

## English Heritage's caesium magnetometer cart

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“It will never fly you know!” seemed to be the resounding pearl of wisdom we received whilst providing months of amusement to colleagues (both human and canine) trundling our prototype magnetometer cart over the parade ground at our base in Fort Cumberland, Portsmouth. Unfavourable comparison with Roman chariots and medieval devices of unspeakable torture were frequently referred to. But now, with great relief, we have a working, field tested system that even dismantles for transport to and from site in the back of the LandRover!

Construction of the cart proved necessary for the operation of our Scintrex Smartmag caesium vapour magnetometers in a system similar to those that been most successfully deployed by our continental European colleagues for some time. Whilst the Scintrex sensors are capable of recording the most subtle of magnetic anomalies, for example the response to an individual timber post-setting, the instruments are

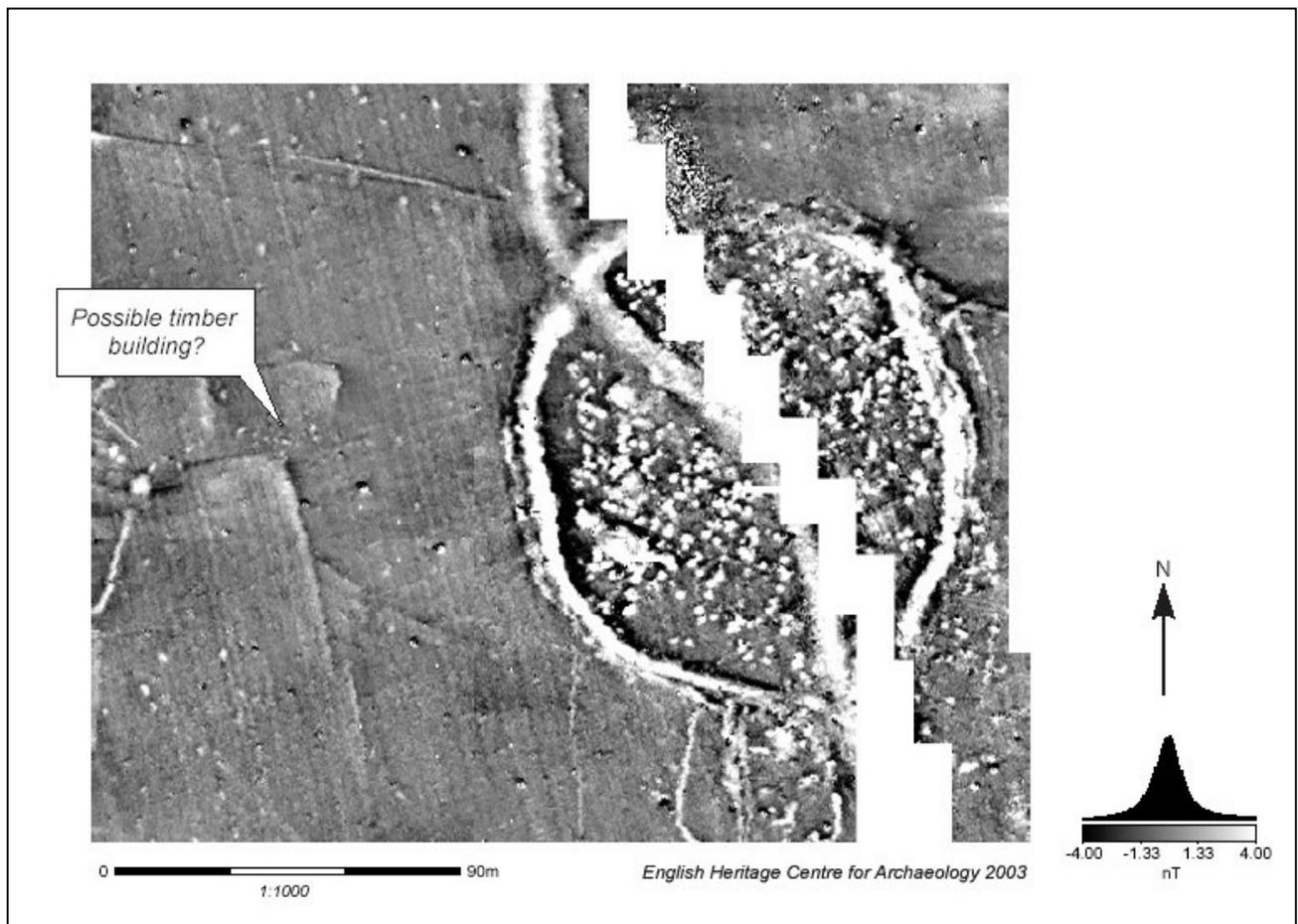
equally sensitive to magnetic material surrounding them, such as the controlling electronics and power supply batteries. To overcome this, our magnetometers have been specially modified to increase the distance between the sensor head and the other magnetic components of the system that would interfere with the recorded signal.

