ISAP NEWS

The newsletter of the International Society for Archaeological Prospection

Issue 23, April 2010

Contents

Editor's Note

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Welcome to the 23rd issue of ISAP News. I do hope you enjoy reading the articles and are tempted by one of the seminars or conferences on offer. As you go about your work in the coming months please do keep the newsletter in mind and consider contributing to one of the future issues.

Contributions, be it articles course announcements or advertisements, for issue 24 should be emailed to me by 21st July.

Total Field Magnetic, Radar, and Archaeological Studies on the Shores of Yellowstone Lake, Yellowstone National Park, USA

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The Montana-Yellowstone Archaeological Project spent four weeks in 2009 along Yellowstone Lake. Previous reconnaissance demonstrated that the site contained an extensive lithic scatter with substantial potential for intact archaeological deposits. We completed seven grids of magnetic surveys at sites selected after observing the distribution of that scatter. Target sources include fire hearths, pit houses, stone rings, and other such cultural features obscured by deposition and flora. Ice rafted obsidian boulders, on the surface and in the shallow subsurface, contribute significant magnetic anomalies. Mature sagebrush limited our use of ground penetrating radar (GPR) to fractions of two grids.

We acquired total field magnetic intensity (TMI) observations at 10 Hz while walking bidirectional transects one meter apart using a Geometrics G858 Cesium magnetometer. Although the presence of substantial sagebrush in the field areas adds much noise during acquisition, we filter the vast majority of it during subsequent processing.

Figure 1: Field area near Yellowstone Lake. Ten terraces, the oldest greater than 10,000 years, resulting from glacial unloading and Yellowstone caldera magmatism, stand above the current shore.

Successively correcting for diurnal variation of the geomagnetic field, filtering to remove corrugation, and then using matched bandpass filtering to separate the magnetic observations into shallow and deep equivalent layers yields the final magnetic maps (figure 2). Here we use matched filtering to remove longer wavelength components from the fluvial system to better isolate the near surface sources. Typically, to best site potential test units we also calculate the analytic signal of the filtered magnetic grids which helps rank the amplitude of anomalies in our work.

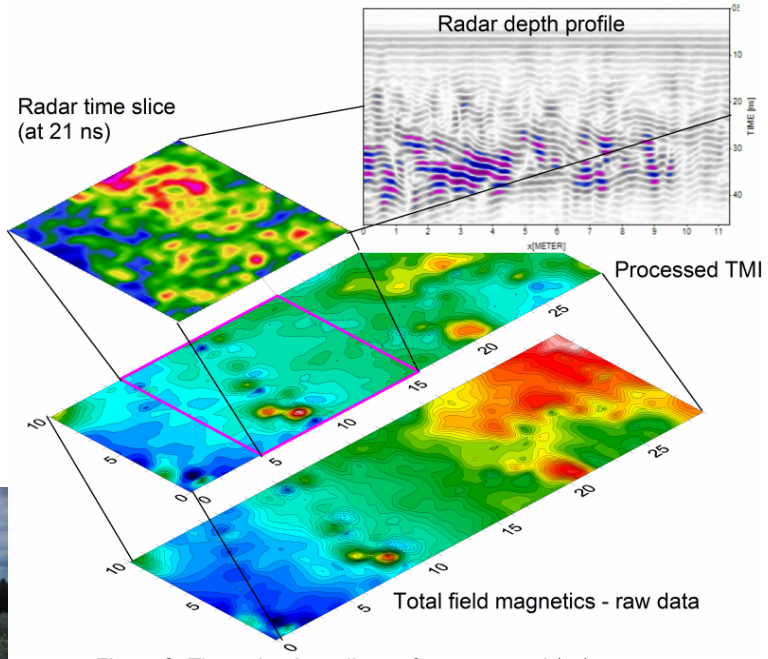

Figure 2: The radar time slice, a 6 nanosecond (ns) average of absolute values from 500 MHz antennas calculated at 21 ns, shows high amplitude arcuate features (warmest colors). Everything below 0.90 meters is fluvial silts and sand as evidenced by GPR interpretation and auguring. The bottom two images compare processed and raw magnetic results (contour interval is 2nT) and show the position of the GPR grid.

