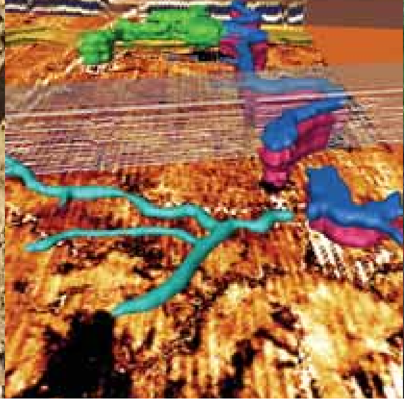

Spring 2009
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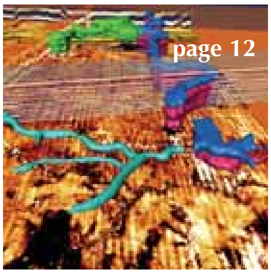
The ARCHAEOLOGIST

This issue

NEW TECHNIQUES FOR PROSPECTION, DATING AND IDENTIFICATION

CONTENTS



Editorial

New techniques for prospection, dating and identification

Yet again we are in depressing times, with the Recession making deeper inroads into our profession after many good, if hard-won, years. IfA's responses were firstly to look at ways it can relieve financial burdens on members (see *TA* 70), then to take stock by undertaking rapid surveys that tell us just what the position is, and to explore ways that archaeologists can help themselves and each other (p7 and 10).

Kenny Aitchison chronicles how the number of archaeologists working in the UK had, in 2007, increased by 20% over the previous five years to a total of 6865. If the losses catalogued last autumn continue, this gain will be lost this summer. He and Martin Locock therefore look at how organisations and individuals can protect themselves, and even thrive, in this situation. This attitude too was the theme of IfA's Recession Seminar. Here, short-term tactics for survival and a strategy for the future were set out, with the triple aims of managing our organisations, protecting the sector and the archaeological resource, and ensuring we make the best of our dialogues with local and central government. Kenny's survey will be repeated this April and so, if you are running a commercial archaeological organisation, do please make sure you fill in the questionnaire carefully so that IfA's case is made on hard evidence.

But we should not despair. As Vince Gaffney says 'the (archaeological) profession and its practitioners are set apart by the wide-ranging skills and experience required to undertake archaeological research. There are few arts disciplines that engage so fruitfully with environmental, material and earth sciences in quite the manner that archaeology achieves on a daily basis'. This *TA* therefore examines some of the latest benefits of this engagement, and what we in turn can offer back to the world.

As in all archaeology, the first step is to understand what we already have. We therefore include an explanation of Bayesian chronology your editor could understand (p18), and appreciate how it enables us to understand chronological relationships between past human activities and environmental change (the what-came-first conundrum of theoretical debate). Many other innovations for site detection and analysis are chronicled here, plus the latest guidelines from English Heritage, training opportunities, a new IfA Group (for geophysics), and plenty more to inspire (or terrify, when you hear the latest on shipworms.....)

Alison Taylor
Alison.taylor@archaeologists.net

Notes to contributors

Themes and deadlines

Summer: Issues today: Recession, heritage protection and treatment of human burials
Deadline: 1 May 2009

Autumn: IFA Conference papers and Annual Report
Deadline: 15 June 2009

Contributions and letter/emails are always welcome. *TA* is made digitally available through our website and if this raises copyright issues with any authors, artists or photographers, please notify the editor. Accessed digitally, web links are especially useful in articles, so do include these where relevant. Short articles (max. 1000 words) are preferred. They should be sent as an email attachment, which must include captions and credits for illustrations. The editor will edit and shorten if necessary. Illustrations are very important. These can be supplied as originals, on CD or as email attachments, at a minimum resolution of 500 kb. More detailed *Notes for contributors* for each issue are available from the editor. Opinions expressed in *The Archaeologist* are those of the authors, and are not necessarily those of IfA.

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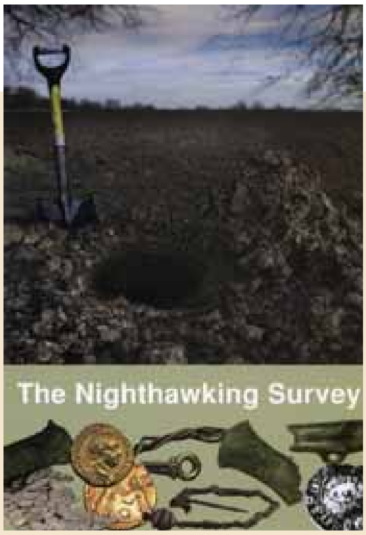
FROM THE FINDS TRAY

Holes dug into a Roman settlement at Icklingham, Suffolk © John Browning



Nighthawking: a survey

After a two-year survey, a report has been published by Oxford Archaeology that replaces rumour and myth with factual evidence for 'nighthawking' (defined as 'the search and removal of antiquities from the ground using metal detectors without the permission of the landowners or on prohibited land such as Scheduled Monuments'). Of the 240 reports investigated, 88 affected scheduled monuments and 35 were on excavations in progress. At Icklingham in Suffolk, over 200 holes were dig during one raid. There is known to be massive under-reporting of this crime, as police see it as low priority, prosecutions are rare and fines are less than for parking offences. The aim of the report is to break this cycle, with recommendations for clear guidance for landowners, police authorities, the Crown Prosecution Service and magistrates. Another recommendation is a central database of reported incidents. Copies of the report can be found on www.helm.org.uk/upload/pdf/Nighthawking-survey.pdf.

New Guidance on Metal Detecting Rallies

Further advice on metal detecting issues is contained in a Guidance Note just published by ALGAO, CBA, English Heritage, the Portable Antiquities Scheme and the Society of Museum Archaeologists, aimed at helping those who get involved in metal detecting rallies. The Guidance is supported by the two largest commercial rally organisers, who promise to run their rallies in line with it in future. It includes sixteen recommendations, including a notice period of at least twelve weeks for the local Historic Environment Record and Finds Liaison Officer, to ensure sites are properly identified in advance and proper preparations made for recording finds. The full text can be found on www.britarch.ac.uk/conservation/portant/detecting.

Heritage protection

The Heritage Protection Bill for England and Wales was in the end absent from the Queen's Speech, but at the same time Linda Fabiani announced that the Scottish government did intend to introduce a bill to amend existing legislation. As non-appearance of the English and Welsh Bill was said to be because of its size (at a time when government has other concerns) rather than any antipathy towards heritage, the more targeted, amending tactics of Scottish Government may well prove a more pragmatic fix. Government, politicians of all parties and the heritage sector are still supporting the Bill at Westminster, but attention is directed towards reforms not requiring primary legislation (www.english-heritage.org.uk/server/show/nav.20038), and the new Planning Policy Statement for England.

FROM THE FINDS TRAY

Maritime Archaeological Day
2 May 2009 Bournemouth University Talbot Campus
This is a chance to see finds from the Swash Channel Wreck site (dated to approximately the 1620s), along with talks, videos and activities related to this wreck and to maritime archaeology in general. The Swash Channel Wreck, off Poole Harbour, has produced an impressive collection of artefacts including iron cannons, wooden barrels, rigging elements, copper, pewter, bones, ceramic domestic material, leather shoes, musket shots, apothecary jars and outstanding carvings. There will be talks by Paola Palma, Dave Parham, and BSc and MSc students from Bournemouth University.

For further information contact: Paola Palma ppalma@bournemouth.ac.uk

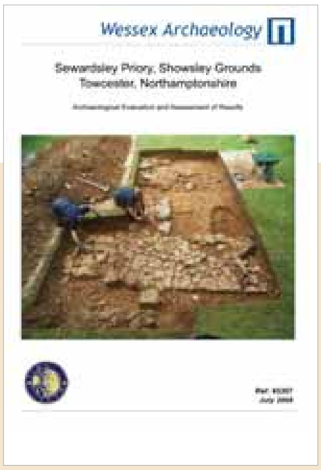
Swash Channel merman - the earliest known ship carving in England.

Marine & Coastal Access Bill in the Lords
The Marine and Coastal Access Bill (M&CA) is being keenly debated in its Committee Stage in the House of Lords. The debate on heritage and archaeology amendments probed the question of why there is no specific reference to marine archaeology in the draft Bill or to English Heritage as a statutory consultee. Without the Heritage Protection Bill, which would have introduced new measures for protecting the marine historic environment, it is currently only historic wrecks that have legal protection. One commitment on behalf of Government is that the marine policy statement will set out the Government's policy on safeguarding the marine environment , including cultural and historic marine heritage. For further information see http://www.britarch.ac.uk/news/090302-marinebill.

Heritage science strategy website
The steering group for the National Heritage Science Strategy has just launched the website www.heritagesciencestrategy.org.uk. This will soon include three reports which provide the evidence base for drawing up the new strategy. These will detail the current use of science in preserving and protecting cultural heritage (available from April), assess the use of science in enhancing our understanding of the past (available end of May), address issues of sector skills and consider practitioner and institutional capacity to deliver improvements in the application of heritage science (available July).

Each report will be available on the English Heritage website, with a one month consultation period. For further information contact
Jim Williams
National Heritage Science Strategy Coordinator
PO Box 2075
Bristol BS35 9BF
NHSS@english-heritage.org.uk

Wessex Archaeology publishes *Time Team*



Wessex Archaeology has just launched a new section on its website detailing their involvement with *Time Team*, including all the post-excavation reports they have prepared from the 2007 and 2008 series. They aim to add earlier post-ex reports produced by Wessex Archaeology, as well as those from the current (2009) series. See http://www.wessexarch.co.uk/timeteam/ to read the reports.

Thomas A Goskar
Web Manager
Wessex Archaeology Ltd

IfA Finds Group spring meeting

Mortimer Wheeler House, Eagle Wharf Road
London N1 7ED
20 May 2009

The theme is *Osteology*, dealing with the broader subject by looking at animal and human bone, worked bone, forensic archaeology and at policy in dealing with human remains. The Finds Group hopes then to arrange a workshop session in the autumn, based on feedback from the meeting. Details are posted on the Finds Group page on the IfA website.

Contact Nicky Powell, npowell@museumoflondon.org.uk, for further details.

Science and Heritage Programme grants

The Arts and Humanities Research Council (AHRC) and the Engineering and Physical Sciences Research Council (EPSRC) are taking forward a joint £8.1m programme, *Science and Heritage,* 'to support leading-edge research which will explore new ways to understand the cultural and physical nature of heritage and to prepare society for the challenges that cultural heritage will face in the 21st Century'. There will be two opportunities for funding

1 Interdisciplinary Research Grants (up to £800,000, duration 1-3 years, must involve at least two collaborating organisations. Outline stage deadline: 14 May 2009, full proposal stage for short-listed projects, deadline: 17 September 2009

2 Post-doctoral Fellowships (to support outstanding early career researchers), duration equivalent to three years full-time, open to researchers with no more than five years post-doctoral or equivalent experience. Deadline: 10 September 2009

The full Programme Specification, including further details of the themes and on other activities under the *Science and Heritage Programme*, and the research already funded, can be found at http://www.heritagescience.ac.uk/.