Rather than carry all this heavy equipment by hand we constructed a cart to act as a mobile instrument platform. Obviously, the components used in the construction of the cart have to be entirely non-magnetic too and able to bear both the weight and mechanical shock associated with operating the system over typical archaeological terrain. Figure 1 shows Louise and Neil operating the cart over the Headlands Enclosure site near Silbury Hill during our first field outing in November 2003 whilst Andy and Paul struggled to keep the 100m survey lines laid out in front of us. The four caesium sensors are separated by

0.5m from each other in a line along the central axle of the cart, allowing multiple, 100m long instrument traverses to be collected simultaneously.

So what advantages does this system offer over more conventional fluxgate magnetometers? Well, we do seem to be getting better sensitivity to weakly magnetised features. But we are also finding that the increased sample density, speed of data acquisition and absence of walking induced “noise” observed with

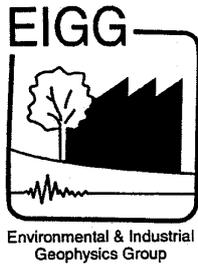
hand held instruments, all greatly improve the quality of the final data. Figure 2 shows an image of the data we collected from a survey over the Headlands enclosure near West Kennet in Wiltshire (survey resolution 0.5m x 0.25m). It illustrates both the resolution of that can be obtained over strongly magnetised features, such as the multi-phase ditches of the ovoid enclosure, and also the response to more subtle anomalies possibly arising from a timber building.



**Logo competition**  
**Would you like to be a regional correspondent?**  
**What conferences are coming up?**

**... see the Noticeboard**

## EIGG archaeological geophysics meeting, London



### Recent Work in Archaeological Geophysics

**Day Meeting 15<sup>th</sup> December 2004**

This will be the sixth meeting on this topic, to be held under the auspices of the Environmental and Industrial Geophysics Group (EIGG) at the premises of the Geological Society, London.

As usual contributors will present recent developments and case studies in archaeological geophysics. As well as oral presentations, there will be (limited) space for commercial and poster displays. Subsequent publication in the journal *Archaeological Prospection* is an option.

A charge will be made for commercial exhibitors and a modest registration fee will be payable at the door for those who are not members of the Geological Society.

In innovation this year, prompted by our shared interests, will be the option of attending a second EIGG meeting on the following day (16<sup>th</sup> December) devoted to '**Forensic Remote Sensing and Geophysics**'. The latter will hopefully include geophysics, aerial and satellite monitoring, non-destructive chemical surveying, laser scanning, GIS, data processing and manipulation, military, industrial and extraterrestrial applications, international monitoring, environmental law and human rights. Applications to criminal and international law enforcement will form the core of the meeting. The techniques used will be of use to archaeologists, historians, geographers and geologists (especially those mapping landforms and involved in oil, gas and mineral exploration).

A reduced registration fee will probably be available for those who would like to take advantage of attending both day meetings.