A representative GPR time slice (figure 2) shows high amplitude radar features in the northeast corner; they have limited associated magnetic anomalies. Furthermore, the radar features are on the faint extension of an old road that cuts the grid. Inspection of the corresponding depth profiles shows those arcuate features result from

sedimentary structures; auguring confirmed the lack of archaeological features.

On Figure 3, the numbered anomalies (1-6) indicate 1x1 meter test units placed on the combined magnetic and GPR interpretations. The excavation results are:

- TU 1 yielded a fire hearth dating to 1720±40 B.P. (Beta-265305), as well as abundant evidence of obsidian stone tool manufacture
- TUs 2, 3, and 4 yielded only boulders. We excavated these, despite each individual anomaly having the character of a boulder with remanent magnetization, because their concentration and alignment was promising. In a nearby area with similar analysis one such buried boulder turned out to be a long-term bench for flaking and other cultural activities.
- At about 0.8 meters below ground surface, TU 5 contained a fire hearth dating to 2920±40 B.P. (Beta-265306).
- TU 6 contained a rock concentration (likely a hearth) dated at 3,100±40 B.P. (Beta-265307).

Our total field magnetometry and GPR studies combined with archaeological assessment and excavation lead to many interesting discoveries and allowed us to better understand the association of the sources and their anomalies. This feedback will help our 2010 prospection and excavation as the surface conditions for geophysical acquisition are challenging. The area certainly warrants additional investigation as we excavated one test unit that yielded a Late Prehistoric hearth approximately 35 cm above an Early Archaic hearth with a radiocarbon date of 5,910±50 B.P. (Beta-265310). This hearth is the only one in all of Yellowstone National Park to have produced an Early Archaic date. The higher, older terraces have great potential.

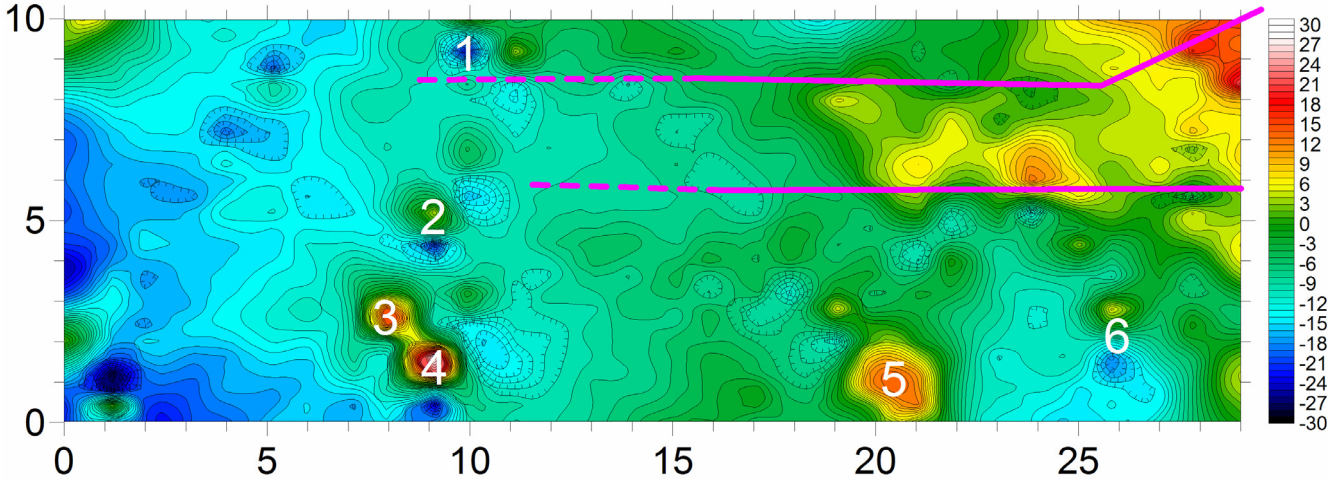

Figure 3: The magenta lines on these processed magnetic results show the interpreted position of a historic road. Numbered anomalies indicate test units; contour interval is 1nT.

An Experimental Proton Precession Magnetometer

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The use of the proton precession magnetometer (PPM) for archaeological survey is attractive both from the point of view of simplicity and potential accuracy and is widely documented. However, making a portable instrument presents some challenges, principally with signal recovery and power consumption. A number of published designs have used frequency counting, but this limits resolution and noise immunity.