Debbie Williams
AHRC/EPSRC Science and Heritage Programme Coordinator
http://www.heritagescience.ac.uk/

FROM THE FINDS TRAY

Finding the Familiar: Dealing with artefacts of the Modern Age
Medieval Finds Research Group and ARCUS
University of Sheffield, Humanities Research Institute
9 May 2009
This workshop will offer an opportunity to discuss 19th- and 20th- century finds, with a range of speakers from commercial archaeological organisations, societies and museums. Some will draw on North American and Australian experience while others will look at material types found across Britain. A speaker from the Historical Plastics Society will address the question of what we can learn from plastics.

For further information, contact Claire Coulter, c.coulter@sheffield.ac.uk, and for registration contact Quita Mould, quita@onetel.com.

Festival of British Archaeology
18 July to 2 August 2009
Previously known as National Archaeology Week, this event has been celebrated and supported by hundreds of heritage organisations since 1990. This summer, over 450 events will be held across the UK at heritage sites, museums, archaeological excavations, community centres, English Heritage and National Trust sites, universities, National Parks and other venues. The Festival is co-ordinated by CBA, which is now calling on potential participants to plan for the 2009 event and to register using the documentation and guidelines that can be found on the festival website, http://festival.britarch.ac.uk.

Cosmeston Community Archaeology Project. Photograph: Jane Stewart

Scottish Community Archaeology Conference
16 and 17 May 2009, Queen Margaret University, Musselburgh
East Lothian Council and Archaeology Scotland (previously, Council for Scottish Archaeology) are holding the first national Scottish Community Archaeology Conference, with opening remarks by Mike Russell, Minister for Culture, External Affairs and the Constitution.

This is a chance for volunteers to share experiences with each other and with archaeologists, interpreters and fundraisers. There will be workshops where volunteers and professionals can share ideas and an exhibition featuring community projects and heritage organisations.

For information or a booking form contact Archaeology Scotland, Suite 1a Stuart House, Eskmills, Station Road Musselburgh, EH21 7PB 0845 872 3333, www.scottisharchaeology.org.uk, East Lothian Council www.eastlothian.gov.uk/archaeology, 01620 827408.

***Cotswold Outdoor* Offer**
IfA members can now get a 15% discount at Cotswold Outdoor (sellers of warm clothes and travel and camping equipment). Please quote 'Institute for Archaeologists' at the till and present your membership card. The discount is also available for phone and online orders. If you have difficulty using this offer please contact the IfA office.

IfA Recession Seminar

Andrea Bradley

"To survive will require collective effort not only to identify tactics for the short term, but also a coherent vision of where we want to be long term."

Jobs are being lost, skilled professionals are leaving the sector, businesses are failing and archaeology in planning, in post-ex and in archive is under threat. We are reminded daily of the long-term nature of this recession and fear for the coming months is naturally at the forefront of our minds. To survive will require collective effort not only to identify tactics for the short term, but also a coherent vision of where we want to be long term. IfA's Recession Seminar (in London at the Museum at Docklands on 16 February) aimed to identify both short-term tactics for survival and a strategy for the future. The debate identified the objectives set out below. They are the drivers for action already taking place across the sector and a framework for evolving aspirations for the development and growth of our profession in a post-recession economy. We must

...in managing our organisations

- ensure that redundancies are managed properly and fairly with selection for redundancy based on clear process, consideration of alternatives and understanding of statutory obligations
- retain specialist skills, in the understanding that those with best skills will be better positioned to respond to demand when the recession ends
- ensure that organisations have sustainable business strategies
- improve commercial risk management processes within businesses

…in protecting the sector and the archaeological resource

- act decisively and firmly should sub-standard archaeology be detected
- collect intelligence on sector skills, to identify emerging skills gaps, and where capacity will be lowest when the recession ends
- ensure funding for post-excavation work, particularly where clients are likely to change – perhaps through up-front payment or later discharge of conditions
- ensure that recruitment standards are not lowered once the market picks up
- react quickly if archives are threatened by business closure
- make more decisions based on the quality, not quantity, of archaeological work that's achievable through the planning process

Museum of Docklands. Photograph: Museum of London

- understand our market better, obtaining advice and expertise of those outside the sector
- commit to a better market operation in the future, based on quality assurance through the Registered Organisations scheme, market knowledge and defined market strategy

…in our dialogue with local and central government

- advocate links between the planning process and quality standards
- find ways to communicate the public/social value of archaeology
- ensure that the new PPS can be strongly enforced (including the possibility of more frequent use of S.106s)
- pursue better model conditions for planning consents and ensure they remain as a charge on the land if not discharged
- make the pitch for archaeology in new terms – terms that reflect current priorities and agenda

Andrea Bradley
andrea.bradley@archaeologists.net

GeoSIG:

IfA Geophysics Special Interest Group

Ken Hamilton

Members of IfA and the wider archaeological geophysical community have come together to form the IfA Geophysics Special Interest Group (GeoSIG). This new IfA group represents the interests of archaeological geophysicists to IfA Council and in the Institute's activities, and is open to both IfA members and non-members. It was set up following discussions within the archaeological geophysical community on how to create and maintain standards for commercial geophysical work. However, the Group quickly decided that it should be aimed at both archaeological geophysicists and users of geophysical data such as curators and contractors.

GeoSIG will produce documents and guidelines relating to geophysical work and promote geophysical work constructively within the structure of archaeology. It is currently examining a number of specific issues, such as

- the practical implementation of guidelines such as *Geophysical Survey in Archaeological Field Evaluation* (English Heritage, 2008)
- production of a set of IfA standards for geophysical investigations
- archiving geophysical data
- training and CPD for practitioners in archaeological geophysics
- training and CPD for users of archaeological geophysics, aimed at curators and contractors

Magnetometer survey of Venta Icenorum, Caistor St Edmund, Norfolk. Courtesy D Bescoby, University of Nottingham

We are looking not only at the form in which data are archived, following ADS guidelines (Schmidt 2002), but also looking at the storage location of geophysical data. GeoSIG will shortly be circulating an on-line questionnaire about the form and location of data, to assess the current state of geophysical archives. We urge anyone with geophysical data, be they geophysicist, curator, contractor or archivist, to help us by filling in the questionnaire on www.harewoodgeophysical.com/geosig/archival.php.

GeoSIG is sponsoring the forthcoming ALGAO:Scotland meeting on geophysics (p9), and there are plans to run more training events in the next few years for curators and contractors, with separate events aimed at archaeological geophysical practitioners.

GeoSIG is working closely with ISAP, EIGG, and EuroGPR to ensure that we keep up to date with developments in the wider geophysical community. The committee also has close links with the Near Surface committee of EAGE. Your GeoSIG committee comprises Peter Barker (Chair), Hannah Heard (Secretary), Ken Hamilton (Treasurer), Roger White and Adrian Butler. There are also representatives from ISAP, EIGG, EuroGPR and English Heritage, and plans to include representatives from ALGAO, CADW, Historic Scotland and NIEA.

Membership is free to IfA members (£10 for non-members). For more information, contact
Ken Hamilton
(ken.hamilton@norfolk.gov.uk, 01362 869275)

Schmidt A 2002 *Geophysical Data in Archaeology: A Guide to Good Practice* ADS (http://ads.ahds.ac.uk/project/goodguides/geophys/)

A role for geophysics in Scottish developer-funded archaeology?

CONFERENCE

Oliver O'Grady

This conference, supported by IfA and ALGAO:Scotland and hosted by the Perth and Kinross Heritage Trust, brings together perspectives from throughout the UK, including curatorial archaeologists, contractors and commercial managers, and representatives from Historic Scotland and English Heritage, to stimulate critical discussion on what future role geophysics should have in development control archaeology north of the border.

The specific impetus for the event has been the author's placement with PKHT on an IfA training bursary in Development Control and Curatorial Archaeology, and his professional interest in geophysical survey techniques. Results of a recent survey of ALGAO:Scotland members undertaken by PKHT indicate that the majority of Scottish local authority areas rarely stipulate geophysics in archaeological briefs. Regional exceptions have been identified, such as the Orkneys and we will be hearing from Susan Ovenden regarding her work in the commercial sphere throughout the Northern and Western Isles.

It is now over five years since the role of commercial archaeological geophysics in Scotland was last discussed in a forum of this kind (Ian Banks of GUARD will be talking about *GOOG five years on*).

This, combined with the recent new edition of English Heritage's guidance on *Geophysical Survey in Archaeology Field Evaluation* and the formation of GeoSIG, make the perfect time to clarify the situation in Scotland through reference to professional best practice throughout the UK.

Papers include:

Recent geophysics in Perth and Kinross **David Strachan** (PKHT, Manager) and **Oliver O'Grady** (PKHT, Assistant Archaeologist)

Beyond Time Team: *Geophysics in the real world* **John Gater** (GSB, Director)

Marine Geophysics and Protecting Scottish Wrecks **Philip Robertson** (Historic Scotland, Senior Inspector of Marine Archaeology)

The use of geophysics in the Highlands and Islands **Susan Ovenden** (Orkney College, Geophysics Unit, Director)

Is it Reasonable? **Sarah Winlow** (PKHT, Heritage Officer)

Is it Sustainable? A contractors view from Scotland **Tim Neighbour** (CFA, Assistant Director)

Geophysical Prospection and Planning - A view from the East **Ken Hamilton** **(**Norfolk Landscape Archaeology, Head of Archaeological Planning)

Going Over Old Ground Five Years On **Ian Banks** (GUARD, Director)

Specs and Guidance for archaeological geophysicists – seeing the way ahead **Peter Barker** (IFA, Geophysics Special Interest Group, Chair)

Conference proceedings will be published as the first ALGAO:Scotland Monograph. Among the outcomes of the event, there will be advice for curatorial archaeologists about the appropriate uses of geophysics for development management.

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Hard Times:
Archaeology and the recession

Working into the twilight... © Wessex Archaeology

Kenneth Aitchison and Martin Locock

Where we were

In 2007 there was more archaeological work being undertaken in the UK than ever before. The housing boom was approaching its peak, and the archaeological profession was reaping the benefits. The *Archaeological Investigations Project* tracks the number of reports deposited with Historic Environment Records in England (the best proxy indicator of the volume of work), and reports that there were 4800 archaeological investigations in England in 2006, of which 93% had been initiated through the planning process.

In the summer of 2007, the *Archaeology Labour Market Intelligence: Profiling the Profession 2007-08* report estimated that a total of 6865 people worked as archaeologists in the UK, an increase of 20% over the previous five years. Around 4000 individuals worked in what can be called commercial archaeology (the remainder working in curatorial, academic and specialist organisations).

Where we are

Since the *Profiling the Profession* census date in August 2007, stock markets have crashed and house prices have fallen relentlessly. The *AIP* estimates that the number of reports will have dropped from the 2006-07 high of 4800 to 4474 for 07-08 (a drop of 7%) and 4158 for 08-09 (a projected drop of 13% over two years).

In January 2009 IfA did a rapid survey of IfA Registered Organisations and FAME members to identify how many archaeological jobs were being lost. There were 130 fewer people employed in October 2008 than in August 2007, and a further 345 archaeological jobs were lost in the quarter from 1 October 2008 to 1 January 2009, representing 8.6% – one in twelve – of the jobs in commercial archaeology and 5% of the entire UK archaeological workforce. Commercial archaeology is transforming from an industry that grew by 5% every year over the past decade to one that is now shrinking by at least that rate.