Those interested in contributing to '**Recent Work in Archaeological Geophysics**' are warmly encouraged to contact the convenor, Andrew David, no later than the 31<sup>st</sup> August 2004:

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For further information on, or offers of contributions towards '**Forensic Remote Sensing and Geophysics**', please contact that meeting's convenor, Alistair Ruffell. Information on both meetings will be circulated to all those showing an interest.

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## Recent student projects at the University of Bradford

Compiled by Armin Schmidt, Course Manager for MSc in Archaeological Prospection (A.Schmidt@Bradford.ac.uk)  
Department of Archaeological Sciences, University of Bradford, West Yorkshire, UK

The following list gives an overview of some of the projects students have undertaken as their dissertation for the course MSc in Archaeological Prospection at the Department of Archaeological Sciences. The projects normally address geophysical and archaeological research questions, albeit with varying emphasis. Research starts in the second semester of the course and is then completed over the summer vacation. In addition, many other projects have been carried out over the years and some form the basis of further investigations.

The magnetic detection of buried mudbrick walls and the potential for the application of geophysical techniques in archaic Euesperides - Alette Kattenberg

Geophysical surveys were carried out on the tell site of the archaic Greek city of Euesperides, northern Libya in April/May 1999. The aim of the surveys was to determine whether buried mudbrick features could be detected by means of magnetic prospection methods and to assess if there was a potential for the application of geophysical methods on the site in general.

In a high resolution fluxgate gradiometer survey over an excavated trench the magnetic signature of a mudbrick wall could be identified. Soil samples were taken for magnetic susceptibility analysis. This analysis showed that there is a magnetic contrast between the mudbrick walls and the surrounding deposits. It was calculated that this contrast is sufficiently high to distinguish between the different deposits in a magnetometer survey.

In non-excavated areas problems were encountered in the magnetometer survey due to the presence of metal objects and the intrusion of modern graves into the archaic layers. In a trench currently under excavation, linear features that probably represent mudbrick walls were distinguished in the data of the magnetometer survey. It was found that these features could only be identified in a magnetometer survey with a spatial resolution of  $0.25\text{m} \times 0.25\text{m}$  or higher and a sensitivity of  $0.1\text{nT}$  for the instrument.

Overall, the potential for the application of geophysical survey techniques on the archaic site proved to be low.

Soils were too dry to carry out an earth resistance survey, and the results of the magnetometer survey were of poor quality due to the presence of metal and modern graves in the survey area.

The impact of fluxgate gradiometer data collection strategies - Heather Gimson

This project examined and assessed the impact of different data collection regimes. This was undertaken through the repeated surveying of two sites, each survey corresponding to a different data collection variable. Consideration was given to the usability and effectiveness of the different variables as well as the time needed to implement them.

It was possible to assess the impact of magnetic scanning as well as the variables within data collection strategies, instrumentation height and orientations. Time lagging was also investigated over highly magnetic features, due to the instrument requiring more time to record a data point.

The large amount of collected data used within this project also provided an opportunity for interpretations to be gained for the selected sites, enabling an enhancement of the archaeological record. Earth resistance surveys were therefore also undertaken to improve the interpretation of the sites.

A sequential approach to site evaluation utilising Ground Penetrating Radar: A case study at Dolbelidr, Denbighshire - James Adcock

It was proposed that Ground Penetrating Radar (GPR) could be introduced as a more mainstream tool for archaeological prospection when used as part of a sequential approach to site evaluation. The dissertation tested this idea by investigating Dolbelidr, Denbighshire (a low-lying river valley site) in search of archaeological remains associated with the house. The methodology involved coarse resolution earth resistance (twin-probe [Geoscan Instruments RM15]) and magnetometer (fluxgate gradiometer [Geoscan Instruments FM36]) surveys (at  $1.0\text{m} \times 1.0\text{m}$  and  $1.0 \times 0.5\text{m}$  reading intervals respectively). The data from these surveys were processed and the site interpreted as being predominantly glacio-fluvial with some overlying

archaeology - possibly building platforms. A series of 6 targets were chosen to conduct high-resolution GPR surveys (225Mhz and 450Mhz [Sensors and Software's PulseEKKO 1000]) in order to clarify the initial findings. The radar data were inspected using both vertical sections and time-slices.

