes”

Burlington House, Piccadilly, London, UK, 16 - 17 December 2008

ENVIRONMENTAL AND INDUSTRIAL GEOPHYSICS GROUP

FORENSIC GEOSCIENCE GROUP

EIGG

Environmental & Industrial Geophysics Group

FGG

Two day meetings at Burlington House, Piccadilly, London: 16th–17th December 2008

16th December: *Recent Work in Archaeological Geophysics*

Shallow geophysical techniques are playing an increasing role in the evaluation of archaeological sites, in their discovery, interpretation and management. This will be the eighth in a succession of biennial meetings in which contributors from the UK and further afield present and debate the results of recent research and case studies. Suppliers of equipment and software also attend and the meeting therefore represents an invaluable opportunity for both archaeological and geophysical practitioners to take advantage of recent research and developments.

Convenor: *Paul Linford*, English Heritage, Fort Cumberland, Eastney, Portsmouth, PO4 9LD, UK; Tel.: +44 (0)23 9285 6749; email: Paul.Linford@english-heritage.org.uk

17th December: *Geoscientific Equipment and Techniques at Crime Scenes*

This meeting aims to capture shared interests between the geological, archaeological, environmental, geotechnical, mining, humanitarian and law enforcement communities and will contain both macro- to microscale organisation. Sessions will include both emerging and current state of the art geoscientific techniques to aid the forensic investigator and will include geophysics, remote sensing (aerial, satellite and landscape interpretation), buried materials, trace evidence and innovations in materials analysis.

STATS GEOPHYSICAL

Co-convenors: *Dr Laurance Donnelly and Dr Alastair Ruffell.* For further information contact Dr Laurance Donnelly, Halcrow Group Limited, Deanway Technology Centre, Wilmslow Road, Handforth, Cheshire, SK9 3FB; Tel.: +44 (0)1625 540 456; email: DonnellyLJ@Halcrow.com

It is anticipated that each meeting will attract 60 or more participants. As well as oral presentations, there will be space for poster and commercial displays.

Those interested in contributing to either meeting are warmly encouraged to contact the respective convenors, and to submit abstracts of up to 1000 words in length, accompanied by suitable black and white illustrative material, no later than the 31st August 2008. These will be collated and made available to all those attending.

Attendance will be free to members of the Geological Society. Non-members will be asked to pay £25 to attend a single day or £40 for both days. Registered students can attend for £10 or £20, respectively. A further charge of £125 per day will be made for commercial exhibitors.

Pre-registration and payment is preferred and will be possible between 1st July – 1st December 2008. Please contact: Louise Martin, English Heritage, Fort Cumberland, Eastney, Portsmouth, PO4 9LD, UK; email: Louise.Martin@english-heritage.org.uk