Where we are going

The overwhelming majority of respondents to the IfA January 2009 survey consider that the market will deteriorate further. Further job losses are anticipated and almost certainly some archaeological practices will go out of business during 2009.

IfA will repeat the survey in April 2009.

These are serious times and hard decisions will have to be made if archaeological organisations are to survive; they will need to become more efficient, more profitable, more flexible, and, probably, smaller and more specialised.

What can companies do?

Face the problem. Make sure that staff have a realistic view of the business prospects and understand your strategy to deal with them.

Focus on the specification. It is easy for the scope of projects to grow beyond their strict purpose. Project managers should ensure that the entire team understand the specification and, in particular, note exclusions. Extra work without extra pay is a loss waiting to happen.

Cashflow and credit control. Relying on an overdraft facility to keep your business solvent runs the risk of collapse if the bank chooses to change its lending policy. Companies should aim to shorten the gap between expenditure and reimbursement by prompt completion and invoicing, and introducing stage payments. One imponderable is the risk that clients may go out of business: it may be worthwhile exploring credit checks for new businesses. Any hint of delays in paying invoices should lead to a suspension of further work.

Staffing. Your staff is both your biggest asset and potentially your biggest liability. Keeping more staff than you have work for is a surefire recipe for disaster. While redeployment is always preferable to reduction, it is a precarious balancing act to ensure that the size of the team matches work available. This applies quite as much to managerial or admin personnel as it does to field staff.

Profitability. There are probably some types of project that are difficult or impossible to complete on-budget; often these are desk-tops, watching briefs, and projects which require a lot of travel and/or accommodation. If they are not guaranteed to lead to bigger projects, micro-profit or non-profit jobs are not what you want to be doing when times are tight.

Cost control. Reduce all budgets: consumables, plant and travel. If it's not needed, don't spend it.

What can individuals do?

Firstly, you can play your part in helping your employer to implement the above. This may, in itself, be enough.

Build a support network - think about who can help you and who you can help. Identify an experienced colleague who you trust who could act as your mentor, passing on advice and ideas in an informal and supportive way. And think about whether you could do the same to help someone who is at an earlier stage of their career.

But you also need to protect yourself by thinking of a Plan B: it makes sense to ensure that your CPD log and CV are up to date, and it is worth thinking about what your next job might be and starting to prepare for it. Finish off any outstanding projects and publications, look out for opportunities for training and networking: you may have been able to rely on your company in the past, but it is time to look wider – even think about whether there is anything else you could, or would want to do? Do you have transferable skills that might find a better market outside archaeology?

Prospects

The recession is going to be a transformative time for archaeology. It will come to an end one day, and the work will come back. We can't predict when that will be, but when it does, archaeology will have changed – in terms of the number of people and organisations doing it, and in the way that we do things. Until then, we all just have to do the best we possibly can in the most difficult of circumstances, and hope that the profession copes better than it has with previous downturns.

Kenneth Aitchison
IfA Head of Projects and Professional Development

Martin Locock
Author of the website *10 simple steps to better archaeological management*
http://10simplesteps.blogspot.com/

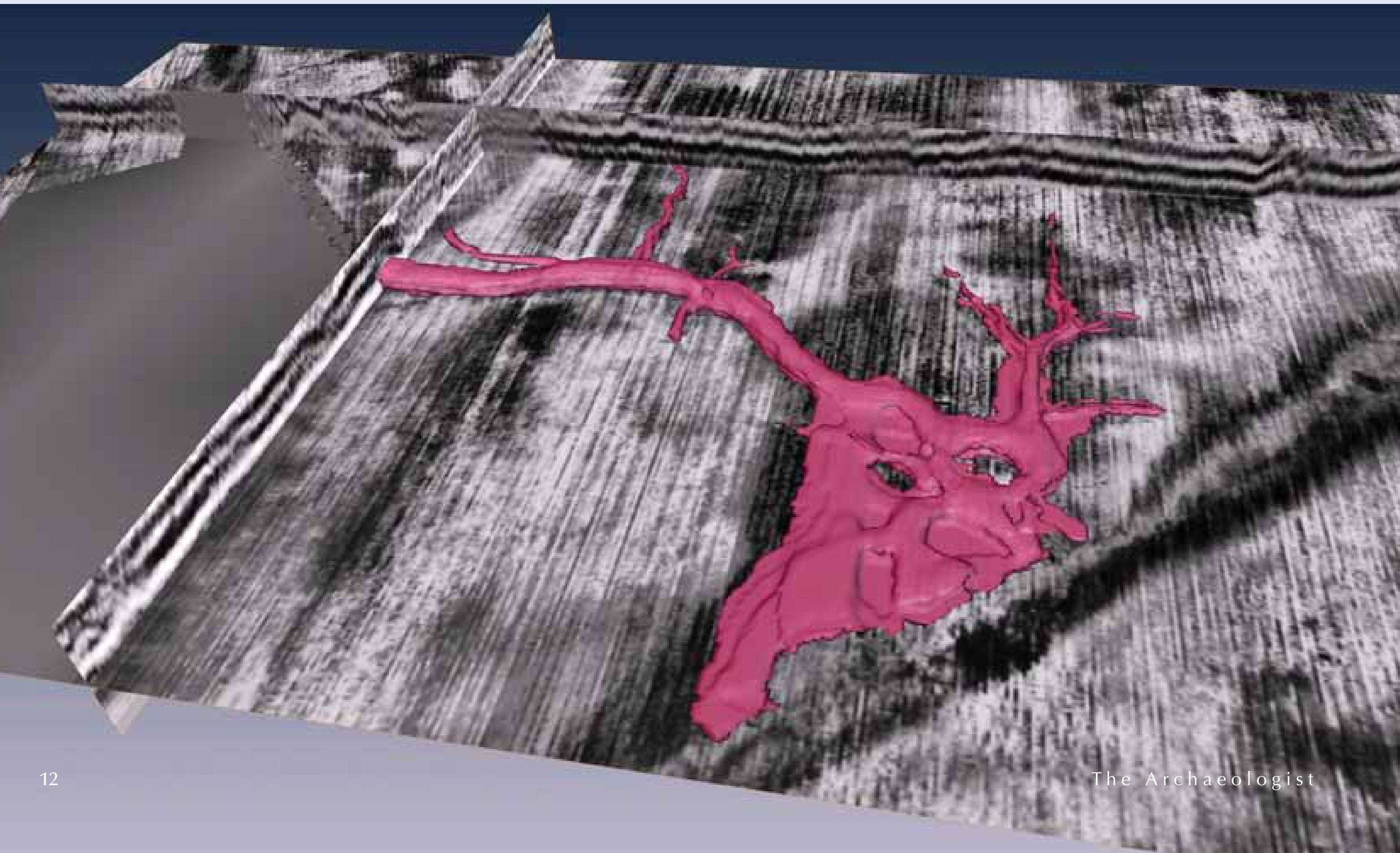
In next TA *we want to look more broadly at the effects and implications of the recession, and how we can best survive it. Readers' responses are welcome. (Ed)*

A wider archaeological **VISTA:**

The current economic situation presents considerable challenges to archaeology and archaeologists within Britain and across the world. Despite this, archaeology remains a uniquely attractive discipline both intellectually and through its capacity to enrich quality of life. It is also true that the profession and its practitioners are set apart by the wide-ranging skills and experience required to undertake archaeological research. There are few arts disciplines that engage so fruitfully with environmental, material and earth sciences in quite the manner that archaeology achieves on a daily basis. Few contribute so fundamentally to the continuing development of the rural and urban fabric of the country and engage as part of a wider heritage industry that leads the world. Here at Birmingham we are relying on this rich diversity combined with the specialist strengths we have built up as a university department with an integrated commercial archaeological arm to make sure we grow, whatever the economy does.

COMPUTER-BASED VISUALISATION
The history of computing applications and, more recently, the emerging significance of computer-based visualisation as a core archaeological activity amply demonstrates our 'two cultures' discipline.

Visualisation is fundamental across the arts and sciences, to trade and industry, indeed to almost all aspects of life, and 21st-century technology has made possible new ways of visualising things, new ways of thinking about things and new ways of



the Visual and Spacial Technology Centre at Birmingham

Vince Gaffney

communicating these thoughts. The enthusiasm of archaeologists to adopt these technologies, from GIS through digital reconstruction to Web 2.0, indicates that archaeology is creating a generation of trained practitioners with skills that will be required as the nation's economy recovers from the current crisis. Moreover, future restructuring within the UK economy is likely to enhance the nation's awareness of the increasing significance of heritage industries to the economy overall. Archaeologists with significant digital skills will be valued within the UK as an essential part of an expanded culture sector rather than an adjunct to the building industry or IT services.

STRATEGIC RESEARCH PRIORITY

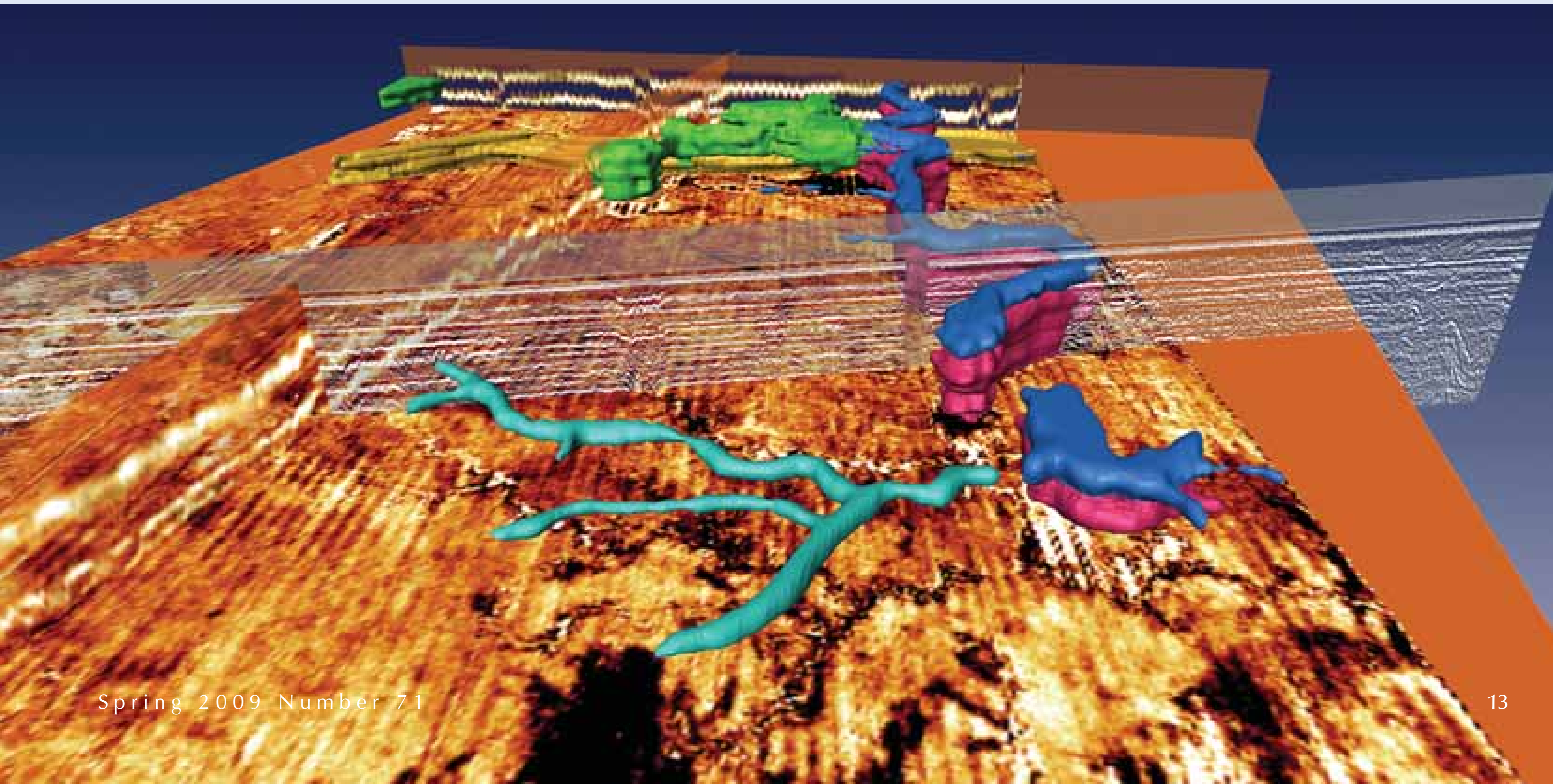
In this context, specialist technology groups within archaeological organisations acquire particular significance. The Visual and Spatial Technology Centre (VISTA) at the University of Birmingham is one example (http://www.vista.bham.ac.uk/). The origins of VISTA lie in the work of a research group based in Birmingham Archaeology, the University's commercial field archaeology unit. During the 1990s this group developed a reputation for innovative applications of technology to the visual and spatial analysis of large archaeological data sets. They managed the Wroxeter Hinterland Project, which included the first complete geophysical survey of a major Roman City in Britain, as well as the Stonehenge Landscapes Project. By 2000, activities included support for other disciplines within the University wishing to use visualisation technologies; further development of the resource was identified as one of the University's strategic research priorities.