A number of Palaeo-river channels (up to 10m wide and 1.5m deep), banks and islands were discovered as well as a distinct building platform (at least 20m x 20m) with a marginally less well defined, slightly smaller structure to the west of it. Associated with these buildings appeared to be some form of landscaping. Other features included ancient field boundaries and pipes. It was concluded that the use of a sequential strategy not only increased radar's efficiency, thus making it a more justifiable technique, but allowed the user to take advantage of the powerful three-dimensional imaging capabilities.

#### Complementing Ground Penetrating Radar with resistivity pseudosections - David Elks

The problems with the application of ground penetrating radar (GPR) in archaeology are well documented. This study addresses the problem related to the near field zone of the GPR transmitting antenna, whilst concentrating on depth analysis.

The near field zone occurs because of the curved shape of the emitted electromagnetic wave front, it can have the effect of masking out responses from shallow objects, leaving them undetected. In an attempt to aid the interpretation of shallow features this investigation has gathered both GPR data and resistance data over two archaeological sites.

Both GPR and resistance data are converted to map and cross section form. These have been interpreted separately and compared qualitatively. The data have also been processed to a common format, which allows them to be combined together. The GPR data that are recorded in the near field zone have been removed and replaced with resistance data from the corresponding depth. This technique allows a single cross section to be produced, which has the advantage of the increased resolution of GPR, with the added benefit of being able to detect the masked-out shallow features.

The test sites used are the Roman Villa at Beadlam and the Late Neolithic/Early Bronze Age henge complex at Thornborough, both in North Yorkshire.

#### An archaeo-geophysical assessment of the GEM-300: a new electromagnetic technique - James Bonsall

This research examines the performance of the GEM-300, a new multi-frequency electromagnetic geophysical instrument, upon a series of archaeological sites in the north of England, with emphasis placed upon its ability to detect subtle archaeological features.

Field data were compared and contrasted with the established techniques of earth resistance and magnetometer surveys. It was found that the EM in-phase data may improve the resolution of magnetic data with respect to ferrous material, and that great success may be achieved for the location of conducting features with the quadrature data. The simultaneous collection of multi-frequency data has provided two new methods for the examination of three-dimensional geophysical data; the EM frequency slice and the EM pseudosection.

A variety of survey procedures have identified ideal parameters for the collection of EM data despite the serious shortcomings of the instrument (e.g., drift, instability). However attempts to calculate apparent conductivity and apparent susceptibility data for direct comparison with earth resistance and magnetometer data were unsuccessful due to these shortcomings.

#### The use of low frequency electromagnetic methods in archaeological prospection - Frances Williams

Beadlam Roman Villa, North Yorkshire and Thornborough Southern Henge, North Yorkshire were surveyed with fluxgate gradiometers (Geoscan FM256 and FM36), an earth resistance meter (Geoscan RM15, twin probe) and a number of electromagnetic (EM) prospection instruments; Geonics EM38B, White's TM808 metal detector, Bartington MS2D field coil and a Pulsed Induction Meter (PIM). The results from each survey method were analysed and compared with each other to determine how useful such EM methods are in archaeological prospection. The data from each method were also used together to complement the other's findings to give a better archaeological understanding of each site. The coefficient of magnetic viscosity was calculated using PIM and MS2 data by calibrating the PIM and combining the two datasets.

The EM instruments were useful in finding anomalies not found in regular methods but, due to ease of surveying, data handling and interpretation, it was concluded that the fluxgate gradiometer and earth resistance survey methods should be used over EM instruments for normal archaeological sites, and EM

instruments should be used on sites where traditional methods do not work so well. These include sites with very hard soil or rock where EM instruments can measure the conductivity without probes, or sites with highly magnetic geology where EM instruments can measure the magnetic susceptibility of the archaeology rather than the remanent magnetic field produced by the geology.