This note describes the construction and evaluation of a prototype PPM instrument,

designed with the aim of achieving good accuracy whilst minimising power consumption. The instrument was designed to provide experimental flexibility, and is constructed as a differential magnetometer, rather than the more commonly used gradiometer.

The PPM sensor relies on the precise relationship between the magnetic field and the precession frequency of the protons within the sensor working fluid, in this case water.

Processing of the precession signal employs amplification and filtering, followed by digitization and processing using a low cost microcontroller. This involves digital conversion of the signal (around 2 KHz in the UK) to a much lower frequency, typically below 10Hz. This is achieved by sampling the precession signal at a rate close to four times the precession frequency, which allows the signal to be analysed as a rotating vector. The initial samples, typically 4000, are compressed down to 32 readings, representing the vector rotation. The frequency and hence field intensity can then be calculated from the vector angular change over the measurement interval. The technique provides very good noise rejection and frequency resolution with a short measurement interval. By using this approach an accuracy of better than 1nT can easily be achieved. The instrument operates over a range of 500nT, with the ability to calibrate to the local field intensity.

Figure 1: The prototype instrument, comprising a portable single channel magnetometer, and associated static reference instrument.

Figure 1 shows the assembled prototype. The survey instrument uses a toroidal sensor to minimise size and weight, having an overall diameter of 100mm. The static reference sensor is slightly larger, constructed as a dual solenoid for simplicity. The instrument can be configured to log readings synchronously or asynchronously. In the asynchronous mode, static readings are taken at typically 3-4 second intervals. Both survey and static readings are time tagged and the readings merged prior to subsequent analysis. In synchronous mode static and survey readings are triggered simultaneously by means of an rf link.

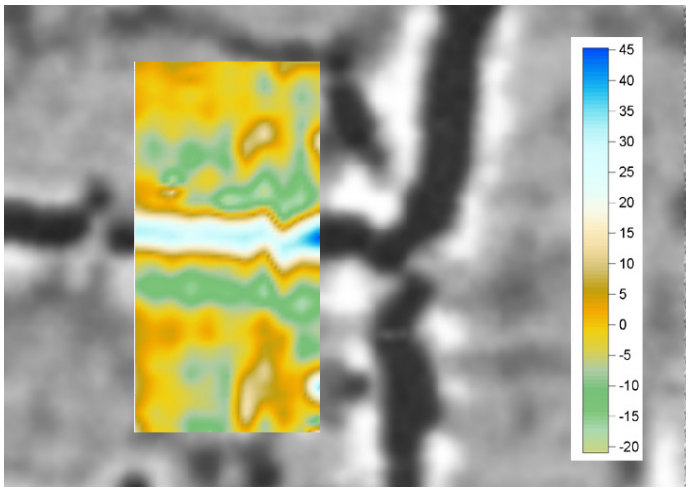

Figure2: A plot showing results obtained at a test site, in comparison with a previously collected fluxgate gradiometer plot.

Statistical analysis of data from several thousand synchronously logged readings shows a standard deviation of less than 250pT, measured to 25pT resolution. Assuming that the variation in the two channels is similar, this gives a single channel accuracy of around 150pT rms. Survey and reference sensor currents were set to 600mA and 950mA respectively, with a polarisation interval of 2.8 seconds. In asynchronous mode accuracy is lower, with a two channel variance of around 0.5nT rms during periods of low geomagnetic activity, caused by the inability to fully suppress geomagnetic variations.

Figure 2 shows a plot of a 10 by 20 metre small area survey overlaid on a plot of a test site previously surveyed using a fluxgate gradiometer. Data was collected as a 0.5m by 1m grid and is shown as a false colour plot for contrast. The background plot is scaled from +10 (black) to -10nT (white), although some clipping of reading peaks will be present. An absolute field sensor gives a markedly increased reading, with a range of around 65nT under the same conditions,

depending on the width and depth of the feature and the gradiometer sensor separation.

Results from surveys carried out with a local amateur archaeology group over several years show that for non-commercial use the PPM instrument can give good accuracy at low cost. One further development envisaged is to transmit both the trigger signal and rover sensor signal to the static sensor. This modification will allow display of survey data as it is collected. The main weakness of the method remains the need for a polarization period of several seconds before each reading, which limits the rate of survey. This may be reduced by using an alternative working fluid. Nonetheless it can provide a very useful instrument, within the capabilities of an amateur constructor with a reasonable knowledge of electronics.