In 2003, external commercial partnership and internal collaboration with the University's Information Services enabled formal establishment of VISTA as a technical facility with a university-wide brief, embedded within Birmingham Archaeology. Success had a snowball effect, attracting further commercial partners and international academic collaborations. Another boost came in 2004, when major investment from Advantage West Midlands, the regional development agency, led to VIN (the Visual Imaging Network) Technology Services as a division of VISTA, providing assistance to businesses with visualisation needs in the region. In 2008 VISTA signed a memorandum of agreement with IBM to promote and develop large-scale computing technologies for archaeology and the arts more generally.

VIRTUAL WORLDS

Varied funding streams combined for a single purpose have enabled the development of a facility

Seeing beneath the sea. Images: University of Birimingham



dedicated to the capture, analysis, display and dissemination of large-scale archaeological data sets. Alongside the processing of traditional GIS and remote sensing data VISTA supports a significant 3D scanning capacity 'Virtual Worlds' laboratory (p22), including a suite of structural or high definition landscape scanners. The processing of terabytes of imaging data is facilitated by dedicated fibre networks linking the centre's own render clusters with the Birmingham 'Blue Bear' large cluster, which was originally provided to analyse data sets from the Large Hadron Collider. Visualisation of data sets generated by archaeological research is supported by dedicated stereo projection facilities with tracking capacity, whilst the VISTA Centre includes two Access Grid nodes. These provide multi-site interactive conferencing over the Internet to support collaborative projects that span international sites.

The availability of technology, however, is not as significant as the people who use it. Our staff engage in leading-edge research projects involving visualisation technology, initiated by individual departments, through consortia of departments or as collaborative research ventures with external partners. Partners have included the US Department of Defence, the University of Princeton, the Slovene Academy of Sciences and Arts, Oberlin College (Ohio), the Department of Antiquities (Libya), the Qatar Museums Authority, English Heritage, Natural England, the Arts and Humanities Research Council and numerous commercial partners.

INUNDATED LANDSCAPE

One recent flagship project has involved exploration of the inundated landscapes of the southern North Sea. At the end of the last Ice Age, rising sea levels inundated an inhabited prehistoric landscape larger than the surface area of the UK. This inundated landscape is now under intensive pressure from trawling, mineral extraction and infrastructure development. The project is using the latest seismic and visualisation technologies to map and explore this lost world. The southern North Sea has been the subject of extensive seismic survey over many years for petroleum and gas exploration, which has created a vast dataset whose value goes beyond the original purpose of locating fossil fuels. Although not collected for this purpose, the top of the seismic columns can be used to reconstruct ancient land surfaces which now lie buried beneath many metres of sediment and the waters of the North Sea.

SEISMIC DATA

The project is being carried out in collaboration with Petroleum Geo-Services (PGS), who donated c.23,000 km^2 of marine seismic data, and is supported by a grant from the Aggregates Levy Sustainability Fund. To date this has allowed the detailed mapping of a uniquely preserved but largely unknown landscape. Rivers, streams, lakes and coastlines lost more than 8000 years ago are now being explored for the first time. Methodologies have developed considerably since the conclusion of the original ALSF project, and VISTA staff are now carrying out similar projects elsewhere in the North Sea, the Irish Sea and the Arabian Gulf.

Work at VISTA demonstrates that archaeology is valuable for fostering interdisciplinary and collaborative research and provides an exemplar of the fruitful exploitation of commercial and academic partnerships, and of innovation in knowledge transfer. Such a model has wider applicability within the discipline. In a time of economic uncertainty it is essential that archaeologists use their considerable skills and experience to best effect. UK archaeology is and will remain an important activity in both cultural and economic terms, regionally, nationally and internationally. We have much to give as well as to receive from other disciplines, and if we want to survive and flourish we should continue to plan on that basis.

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New developments in **Geophysics**

Eamonn Baldwin, Jimmy Adcock
and Meg Watters-Wilkes

The Foerster Ferex in use in Turkey with GPS positioning

The Foerster Ferex in use in Shropshire with GPS positioning integrated into the data collection. The three sensors are visible on the frame

The Ferrex© 4.032 Magnetometer

It's peculiar what archaeology borrows and adapts from other fields; sometimes the less obvious technology proves more favourable. For example, our most basic tool – the 4 inch (WHS) trowel, is primarily a pointing tool, not a digging one. A more recent example is the Ferrex© 4.032 Magnetometer, a magnetic measurement system developed by German manufacturer Foerster for subsurface detection of unexploded ordnance (UXO). Bomb detectors don't usually feature in the archaeological tool-cupboard; regardless, VISTA, within the Institute of Archaeology and Antiquity, Birmingham (IAA) has recently invested in just such a system for its Geophysics Division.

Deadly or harmless?
The reason lies in the development of the Ferrex system, which was driven by the need to distinguish between potentially dangerous UXO and innocuous items such as scrap metal. One might not expect an instrument of this sort to have the sensitivity to pick up the subtleties of buried archaeological features such as pits, ditches and walls. But in the effort to provide data sound enough to discriminate between the deadly and the harmless Foerster have developed a magnetometer based on the Fluxgate technology used in archaeological geophysics. In archaeology, this technology is nothing new. Instruments such as the FM256 Gradiometer (Geoscan Research) and the Grad601 gradiometer (Bartington) are deployed routinely in both contract and research archaeology to carry out detailed large area magnetic surveys.

Consistent data-set
In Foerster's Ferrex system the probes are non-directional and are factory-set. This means that the direction in which the probe is held becomes immaterial and instrument set-up procedures in the field are reduced to an occasional 30 second calibration routine. Anyone who has calibrated a FM256 or FM36 will immediately appreciate the benefit of this, and not only in terms of time saved.

Furthermore, unlike the FM256 and the Grad601, the Forester is a multi-probe system that accommodates up to four probes. These are mounted on a frame which is wheeled over the survey area with ease. This has the added benefit of keeping the height of the probes constant, ensuring a consistent data-set. Probes can be assembled at a 0.5m or 0.25m spacing interval; half or quarter that of the Grad601. Magnetic readings may then be sampled as frequently as 0.10m intervals. This sort of resolution (or sampling ratio) makes up for the slightly less sensitive sensors of the Ferrex probes, at least in comparison to the FM256 or Grad01.

Real time and real world
As if these innovations aren't enough, Foerster have provided the facility to integrate leading brand survey-grade GPS units into the system. The

advantage is twofold. Firstly, when the Ferrex system is coupled with a Leica 1200 SmartNet receiver, such as those used in IAA, Birmingham, every reading is logged in real-time with its own real world co-ordinates. In other words there's no need to geo-reference your survey grid to the national mapping system retrospectively. In fact, with the Foerster, one can dispense with setting out a grid matrix entirely. How come? Well, the real time co-ordinate information that is streamed through the GPS receiver can also be used to navigate the operator along imaginary survey lines, effectively creating a virtual grid. All the operator need do is select a start and end point which the Foerster field computer takes as a base line from which to build the imagery grid. The result is fully referenced and custom-sized grids orientated to the needs of the survey or operator. So, the second benefit is obvious: no more untangling survey lines and ropes; no more reeling in muddy tape measures; no more hauling and hammering-in stacks of survey stakes over site; and no need for a total station for set-out.

Most important of course, are the results. The kit was originally field-tested by a team from IAA in conjunction with Chris Gaffney from the University of Bradford at the World Heritage Site and ruined Hellenistic city of Cyrene in Libya. The results were startling and revealed, despite the difficult terrain, the plan of the ancient city in intricate detail. The Ferrex has since seen continual use by the IAA across Britain and Europe on research, contract and training projects, including Stonehenge. It has certainly proved a welcome addition to the IAA's Geophysics cupboard.