Archaeological assessment of urban and brown field sites by geophysical prospection - Kenneth Hamilton (PhD thesis)

The project aims to develop a methodology for the investigation of urban and brown field sites, using those geophysical techniques that are most commonly available to commercial field archaeologists. Several case studies in Bradford, Leicester, Carlisle, Keighley and Libya were used to investigate the aims and objectives of this project. The project found that the interpretation of magnetometer surveys in urban areas was complicated by the effects of large iron objects on the surface, which produced extended ferrous anomalies, masking smaller archaeological anomalies. Ground Penetrating Radar was found to be adversely

affected by the ground conditions on urban sites, with depth penetration greatly reduced, and interpretation very difficult due to the complexity of results. Sampling strategies were derived for the investigation of urban and brown field sites, utilising high-resolution surveys.

The project examined integrated prospection strategies and confirmed the importance of complementary techniques, as well as the inclusion of as many non-geophysical data as possible in the interpretation of a site. In particular, documentary evidence was found to be particularly helpful when examining industrial archaeology sites. The project examined the possibilities of data processing. Most currently available processing methods were found to be inadequate for processing data from urban and brown field sites, because of a combination of the amplitude of unwanted anomalies and the similarity between anomalies of archaeological interest and unwanted anomalies. Time slices were found to be a particularly effective method of displaying and examining Ground Penetrating Radar data. The possibilities of animation as a method of displaying complementary data and ground penetrating radar time slices were examined.

## Update from the Near East

Tomasz Herbich Institute of Archaeology and Ethnology, Polish Academy of Sciences, Warsaw, Poland

In September/October 2003 Tomasz Herbich carried out for the Polish Center of Mediterranean Archaeology a magnetic survey in Jiyeh (Lebanon), a Roman and Byzantine town north of Beirut. The prospection was carried out on a necropolis endangered by the building of a hotel complex on the outskirts of the town. Unfortunately, bulldozers had already destroyed most of what could be found in the cemetery. In the town area, the survey detected the remains of a basilica. Geophysical prospection in archaeology may soon become a commonplace thing in Lebanon as the local antiquities office has established a well-equipped geophysical laboratory including equipment for magnetic, electric resistivity, electromagnetic and radar surveying, everything with appropriate state-of-the-art software and trained personnel (!). Japan has provided sponsorship for purchasing the required equipment.

In October 2003, Herbich went back to Saqqara to conduct a survey this time for a Louvre Museum expedition. Prospection covered an area next to the causeway of the pyramid of Unis, to the southeast of Djoser's enclosure. Work was hampered by disturbances and rubbish on the surface, both the effects of earlier excavations in the area. Even so, the results brought to light an interesting structure (possibly a mastaba), to be verified archaeologically in the coming season.

In January 2004, Herbich participated in the work of an American-British mission in Khargah Oasis. Magnetic prospection of two Roman-period settlements brought to light in one of them (Muhammed Tuleib) a complex of furnaces.

# Archaeological trials of the University of Leicester Multi Sensor Platform

Chris Leech Geomatrix Earth Science, Hockliffe, Bedfordshire, UK

Dr. Ian Hill and Tim Grossey of the University of Leicester's Geology Department ran a series of tests at Wroxeter in October 2003 with the department's Multi Sensor Platform (MSP) towed by a small all-terrain vehicle.