Thanks are due to Duncan Hale of Archaeological Services Durham University for guidance with survey techniques and fieldwork.

Geophysical Studies on the Evolution of the Molise Landscape

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Who 'knows' the landscape with its layers? What is known for certain is that it is the result of complex dynamics, produced by what is generally understood as cultural processes. This gives an opportunity to reflect on the meaning of the planning; the idea that people lived in landscape and that the distribution of their material remains over broad areas gave a larger understanding of past behaviours.

The passage between the Samnites and Romans in Molise Region (Italy) (see figure 1) was gradual and not violent, as the historians said, and there is not a sharp division between Roman farm life and those agricultural practices existing in Low Molise before the Roman period. The Roman people had been taking advantage of the Samnite geo-morphological choices about rural land exploitation which allowed a good production of food and commodities. This was justified because, in a delicate period of alliances, the Romans preferred to not crack down on the equilibrium with this particular aggressive Italic people but get involved slowly in the Samnite social and economic system (in which the agriculture was the fulcrum), preserving all the uses and structures they could preserve.

For example, the area close to San Giacomo degli Schiavoni town (see figure 1) has always been subject to particular archaeological investigations in order to localize the ancient settlement of Uscosium, the Samnite town first and then the Roman municipium. The research has not been a success until now, but the survey collected during this work has changed the situation. In fact, before having an autoptic survey in the locality San Pietro, during the analysis of some satellite photographs, the presence of relevant crop-marks emerged on the soil due to some manmade structures as roads crossing or similar.

Figure 1: The map of Italy, in orange the Molise Region (top); the particular of the Molise Region (middle) and the localisation of San Giacomo degli Schiavoni town (bottom).