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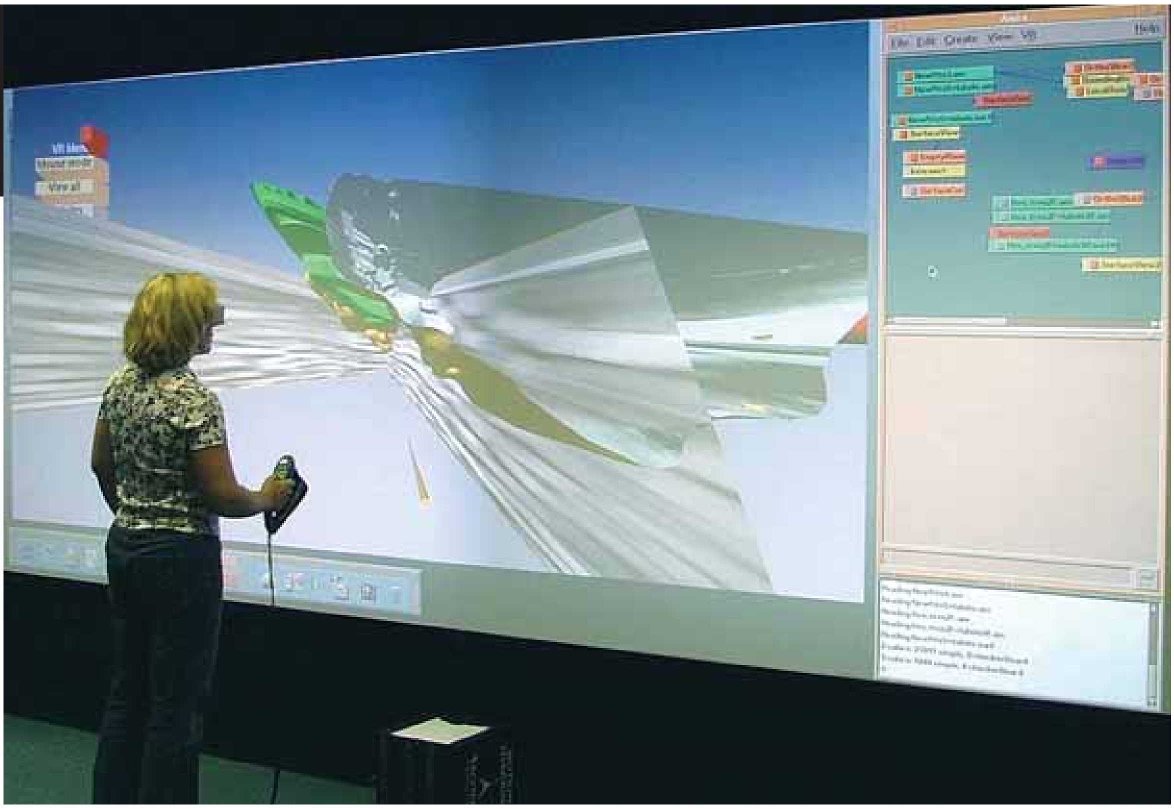
Ground penetrating radar: recent improvements

Jimmy Adcock and Meg Watters-Wilkes

Recent hardware developments within the world of ground penetrating radar (GPR) have witnessed the introduction of multi-channel systems capable of simultaneously capturing a larger amount and range of data (depth-wise) from within a single survey transect. Survey time is consequently reduced, and technical concerns regarding the balance between signal strength (depth) and survey resolution (sampling ratio) are eased. Furthermore, the integration of survey-grade GPS units with GPR systems is further reducing survey times and increasing flexibility in the field.

Meg Watters exploring GPR modelling data in 3D on the Machdyne PowerWall in the VISTA centre



Modelling archaeological surfaces

However, it is software improvements that have really changed the face of GPR. Today's software packages are more intuitive, have quicker, more powerful processing algorithms and provide a huge range of visualisations. Early analysis only used individual radargrams – effectively electronic section drawings – but it soon became possible to combine these (like slices in a loaf) to produce 3D data blocks. These can be cut in any direction or shape, though most commonly horizontally (like a layer cake) to map reflection amplitudes, in plan, at different depths. This has subsequently moved onto volume plots – stripping away the 'quiet' matrix of entire datasets to leave only the strongest responses (equivalent to a jailbird removing the sponge of their cake to reveal the hacksaw baked within). 3D representations of archaeological features such as those revealed and modelled by GSB Prospection at Caerwent last year are now becoming commonplace and are as close to a complete representation of a buried resource as is currently possible without resorting to the 'spade and sweat' approach. An alternative option is to automatically detect horizons running through a dataset to model archaeological surfaces (eg palaeolandscapes) rather than using horizontal slices, in which surfaces might simply dip in and out.

Earlier monument

Recent work by IAA at Catholme Ceremonial Complex, Staffordshire demonstrated that the ability to visualise 3D data establishes a new method of extracting archaeological information from geophysics through data interpretation and presentation. State-of-the-art visualisation software allowed a range of data types such as resistivity and magnetometer data to be combined with GPR data and even archaeological section drawings, and explored in a single 3D environment. The enhanced visual perspective exposed not only the underlying form of various archaeological features but also their interrelationships, contributing to their interpretation and informing subsequent investigations. The strength of such 3D analysis was proven at Catholme when visualisation results identified a circular series of pits lying beneath a ring ditch. Subsequent excavations proved this to be an earlier phase of monument construction. Significantly, this phase would have been missed by excavation alone, which sampled the ring ditch in plan and section according to the scheduling constraints.

One drawback to the advances in modelling and visualisation is the volume of data produced. As surveys become larger, datasets grow exponentially as does the processing time and power required for real-time display of the subsequent models. However, the possibility of using remote access networks as a means of time-sharing powerful super-computers (such as the University of Birmingham's BEAR Cluster) will undoubtedly become more commonplace.

In contrast, on a lower-tech note, GSB have attempted to reproduce dynamic models without requiring a monitor or PC (ie for permanent display boards etc) by employing lenticular technology (perhaps best known for its use in free toys and novelty postcards). The multi-image arrays, printed under an integral plastic lens, produce strikingly effective yet inexpensive, animations or 3D effects to help grab the public imagination.

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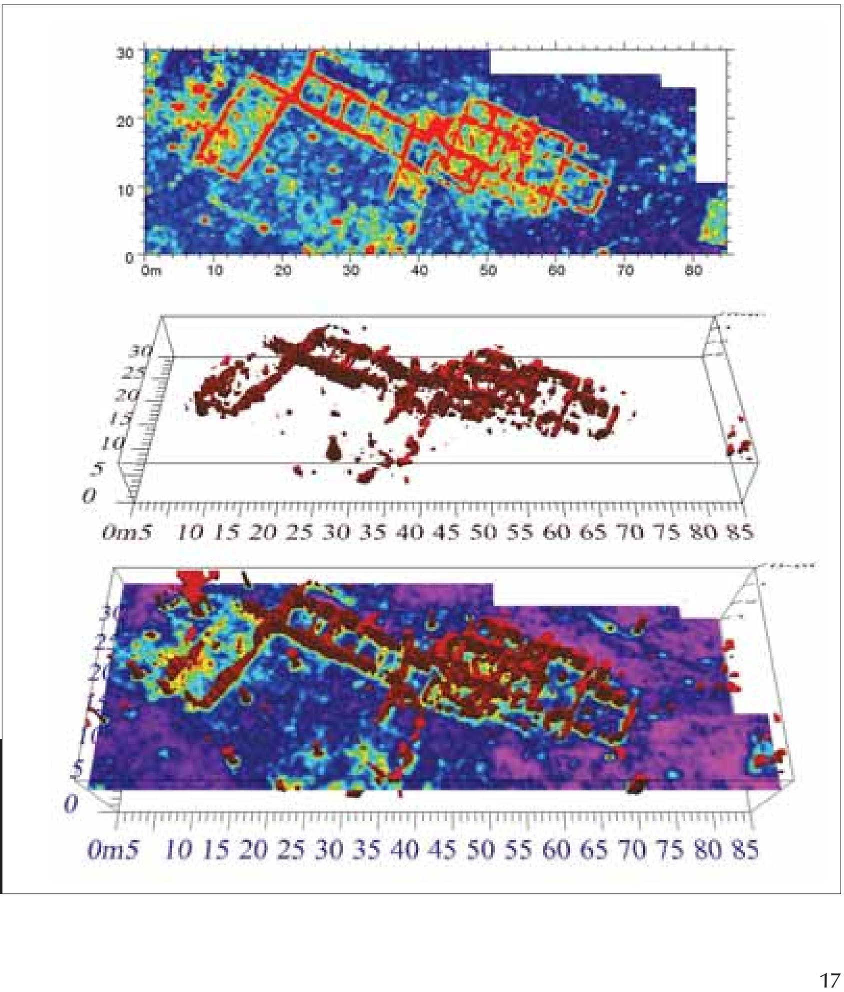


250MHz GPR data collected by GSB Prospection as part of a Time Team investigation at Caerwent Roman town, Monmouthshire: time-sliced data (top); volumetric plot (centre); combined output (bottom)."

Tomb of the Revd Thomas Bayes. This 18th-century clergyman devised an effective statistical system for improving his chances when betting on the races

BAYESIAN CHRONOLOGIES:

yet another rediocarbon revolution?

Peter Marshall and Benjamin Gearey

An 18th-century clergyman with a penchant for a flutter on the horses might seem like an unlikely person to have sparked a seismic shift in the world of radiocarbon dating. Nevertheless, it is the Revd Thomas Bayes' deceptively simple theorem, published in 1763, that is at the heart of recent developments in the way we approach archaeological chronologies. It is the application of a Bayesian framework for interpreting radiocarbon dates from Neolithic long barrows that has led Alex Bayliss, Alasdair Whittle and their collaborators to state in the *Cambridge Archaeological Journal* 'we will not bluff you with date substitutes… we do mean…explicit, quantitative probabilistic estimates of real dates when things happened by the agency of particular people in specific places in the Neolithic of southern England.'

ANSWERS UNDER OUR NOSE

Not long ago, most of us felt we had a decent understanding of chronology if we were able to calibrate our radiocarbon results or appreciated the implications of the 'Halstatt Plateau' for dating the Iron Age. But Bayes theorem has added a different terminology to the world of chronology; 'standardised likelihoods', 'posterior beliefs' and 'prior beliefs' are all part of the new lexicon. So why is this school of statistical thought leading researchers to invest in yet more radiocarbon dating programmes and also to reassess and re-analyse lists of old dates, in search of chronological answers that may have been under our noses all the time?

PRIOR AND POSTERIOR BELIEFS

Simply put, Bayes theorem states that new data ('standardised likelihoods') are analysed in the light of what we already know about a particular problem ('prior beliefs'). Understanding that emerges from this produces 'posterior beliefs'. Bayes theorem can be applied to any statistical problem, but in the context of archaeological chronology 'standardised likelihoods' are generally age estimates produced by radiocarbon dating. Prior beliefs are most often our knowledge of the stratigraphy of a site or section; that dated samples relate to a single phase of activity or are in a stratigraphic order, for example. The resulting 'posterior beliefs' that combine this information are referred to as '*posterior density estimates*' and are expressed as probability distributions similar to calibrated radiocarbon.

The use of Bayesian methods is not unique to archaeology – they are used in weather forecasting, health care policy and criminal justice, to name a few. A common practical application is in email 'Spam filters'. It is hardly new even in archaeology, having been first used in the 1980s for analyses of radiocarbon dates and the ceramic sequence at Danebury.