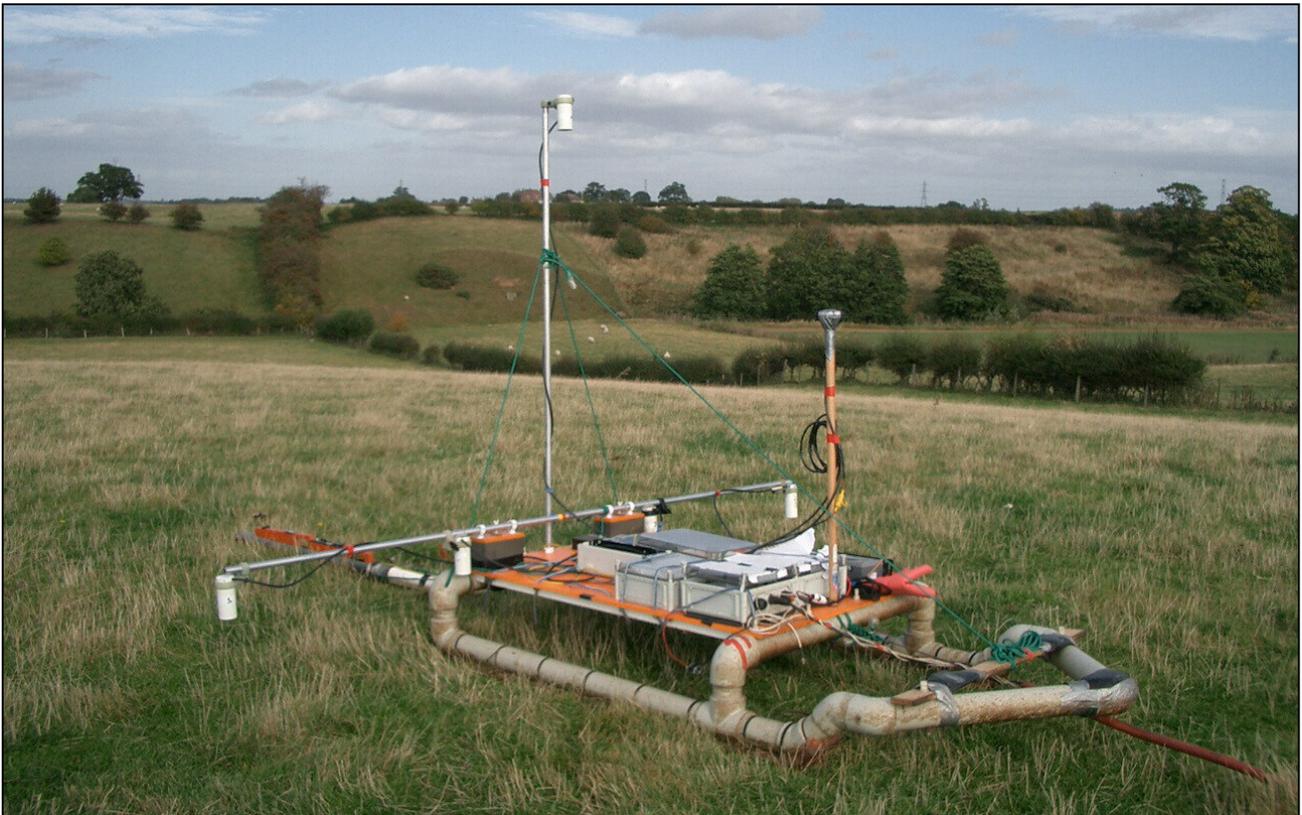
The idea is to determine if a rapidly moving platform such as this can produce good enough quality archaeological data from multiple sensors to be of use for archaeological prospection on large surveys whilst also being applicable for mineral and site exploration purposes. The sensor arrays deployed can be tailored towards the application and the MSP is towed at approximately 7kph, though this can be reduced.

Up to 30 line km have been traversed in a single day

with the MSP, which translates to 180 line km of data in the case of six caesium vapour magnetometer sensors mounted transversely at 1m spacing. Different sensor arrays have been experimented with, and the data is still being processed at this time, so we cannot say yet which array type and sensors give the best results.

The photo below shows the MSP carrying four caesium vapour magnetometer sensors with one on a mast as a compensating sensor, also the Geonics EM38 and a differential GPS.