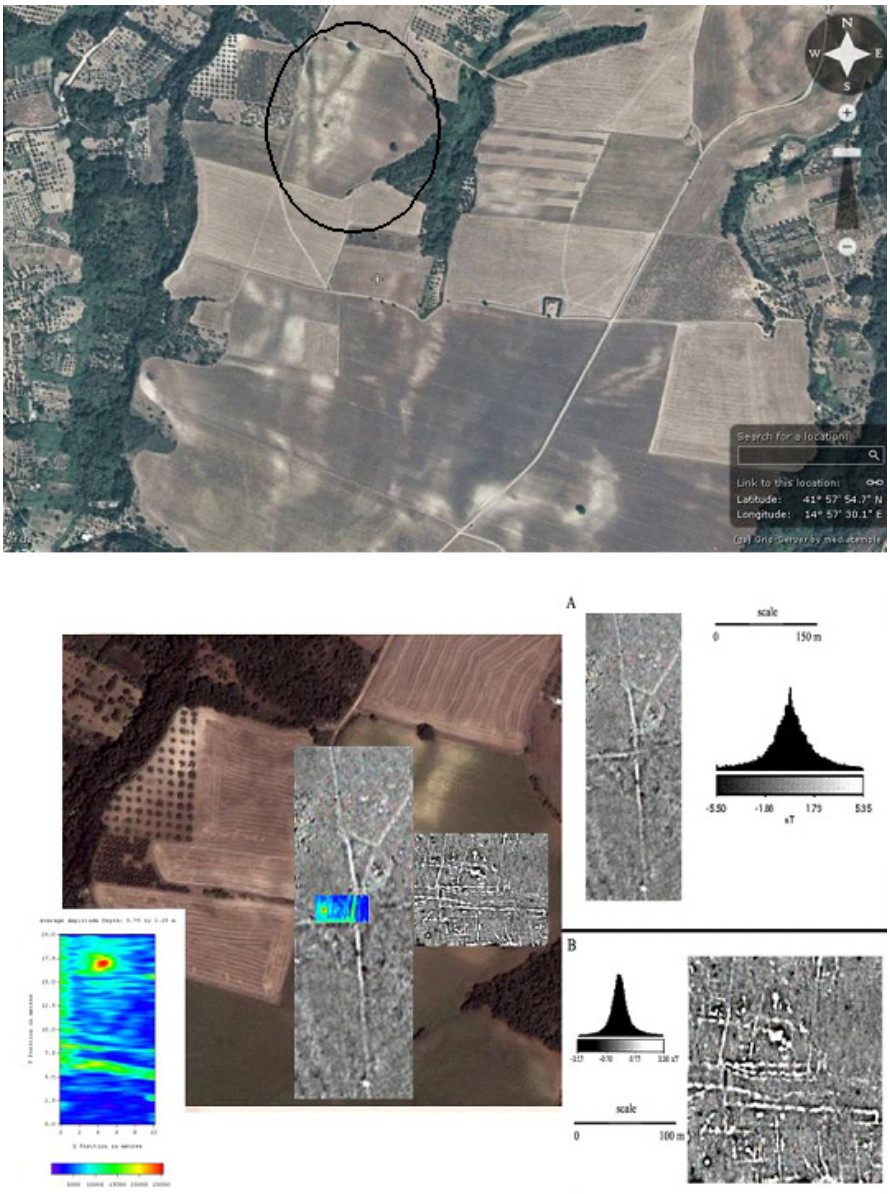

Figure 2: The satellite photographs (top) in which some crop-marks are pretty clear (the investigated area is in the black circle); the geophysical results in locality San Pietro, San Giacomo degli Schiavoni.

The autoptic survey, then, has found a very large and intensive scattered area of ceramic fragments, bricks, marble parts, bones and other fictile elements within about a kilometre range.

Obviously, the geophysical surveys displayed clear anomalies due to roads crossing and to a built-up rural area in the northern investigated areas. Both bistatic G.P.R. (using for particular details – NogginPlus Smart Cart, 250 MHz antennas) and magnetometer (using for large scale survey – Overhauser, GSM-19) informed the understanding of how wide this kind of buried site is. This evidence, linked to the literature, lead to the thinking that the site is Uscosium (see figure 2).

These anomalies confirm the conscious choice of the Roman people to re-use the precedent Samnite settlement, first of all, for the strategic position, near the L'Aquila – Foggia droveroads. Into the bargain, the modern intensive rural exploitation of the area has hidden the exact localisation of the site, but it confirms the marked rural vocation of this area also in the ancient periods. Finally, the presence of a Republican Roman villa (see figure 3) in the neighbourhood – brought to the light by the Archaeological Superintendency – reveals the great importance of this ancient town, so that the Roman elite has chosen to build a luxury place of residence.

Figure 3: The villa rustica excavated in San Giacomo degli Schiavoni by the Archaeological Superintendency near the investigated area.

Conference, Seminar and Course Announcements

National Park Service's 2010 Archaeological Prospection Workshop

Knife River Indian Villages National Historic Site, North Dakota, USA, 24-28 May 2010

The National Park Service's 2010 workshop on archaeological prospection techniques entitled *Current Archaeological Prospection Advances for Non-Destructive Investigations in the 21st Century* will be held May 24-28, 2010, at the Knife River Indian Villages National Historic Site near Stanton, North Dakota. Lodging will be in the in the communities of Beulah, Hazen, and Riverdale, North Dakota. The field exercises will take place at the Knife River Indian Villages National Historic Site. The park preserves the historic and archeological remnants of the culture and agricultural lifestyle of the Northern Plains Indians during the 18th and 19th centuries. Co-sponsors for the workshop include the National Park Service and the State Historical Society of North Dakota. This will be the twentieth year of the workshop dedicated to the use of geophysical, aerial photography, and other remote sensing methods as they apply to the identification, evaluation, conservation, and protection of archaeological resources across this Nation. The workshop will present lectures on the theory of operation, methodology, processing, and interpretation with on-hands use of the equipment in the field. There is a registration charge of $475.00. Application forms are available on the Midwest Archeological Center's web page at http://www.nps.gov/history/mwac/. For further information, please contact Steven L. DeVore, Archeologist, National Park Service, Midwest Archeological Center, Federal Building, Room 474, 100 Centennial Mall North, Lincoln, Nebraska 68508-3873: tel: (402) 437-5392, ext. 141; fax: (402) 437-5098; email: steve_de_vore@nps.gov

GPR 2010, XIII International Conference on Ground Penetrating Radar

Castle "Carlo V", Lecce, Italy, 21-25 June 2010

The Institute for Archaeological and Monumental Heritage IBAM-CNR, the Department of Innovation Engineering and the Department of Science of Materials of the University of Salento are pleased to invite you in Italy for the XIII issue of the GPR conference. We invite you to visit the web site http://www.ibam.cnr.it/gpr2010/ to appreciate the initiatives, the organization, the work done and being done to realize the event in the best way. We look forward to meet you in Lecce.