Software for Bayesian chronological analyses

Program	Web address
OxCal	http://c14.arch.ox.ac.uk/embed.php?File=oxcal.html
BCal	http://bcal.shef.ac.uk/
Ren-Date	http://www.meteo.be/CPG/aarch.net/onlytxt/rendate.otxt_en.html
CPGchron	http://ftp2.uk.freebsd.org/sites/lib.stat.cmu.edu/R/CRAN/src/contrib/Descriptions/CPGchron.html
Bpeat	http://www.cimat.mx/~jac/software.html

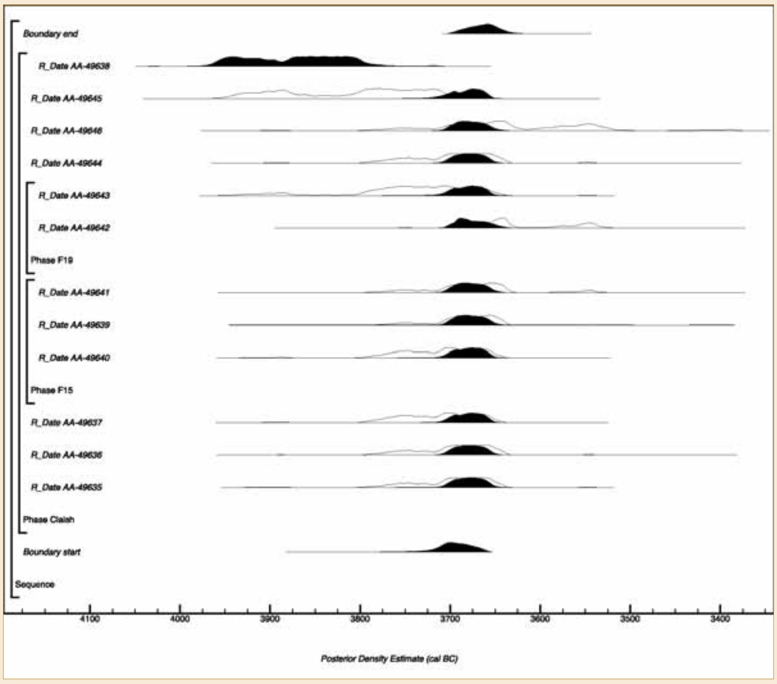
DATING FOR NEOLITHIC CLAISH

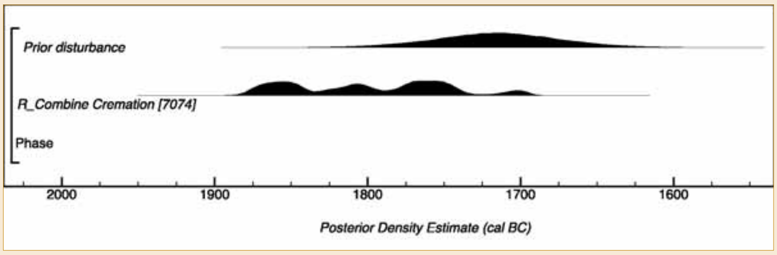
Incorporation of Bayesian statistics and Markov Chain Monte Carlo (MCMC) methods into statistical packages such as OxCal and BCal together with information from archaeology now permit a robust approach to the construction of chronologies. For example, in dating a Neolithic building at Claish, Callander, our 'prior beliefs' are that at an unknown time in the past, the building was built and occupied for a period before being abandoned. The 'standardised likelihoods' are 12 calibrated radiocarbon dates obtained on charcoal and carbonised cereal grains from post holes and hearth contexts. Our model incorporates 'prior beliefs' and 'standardised likelihoods'. As well as producing '*posterior density estimates*' (in black) for the 12 calibrated radiocarbon dates we also have two new distributions for when the building was built (*start; 3750-3650 cal BC (95% probability*)) and was abandoned (*end; 3700-3630 cal BC (95% probability)*). We have no radiocarbon samples for these events; they are derived from the distribution of our 12 standardised likelihoods, and take into account that we are unlikely to have dated either the earliest or latest sample.

WOODLAND CLEARANCE AND BRONZE AGE BURIAL: WHICH COMES FIRST?

Bayesian approaches also impact on the world of environmental archaeology. Constructing chronologies for peat deposits for example, the source material for pollen diagrams, requires incorporation of absolute and relative dating. Precise and accurate chronologies are essential for comprehensive records of past environmental change and for evaluating correlations between archaeological and palaeoenvironmental evidence of human activity. An example of the way these can be combined and compared is shown here. This shows the posterior density estimates for palynological evidence of woodland clearance from a radiocarbon-dated pollen sequence adjacent to Sutton Common alongside dates for a Bronze Age cremation burial from a nearby mortuary enclosure. In this instance, the posterior density estimate for the clearance phase derived from our Bayesian model indicates a 90% probability that the cremation pre-dates palynological evidence for human activity. The Bayesian approach thus allows us to understand in greater detail the chronological relationship between past human activities and environmental change. A proper understanding of chronology enables a move towards more comprehensive insights into the how, why and when of the past.

BELOW: Probability distributions of radiocarbon dates from Claish Neolithic house: each distribution represents the relative probability that an event occurred at a particular time. For each of the radiocarbon measurements two distributions have been plotted, one in outline (simple radiocarbon calibration), and a solid one (the chronological model used). Other distributions correspond to particular aspects of the model. For example, '*Boundary start*' is the estimated date for the start of use of the Neolithic building. The large square brackets down the left hand side along with the OxCal keywords define the overall model exactly (http://c14.arch.ox.ac.uk/).





ABOVE: Probability distributions of the date of the Bronze Age cremation burial [7074] and (top *Prior disturbance*) woodland clearance inferred from the pollen record from Sutton Common.

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Understanding *hidden* landscapes

Henry Chapman and Benjamin Gearey

Since the work of Mick Aston and Trevor Rowley in the 1970s landscape archaeology has grown considerably. Integration of applied theoretical approaches during the 1980s and 1990s brought added depth to the discipline, whilst developments in environmental archaeology and application of spatial technologies such as GIS expand the potential toolkit. Still, a particular challenge is provided by 'hidden landscapes', those which cannot be observed directly and which have changed considerably over time. An example is 'Doggerland', the drowned landscape of the southern North Sea which, as recovery of archaeological material in the nets of deep sea trawlers demonstrates, was once part of the north European plain. Now, work by Vince Gaffney and his collaborators at the University of Birmingham is demonstrating that it is possible to explore and understand these submerged environments.

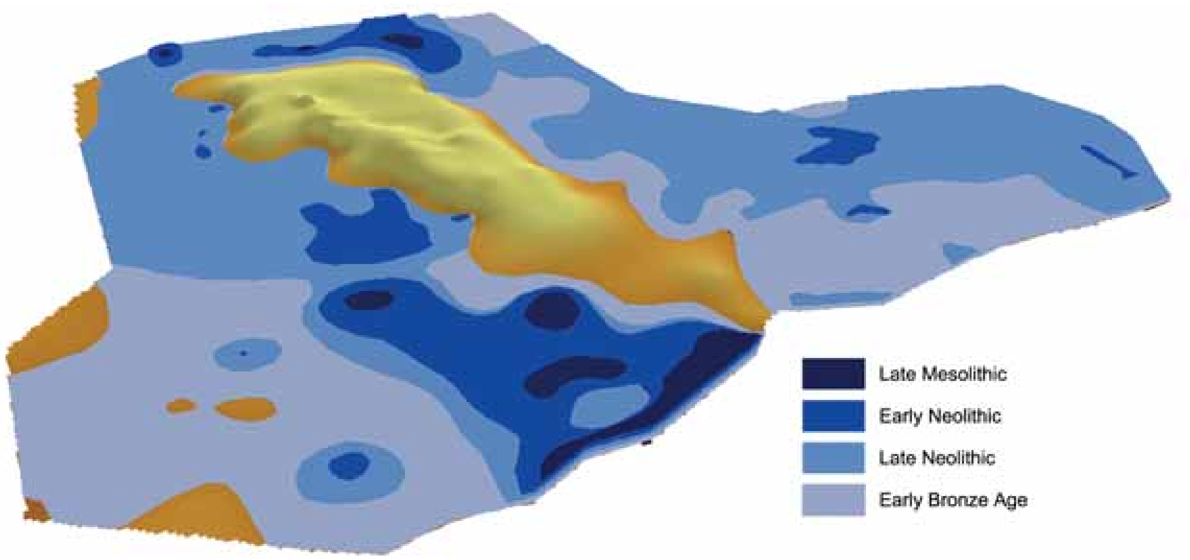
Concealed environments

Other wetland environments provide less dramatic examples of hidden landscapes but present similar challenges. For example, the accretion of alluvial deposits on floodplains or the spread of upland blanket peat can conceal areas which were once dry land. These contexts are particularly valuable because they may preserve organic archaeological material as well as palaeoenvironmental remains, providing valuable information on the character of these past environments.

Bog bodies, metalwork and coin hoards

Recent work funded by English Heritage on the lowland raised mires of Hatfield and Thorne Moors in south Yorkshire has begun to investigate the potential for modelling the growth of these peat bogs, with the aim of understanding implications for past human activity and the location of archaeological sites. We know from previous environmental work that until the mid-Holocene, these were dry landscapes. Rising sea levels and subsequent flooding of low lying areas resulted in a slow but steady shift from woodland to fen, and from fen to bog. Previous archaeological finds, largely discovered during peat cutting and many now lost, include bog bodies, metalwork and coin hoards, demonstrating that people were active in these areas as they were across the wider area of the Humberhead levels.

Modelling the evolution of wetlands on Hatfield Moors using GIS



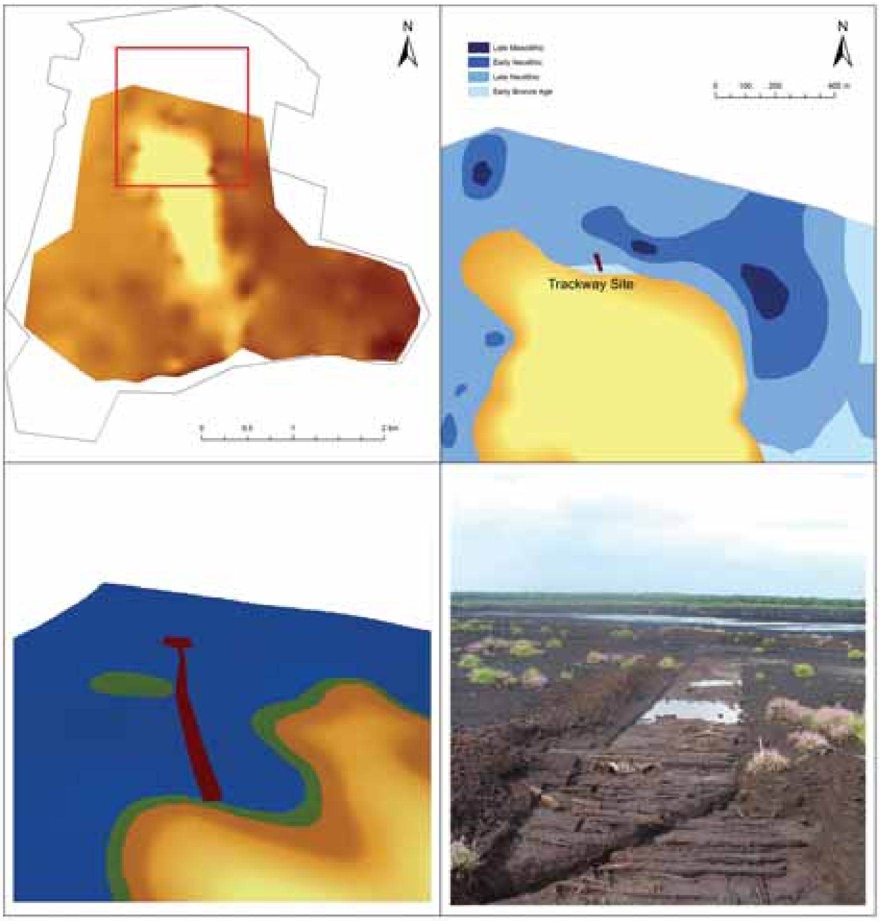
New methods and old

Any attempt at a 'hidden landscape archaeology' of these pre-peat land surfaces that hopes to contextualise archaeological sites and remains requires an understanding of the spatial and temporal processes and patterns of peat spread. Normally, establishing this for peatlands of such size requires significant investment in survey and associated palaeoenvironmental analyses and so, rather than generating extensive new data, we chose to assess the potential for using existing datasets, such as palaeoenvironmental studies, alongside limited bespoke new data to produce robust and testable models of landscape change. Ground Penetrating Radar (GPR) data have informed us about the topography of the pre-peat landscape, whilst Lidar and borehole data allow us to investigate the depth of peat surviving in different areas of the moors and to collect samples for radiocarbon dating. Historical and modern mapping and various palaeoenvironmental information are also brought in to help inform us on the character of the past landscape.