*Dr. Ian Hill is a Senior Lecturer in Geophysics; Tim Grossey was a Geophysics Research Student and has now moved into the commercial world.*



# International Conference on Remote Sensing Archaeology, Beijing

**18-21<sup>st</sup> October, 2004**

**Venue:** Beijing Friendship Hotel, China

**Organized by:** Chinese Academy of Sciences; Ministry of Education, PRC; Ministry of Science and Technology, PRC; Ministry of Culture, PRC; National Bureau of Cultural Relics, PRC & the National Natural Science Foundation of China.

**Hosted by:** Joint Laboratory of Remote Sensing Archaeology, in affiliation to the Chinese Academy of Sciences, Ministry of Education, PRC; and National Bureau of Cultural Relics, PRC.

## **Conference Themes and Main Topics:**

The theme of the conference is “**Understanding Historical Cultural Heritage with Space Technology**”. As the acquisition of spatial information is advanced dramatically in today’s digital era, more and more high spatial and spectral resolution remote sensing data as well as multi-frequency and multi-polarization SAR images are available for archaeological research, and the application of space technology are becoming an important component in world heritage conservation. The conference of “Space Applications on Cultural Heritage Conservation”, held in November 2002 in Strasbourg of France in dedication to commemorating the 30<sup>th</sup> Anniversary of the UNESCO World Heritage Convention, marks the importance of spatial information for understanding the past of our history. Therefore, the conference with this specific theme will bring experts to present and discuss their latest research results in archaeological applications of spatial information, non-destructive detection techniques, and virtual heritage techniques to world heritage conservation in the historical and the capital city of China, Beijing. It is anticipated that the conference will add more knowledge to our understanding of historical cultural heritage through the applications of space technology and other cutting-edge digital technologies.

## **Main Topics:**

- Sensors and Platforms for Archaeological Prospecting
- Techniques and Methods for Remote Sensing Archaeology
- Image Processing Techniques for Archaeological Information
- Integrated Technology for Archaeological Investigation
- Spatial Analysis of Archaeological Information
- Palaeo-Environment Re-Construction
- GPR and other Non-Destructive Prospecting Methods for Archaeology
- Virtual Archaeology and Virtual Heritage
- Cultural Heritage Conservation with Digital Technology
- Education Prospective for Digital Techniques on Archaeology

## **Submissions:**

- Deadline for Submission of the Abstract: June 30<sup>th</sup>, 2004
- Notification of Acceptance: July 31<sup>st</sup>, 2004
- Deadline of Submission of Full Papers: August 31<sup>st</sup>, 2004
- The abstracts of 250–500 words in length should be written in English and must include: title, author(s), affiliation, address, tel/fax numbers, e-mail address. Submission of an Electronic file in text, word or pdf file format is strongly recommended. The Author(s) can send Abstract(s) by email to [wcl@irsa.irsa.ac.cn](mailto:wcl@irsa.irsa.ac.cn)

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**Useful website:** <http://www.rsarch.cn>

## Noticeboard

### Competition!

#### Could you be the designer of the ISAP logo?

A prize of free membership for 2005 is being offered for the best design, which will be chosen by the Management Committee and adopted by the Society. It will appear on the newsletter, web site and various other places.

The deadline for entries is 31<sup>st</sup> July 2004: to enter, send your design by email or on disk/CD to the Editor (for address see below). Please provide the logo in a standard format and ensure you've included your contact details.

The winner will hopefully be announced in the next issue of **ISAP News**.

### Treasurer appointed

**Chris Leech** has been appointed the Treasurer of the ISAP and has been busy organising important things such as the Society bank account.

Chris graduated with a BSc in geophysics and has been actively involved in the shallow geophysics industry for 25 years. He has carried out geophysical surveys of all types in Africa, India, Australia as well as the UK and mainland Europe. He has expertise in magnetic, seismic, EM and resistivity methods.

Chris is currently a director of Geomatrix Earth Science and is an active member of EAGE and EEGS; he is also secretary of EIGG, a sub-group of the Geological Society of London. Recently he has been involved with testing of a Multi Sensor Platform for geophysical survey at Wroxeter Roman City, Shropshire, UK (see page 20).