The possibility to register on-line should soon be activated. When it is, a reduced fee will be available for one month starting from the moment of the opening of the on-line registration. After that the fees increase by 100 Euros.

Early Registration
370 Euros for full registration
220 Euros for student registration

Later Registration
470 Euros for full registration
320 Euros for student registration

These fees include the participation to the social dinner

For more information on Workshops, Tutorials and the Programme, please visit the website.

AARG 2010

Bucharest, Romania, 16-18 September 2010

* FIRST CALL FOR PAPERS *
International aerial archaeology conference

AARG 2010 Bucuresti

16 - 18 September 2010

Organised by the
Institutul de Memorie Culturala (CIMEC)
and the Aerial Archaeology Research Group

** Proposals for sessions, papers and posters are invited**

16 – 17 September: Conference Papers
Sessions will include: Aerial Archaeology in Romania and SE Europe; Lidar in context; Interpretation; Postgraduate research; New Projects; Presenting aerial data

18 September: Field Trip
Neolithic sites south of Bucharest, towards the Danube

Closing date for proposals of papers, posters and sessions is **31st May 2010**

Conference Organising Committee

Professor Dr hab. Wlodek Rączkowski (AARG, University of Poznań)
Dr Irina Oberlander-Tarnoveanu (CIMEC), Dave Cowley (AARG, RCAHMS)
Carmen Bem (CIMEC), Lidka Żuk (AARG, University of Poznań)

Address for conference correspondence:

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

Conference website - http://aarg2010.cimec.ro/

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Student/Young Researchers Bursaries For Aarg 2010

These are to support bona fide students and young researchers who are interested in aerial archaeology and wish to attend the conference. Applications to Dave Cowley at the above address, by letter or email. There is no formal application form but please provide the following information:
Your 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 travel costs to attend.
Closing date for applications is 31st May 2010

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

Pre-conference workshop

Remote-sensing mapping programmes in archaeology: planning, organisation, results
15th of September - Ministry of Culture, Bucuresti, Romania
Contact Irina Oberlander-Tarnoveanu for more details (Irina@cimec.ro)

Recent Work in Archaeological Geophysics and Environmental Forensics

Burlington House, Piccadilly, London, UK, 15-16 December 2010

NSGG Near-Surface Geophysics Group

FGG Forensic Geoscience Group

Two day meetings:
Archaeological Geophysics
Environmental Forensics
Geological Society of London, Burlington House, Piccadilly, London
Burlington House, Piccadilly, London
15th and 16th December 2010

15th December 2010: *Recent Work in Archaeological Geophysics*

Shallow geophysical techniques are now a well established tool for the evaluation of archaeological sites, from their initial discovery to subsequent interpretation and management. This will be the ninth in a succession of biennial meetings in which contributors 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 and those in academia 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; Fax: +44 (0)23 9285 6701
email: Paul.Linford@english-heritage.org.uk

16th December 2010: *Environmental Forensics*

This multidisciplinary meeting will capture shared interests between the geological, environmental science, engineering, geotechnical, mining and archaeological communities in assessing the impact of changes to the environment that may result in legal proceedings. Sessions will include geophysics, remote sensing, geology, hydrogeology, geochemistry, isotope geochemistry.

Convenors: Dr Duncan Pirrie, Helford Geoscience LLP, Menallack Farm, Treverva, Penryn, Cornwall, UK, TR10 9BP, UK; Tel: +44 (0)1326 341142
email: dpirrie@helfordgeoscience.co.uk
Dr Alastair Ruffell, School of Geography, Archaeology & Palaeoecology, Queen's University, Belfast, N. Ireland, BT7 1NN; Tel: +44 (0)28 9097 3407
email: a.ruffell@qub.ac.uk

It is anticipated that each meeting will attract 100 or more participants. As well as oral presentations, there will be space for commercial and poster 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 greyscale illustrative material, no later than the 31st August 2010. 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 £15 or £20, respectively. A further charge will be made for commercial exhibitors. Pre-registration and payment (to NSGG) is preferred and will be possible between 1st June – 30th November 2010. Please contact: Louise Martin, English Heritage, Fort Cumberland, Eastney, Portsmouth, PO4 9LD, UK; email: Louise.Martin@english-heritage.org.uk