Trackways through a changing landscape

This broad range of information has been modelled and manipulated through GIS software, enabling us to map the spread of peat in time and space. Where were the earliest pools and when did they develop? How fast was the spread of peat? Answering these questions allows us to move on to address cultural, landscape archaeology questions. What impact did the development of wetlands have on the movement of people through the landscape? Which routeways remained accessible the longest? Where might sites of different types and periods be preserved? On Hatfield Moors we investigated the landscape archaeology of a later Neolithic timber trackway. Modelling of the pre-peat landscape and manipulation of the radiocarbon chronology for peat growth indicated that the site was located at the edge of one of the earliest areas of wetland development at a time when much of the rest of the landscape was dry. In addition, we mapped the extent and temporal span of surviving peat deposits, which we hope will assist future management of the moors.

Hidden landscapes such as peatlands provide a unique challenge for landscape archaeology and one which requires a multi-disciplinary approach. Whilst we might never be able to observe them directly, the application of new technologies allows us to explore them remotely.



The modelling of landscape evolution on Hatfield Moors has been used to interpret a later Neolithic trackway and platform – the site was constructed at a time of dramatic environmental change resulting in the death of woodland, the opening up of the landscape and the emergence of new wetland environments

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The past in three dimensions 3D

Helen Moulden

In the 1860s, François Villème created a process known as photo sculpture. Using 24 cameras, profiles of objects were reproduced on photographic plates, projected onto a screen using a magic lantern and transferred to clay using a pantograph. Since then, the evolution of technologies that capture shape by optical means has been considerable, and there are now many instruments available for use in different environments. These operate on differing principles according to the task at hand and have varying levels of accuracy, but essentially use laser technology to map the surface geometry of target objects. In the last decade, use of 3D laser scanners within the archaeological profession for analysis and documentation of historical and archaeological finds has been increasing, although implementation has been hindered by the high cost of 3D sensors and the processing software required.

Today, such technology is much more affordable. In 2006, NextEngine Inc, of Santa Monica, California, released the first consumer 3D desktop scanner (base price $2995). While not the fastest at data capture, the NextEngine device produces high fidelity models, and its low cost places 3D object scanning within our reach. Such scanners enable alternative forms of analytical assessment for artefacts, and are also invaluable in archiving and dissemination. With today's increased emphasis on digital recording for database archiving and dissemination via the Web, 3D object capture is likely to make inroads into numerous branches of archaeology.

Databases and dissemination

So far, despite the quantity and variety of online databases, pervasive storage of archaeological object data in 3D digital formats has yet to emerge. A database that provides an interactive viewing platform for models of archaeological items, with associated information such as origins and site locations, is the next logical step. This will have huge benefits for identification, research and dissemination, and can satisfy several audiences. It is a highly convenient way to send accurate 3D representations to specialists, especially invaluable where it is illegal to remove finds from a country, and it allows public access to antiquities that otherwise might never be seen.

Egypt at a touch

One project which capitalise on these possibilities is underway in the University of Birmingham's Virtual Worlds Laboratory. The Eton Myers Collection Virtual Museum project has been sponsored by JISC (Joint Information Systems Committee) to provide 'virtual' access to the collection, one of the most impressive of its type in the world for Egyptian antiquities and art. 3D models of a proportion of the objects will be created as a base for an Internet-based Virtual Museum, enabling worldwide access to previously unseen items of unique provenance and historical value.

Access, manipulation and haptic feedback

Similar use of 3D object scans in museums could enhance outreach programmes, with representations on screens that could be manipulated by viewers. Similarly, a visitor could view items not on display at that moment, and models might be used in conjunction with immersive display technologies to enhance a visitor's interaction with items. In particular haptic feedback is a technique which provides tactile responses to a user when interacting with synthetic models by applying simulated forces, vibrations or motions. Loaned artefacts might also be acceptably replaced by a 3D model temporarily. Or, if replicas are required, 3D printing technology enables fabrication of detailed object replication using powder-based layering, as used in the field of rapid engineering prototyping.

Landscapes, historic buildings and digital arching

Elsewhere, we are seeing increasing use of 3D scanning technologies for landscape analysis and building recording. Airborne Light Detection and Ranging technology (Lidar) obtains elevation and intensity data based on time reception and varying reflections from different material properties, and is used to efficiently map a territory and provide high radiometric and spatial resolutions. Among other purposes, this airborne scanning method can aid in the discovery of new sites. Building scanning is being employed in commercial archaeological environments such as Birmingham Archaeology, and is assisting research through more advanced computational analyses and recording of structures. This has led to the formation of the CyArk 3D Cultural Heritage Archive, an online repository dealing with preservation of Cultural Heritage Sites by collecting and archiving data captured through laser scanning and digital modelling. The site provides open access to 3D point cloud data through a Web-based Java application that allows interaction between a user and a model.

With the barriers to the use of 3D scanning falling away as new low cost products reach the market, this is a sphere that is becoming ever more accessible to archaeologists. What is now required is development of a skills base to take full advantage of such technology, and further integration of 3D viewing capabilities in standard Web browsers. The future is looking bright for this area of archaeology.

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Untextured high resolution 3D model of a shabti constructed from laser scan data. Intricate details include heiroglyphic writing surrounding its body become clear

Details of mummified hand with faience ring, recorded in 3D

Science@Silchester

Michael Fulford

Using GPS to gather digital plan data in the field, as part of the VERA project

Our *Silchester Town Life,* Project carried out under the auspices of the University of Reading, is an in-depth study of a residential *insula* at the centre of Iron Age and Roman *Calleva Atrebatum*. Work began in 1997, its overarching aim being to characterise the development of urban life from the later 1st century BC to abandonment between the 5th and 7th centuries AD. Despite earlier excavations the stratigraphy is still well preserved and so work is slow, and we have only just reached the 1st century AD. At last we have a 3000 square metre trench in which to investigate the birth of a complex, nucleated settlement in late Iron Age Britain.

Geochemical sampling and the use of hearths

Recovery and analysis of biological data was at the heart of the project from the outset, and early on we also adopted sampling strategies to recover metalworking evidence. Originally the emphasis was on the macro and microscopic remains of iron making and iron working but, with funding from the Headley Trust, we have embarked on an ambitious programme of systematic geochemical sampling and analysis to address questions about the extent of non-ferrous metalworking in the *insula*, and to gain better understanding of the use of hearths. Led by Dr Sam Cook, this project has provided geochemical finger-printing of the use of internal spaces and of associated hearths. It has raised questions about distinguishing between the products of domestic occupation, residues left by cooking and food consumption and activities other than metalworking, and those left by metalworking itself. Confidence in the existence of metalworking is assured by high ppm (parts per million) concentrations, eg of copper, lead and zinc.

Leaking buildings

Experimental archaeology, another theme of research at Reading, has much to contribute to our understanding of this geochemistry. When linked with

BELOW: Phytolith multi-cell, *Phragmites communis* (reed)

BELOW RIGHT: Evidence from micromorphology; an impregnated monolith taken from floors within an Early Roman building

evidence from micromorphology (taught as part of the department's world-renowned MSc Geoarchaeology programme), fascinating detail emerges. Rowena Banerjea's doctoral research for example informs us of the use and condition of individual early Roman buildings – flooring and roofing material of rushes and reeds, animals sharing the same space as humans, leaking roofs and eventually the decay of buildings.

Provenance of tesserae

Development and application of scientific techniques draws great benefit from the department's location in the School of Human and Environmental Sciences, which supports high quality research in geosciences. This School has a long history in provenancing materials, particularly stone, exemplified by research conducted on our stone tesserae. Professor John Allen and colleagues from the Natural History Museum, the British Geological Survey and the University of Leicester have shown how important the Isle of Purbeck (known for Kimmeridge Shale and Purbeck marble) was in the supply of a range of materials – reds, yellows and grey-blacks. It looks as if even chalk tesserae were selected from a particular facies of chalk in Purbeck to provide white tesserae. These materials were used in 1st- and 2nd-century Roman mosaics as far as Caerleon to the west and Eccles to the east, as well as London and the sequence of palatial buildings at Fishbourne.

3D projection and analysis

Sustained sampling programmes have recovered a great variety of environmental and metalworking data. As we approach the fascinating period of *Calleva*'s origins, the key is to ensure sufficient resources to maximise the benefits these data can deliver. Crucial to this is the IADB (Integrated Archaeological Database), developed by Mike Rains of York Archaeological Trust, which has benefited from significant developmental resource from the JISC since 2004. The database, and its capacity to integrate various strands of field data, is at the heart of post-excavation analysis. Up to now it has operated in two dimensions, but working with Professor Mark Baker of the University's School of Systems Engineering as part of the VERA project, we aim to have 3D projection and analysis of field and sample data later this year.

The work of *Science@Silchester* lies not so much in the development of new techniques but in co-ordination, integration and sustained application of multiple approaches developed elsewhere. New knowledge and insights that this strategy is providing are addressing the key research objective of characterising urban life at *Calleva* over time with resounding success.

For up to date information on the project, see www.silchester.reading.ac.uk, and for VERA (The **V**irtual **E**nvironments for **R**esearch in **A**rchaeology) see http://vera.rdg.ac.uk/.