### AP2003 Cracow conference web site

Tomasz Herbich would like to remind everybody that the Conference web site has been updated with news and photos taken during the Fifth International Conference on Archaeological Prospection, Cracow.

### Other conferences and events

This is a brief listing of topical conferences and events coming up around the world – if there's something happening you think we ought to know about, send me the vital information for inclusion here.

**AARG** Munich, September 2004 – see notice p8

**CIPEG** International Association of Egyptology 9<sup>th</sup> Annual Congress, Grenoble, 6–12th September 2004

Contact: Krzysztof Grzymiski, Secretary of CIPEG, Egyptian Department, Royal Ontario Museum, 100 Queen' s Park, Toronto, Ontario M5S 2C6, Canada.  
Fax: +1 416 586 5877  
E-mail: [Krzysg@rom.on.ca](mailto:Krzysg@rom.on.ca)

There is to be a Panel on "Remote sensing in Egyptology". This will cover geophysical prospection, the uses of satellites and surveying strategies. *Sarah Parcak*

**EAGE** Near Surface 2004, Utrecht, 6-9th September

Near Surface Division annual conference, European Association of Geoscientists and Engineers. Has a couple of sessions on archaeological subjects.

Web: [www.eage.nl/conferences](http://www.eage.nl/conferences)

**EIGG** "Recent work in Archaeological Geophysics" and "Forensic Remote Sensing and Geophysics", London, December 2004 – see notice p16

**ISPRS** "Geo-Imagery Bridging Continents"

XXth Congress of the International Society for Photogrammetry and Remote Sensing, Istanbul, Turkey, 12-23 July 2004

Web: [www.isprs2004-istanbul.com](http://www.isprs2004-istanbul.com)

### International Conference on Remote Sensing and Archaeology

Beijing, October 2004 – see notice p21

## Membership

The **ISAP web site**, [www.archprospection.org](http://www.archprospection.org), is currently hosted by the University of Bradford.

The **members' mailing list** is an e-mail discussion forum for anything and everything ISAP. (It would be a good place for feedback on the newsletter, among other things ... )

Your **subscriptions for 2004** are due – thanks to those who have paid already. For enquiries about membership and subscriptions, go to the ISAP web site or contact Hon. Secretary Armin Schmidt (e-mail [A.Schmidt@Bradford.ac.uk](mailto:A.Schmidt@Bradford.ac.uk)).

In case you needed reminding, it's amazing value at only £7 or € 10 a year! Current benefits include access to the mailing list, the newsletter and a reduction in the subscription fee for Wiley's *Archaeological Prospection* journal.

## Contributors to ISAP News

The Editor wishes to thank those who contributed to this issue:

R. Gabrielli et al.; Chris Gaffney; Tomasz Herbich; Chris Leech; Neil Linford et al.; Salvatore Piro, Martin Roseveare; Norbert Schleifer; Armin Schmidt and Rob Vernon.

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## Regional updates in ISAP News

Tomasz Herbich has proposed that a series of regional summaries co-ordinated by particular correspondents would be a good way to include an up to date overview of work in progress. He has volunteered to look after the Near East, where much of his work goes on, providing brief summaries of projects (see p19).

The Editor proposes to look after Britain and Ireland: other regions could be areas of Europe, the Americas, Far East, etc., or individual countries.

If you would like to be a regional correspondent, please contact the Editor.

## The next issue of ISAP News

Issue 2 of the newsletter is planned for an August release - the **deadline for items is 31<sup>st</sup> July 2004**. Contributions of all types are welcomed, including articles, updates on your activities, reviews, letters, conference notices ...

Please follow these guidelines for contributions:

- text as MS Word document
- pictures as .jpg or .gif
- label e-mail attachments clearly, try to keep the size reasonable and zip them if possible.

Thanks, I look forward to hearing from you.

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