Journal Notification

Archaeological Prospection 17:2

Volume 17 Issue 2 has gone to press. It includes the following articles:

Invited Paper: *Ideas for the future of archaeological geophysics, with GPR as an example.* L Conyers and J Leckebusch

LIDAR-derived Local Relief Models (LRM) – a new tool for archaeological prospection. R Hesse

The structure of Upper Mesopotamian cities: insight from fluxgate gradiometer survey at Kazane Höyük, southeastern Turkey. A Creekmore III

Complex attributes of the magnetic signal for multiple sources: application to signals from buried ditches. C Milea et al

Multi-Offset Ground Penetrating Radar Methods to Image Buried Foundations of a Medieval Town Wall, Great Yarmouth, UK. A Booth et al

Book Review: 'Archaeological Investigation' Martin Carver, and 'The archaeology of Britain: an introduction from Earliest times to the twenty-first century'John Hunter and Ian Ralston (eds). Review by C Gaffney

PhD Studentship

Research into knowledge-based approaches for the integration and prediction of data related to archaeological prospection.

UNIVERSITY OF BRADFORD
MAKING KNOWLEDGE WORK

DART - Detection of Archaeological Residues using remote sensing Techniques
Studentship: Research into knowledge-based approaches for the integration and prediction of data related to archaeological prospection.

Applications are invited for a PhD studentship within the Division of Archaeological, Geographical and Environmental Sciences, University of Bradford, UK.

The candidate will work as part of a multi-university, multi-disciplinary project called Detection of Archaeological Residues using remote sensing Techniques (DART), which will focus on analysing the physical and environmental factors that influence archaeological residues' contrast dynamics with the overall aim of improving feature detection. The DART project consortium consists of 25 key heritage and industry organisations, academic consultants and researchers from the areas of computer vision, geophysics, remote sensing, knowledge engineering and soil science. The candidate will work closely with these partners and may be expected to spend periods of time at their institutions.

This PhD will combine research in geophysical data acquisition and analysis, and knowledge management. As part of this project the prototype of a decision tool will be developed that will help to evaluate and synthesise information from the overall project. This research will lay the foundations for the development of decision tools that link soil properties with remote sensing and geophysics data of the studied sites and their archaeological residues. Remote sensing information will be acquired as part of the overall project. The candidate for this PhD will collect geophysical measurements of earth resistance and GPR over the buried archaeological remains of the investigated sites. Direct comparison will be made between the hyperspectral data provided by remote sensing platforms and earth resistance area surveys to be collected for the test areas; and between in-situ soil data, and resistivity imaging (ERI) and GPR profiles around the location of the buried soil sensors.

Two approaches are envisaged for the knowledge management of the large quantity of information available. The first tool ('static') will utilise the domain ontologies; general soil information for the sites; historical environmental and vegetation records; and metadata from aerial image archives in order to reduce the search space within those archives for the identification of archaeological residues. The second tool ('live') will utilise the domain ontologies; live soil measurements; geophysical and remote sensing surveys; and satellite-derived environmental and vegetation data for the planning of prospection strategies. This latter tool will predict, based on environmental estimates, what archaeological residue types can be detected, with which techniques or sensors and at what times. The predictions will be tested by deriving a programme of bespoke hyperspectral flights and geophysical surveys in an unstudied area and comparing results with known archaeological residues. This development of knowledge management tools will be co-supervised by Prof. Anthony Cohn, University of Leeds.

The studentship should appeal to candidates with a minimum of an upper second class honours degree with an interest in earth sciences, engineering and computing, who are comfortable working in laboratory and field environments and have a strong IT background.

Under AHRC funding rules, this studentship is only available to UK residents (as defined by AHRC rules: http://tinyurl.com/ahrc-elegibility). The stipend will be paid at current AHRC rates (£13290 in 2009/10) per annum for three years full-time and the project will also cover university PhD registration fees. Residents of other EU countries may apply, but are only eligible for the fees award -- they would need to have their own sources to cover their living expenses.

To discuss this project further, please contact Dr Chris Gaffney (C.Gaffney@bradford.ac.uk), including your CV with the enquiry.

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