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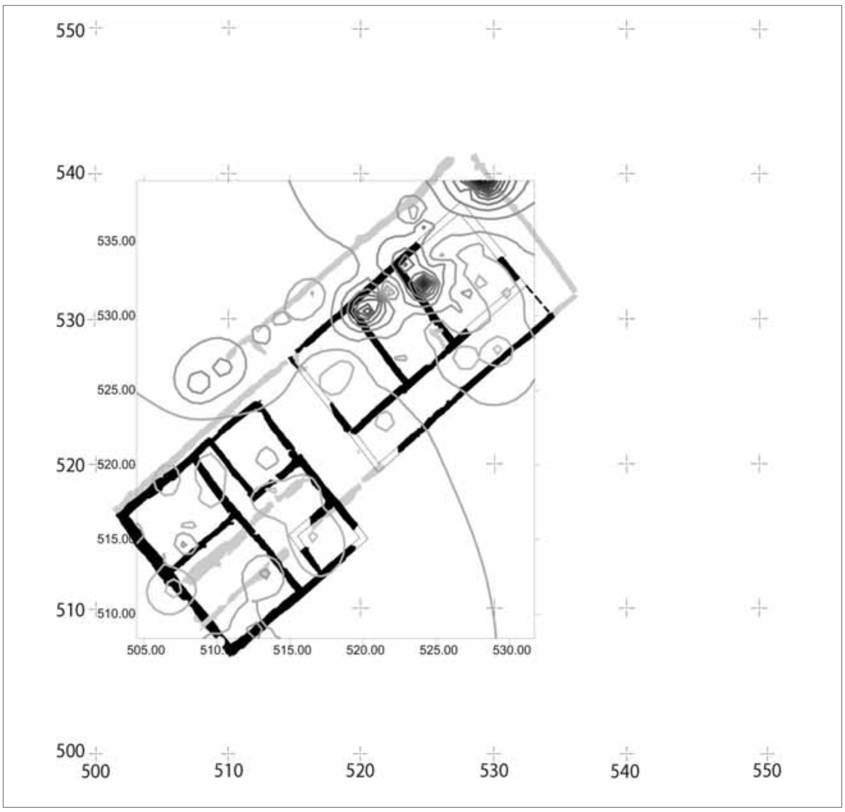
All photographs: Department of Archaeology, University of Reading

Using digital pens to gather digital context data in the field

Geochemical sampling in Insula IX: lead 'hot spots' identified within the early Roman buildings on site



Finding archaeology on claylands:

AN INCONVENIENT TRUTH

Patrick Clay

Digging on clay in January - why clayland sites will never be popular with archaeologists © ULAS

Let's face it – archaeologists don't like working on clay soils. In summer these can be as hard as concrete while in winter they seem to be under water most of the time. Traditional fieldwalking can often be unproductive, cropmarks usually only appear in exceptional (very dry) conditions, and there are few visible pre-medieval monuments. Lack of evidence has meant lack of research, which in turn means claylands are dismissed as areas of little archaeological potential. Even when they are surveyed, fieldwalking has often been undertaken at a lower resolution than 'lighter' soils in view of their perceived lower potential (eg Hall 1985, 28). As a consequence clay areas show fewer HER records, helping reinforce preconceptions.

One of 17 individual hoards of Iron Age silver and Roman Republican coins during excavation. This site on boulder clay was first located by fieldwalking by a local community group. Subsequent metal detector survey, geophysical survey and trial trenching established its extent and significance. © ULAS

300 SITES IN 90 MINUTES

More field survey and evaluation over the past thirty years has begun to redress the balance (eg Clay 2002; 2007; Mills & Palmer 2007). It is becoming clear that, far from being ignored, they were being exploited extensively if not intensively from the Mesolithic onwards. Examples of this new evidence include remarkable results from aerial photography in Bedfordshire where, in the summer drought of 1996, vertical photographs taken for Bedfordshire County Council revealed 300 sites as cropmarks from ninety minutes of flying, most of them previously unknown and most on clay substrata. Fieldwalking surveys in some East Midlands clayland areas have now found evidence of Neolithic to Bronze Age 'core areas' every 3.6 sq km and late Iron Age sites every 1.82 sq km (Clay 2002).

Despite this progress, clayland archaeology is still 'hard to reach', in that it isn't often visible without intrusive work. An examination of a sample of 85 evaluations undertaken since 1990 on clay soils where there was no previously known archaeology has come up with some interesting results. Criteria were

- no previously known archaeological evidence
- greenfield sites with clay substrata – not urban or village core
- positive result defined by archaeological deposits with material remains – finds suggesting domestic or ceremonial activity. These did not include medieval field systems (ridge and furrow)

TRIAL-TRENCHING REQUIRED?

Of this sample 42 evaluations (49.4%) located new sites while 43 (50.6%) were negative. Of the positive results only three (7.1%) were located by fieldwalking and two by geophysical survey, whilst 37 (88.1%) were from trial trenching. Does this reflect a distrust of geophysical survey as a technique of detection for these substrata in the 1990s? More recent results show that this technique can be successful on clay soils.

The predominance of Iron Age sites is particularly remarkable, perhaps a reflection of more widely spread smaller farmsteads during this period, compared with fewer but larger sites from later periods. Later sites are also more commonly still settled today, and so do not show in greenfield areas. Examples of the type of previously unknown clayland sites that can be found include a Neolithic site from Rothley, Leicestershire (Hunt 2006), only located from trenching a very low density flint scatter, and the remarkable East Leicestershire hoard of over 5000 Iron Age coins located from fieldwalking and subsequent metal detector and geophysical surveys (Score 2006).

Period	**No.**	**%**
Late Upper Palaeolithic	1	2.4
Neolithic	2	*4.8*
Earlier Bronze Age	3	*7.1*
Later Bronze Age	1	*2.4*
Iron Age	19	*45.2*
Iron Age and Romano-British	3	*7.1*
Romano-British	9	*21.4*
Anglo Saxon	2	4.7
Medieval	2	*4.7*
Total	**42**	**100**

So what can we conclude? The following may seem blindingly obvious but it still needs re-stating

- HERs are not a true reflection of the archaeological resource
- thorough survey/evaluation of blank areas is necessary, or data will be lost and biases continue (a truism for all substrata throughout Britain but unfortunately there are still very variable responses from different planning authorities to areas of unknown potential)

Clayland sites are more difficult to find but can often reveal higher quality archaeological remains than, for example, sands and gravels which often have poor bone and organic survival. Although most positive results followed trial trenching this should not be viewed as the only way to locate these sites. Techniques are developing all the time and, increasingly, geophysical survey can be successfully used as a first stage in evaluation, with appropriate trenching samples to follow.

Although it will never be popular with archaeologists, clay can be worth the effort.

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Mills J and Palmer R (eds) 2007 *Populating Clay Landscapes* Stroud: Tempus.

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A notable discovery at Rothley was an incised plaque which, when complete, would have been symmetrical, possibly showing a stylised face within a rectangular frame. © ULAS

Part of a Late Neolithic assemblage from a previously unknown clayland site at Rothley, Leicestershire, located by trial trenching. Situated on a north-facing slope of Mercia mudstone, geophysical survey had been largely negative while fieldwalking had only resulted in a dispersed spread of lithics. However, trial trenching targeting a slight concentration of worked lithics located an occupation site which included a possible building and pits with structured deposition of artefacts associated with Grooved Ware. © ULAS

Lidar survey | applications in the woods

Jon Hoyle

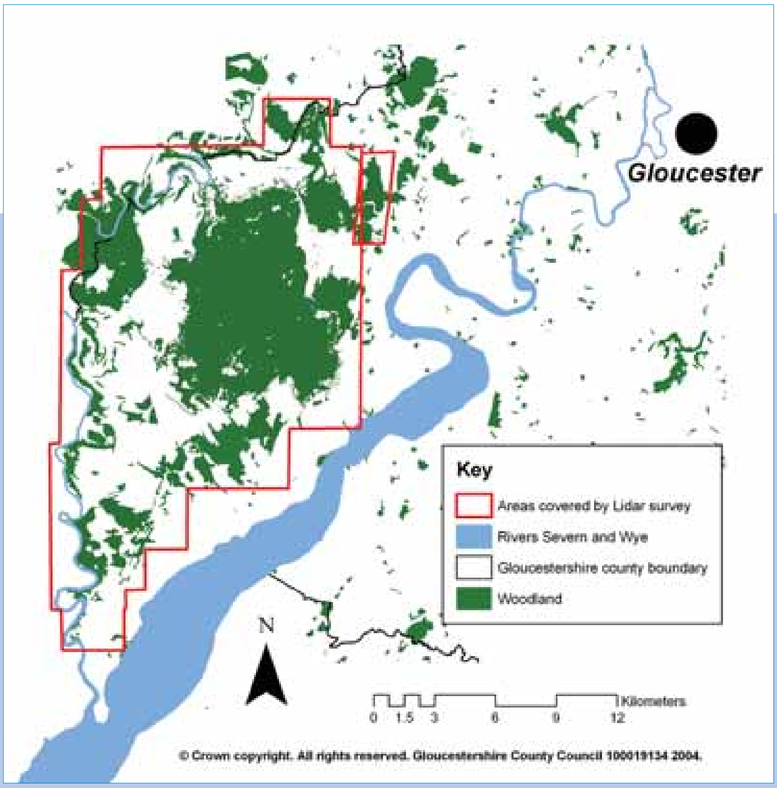
Our interest in Lidar was the result of a project to investigate the archaeology of the Forest of Dean in Gloucestershire. About 118km^2 (35%) of the area is under woodland, including an almost continuous single block of about 88km^2 and, apart from post-medieval industries, few archaeological sites are known in the wooded areas. This is despite numerous indicators suggesting prehistoric, Romano-British and medieval activity.

Earthworks under trees

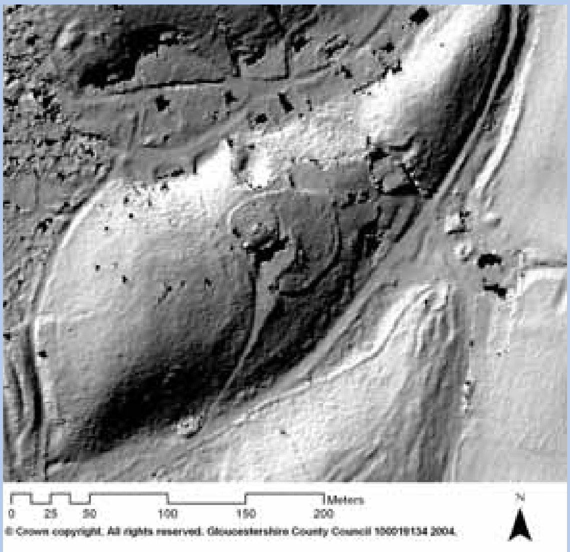
After trialling a number of prospecting techniques in woodland, all of which, including rapid walkover survey, would have been hugely expensive in such large areas of woodland, in 2006 Gloucestershire County Council Archaeology Service (using English Heritage ALSF funds), and the Forestry Commission jointly commissioned a Lidar survey of c. 278km^2. This included most of the woodland in Dean, and took advantage of an innovative use of Lidar developed by the Cambridge Unit for Landscape Modelling, applying a vegetation removal algorithm to Lidar data. This process separated out the laser pulses which had not been blocked by the trees, and mapped the micro-topography of the ground surface normally concealed by woodland cover.

Subsequently the Forest Research branch of the Forestry Commission produced a series of hillshaded images of the ground surface, which could be illuminated from different directions to emphasise earthwork features. These were imported as georeferenced layers onto our GIS.

So far, the full potential of Lidar data have not yet been realised, and there are a number of current initiatives to manipulate raw data to tease out yet more information of value to the archaeologist. Most users, however, engage with Lidar in the form of these hillshaded images, which are comprehended and used in a similar way to aerial photographs. But Lidar images are not aerial photographs, but the result of a mathematical process which records variations in the relative height of features on the ground, and expresses this as an intelligible image of the ground surface. Contemporary landscape features such as roads and field boundaries cannot be differentiated from archaeologically significant earthworks without comparison with other data sets, such as current OS maps detail.



Location of the Forest of Dean Lidar survey



Modern house masquerading as a hilltop enclosure

A thousand new features

Processing produces other anomalous results. Areas of conifer can be impenetrable enough to block the Lidar, and dense undergrowth, particularly in areas of recent clearfell, has a similar effect. The processed hillshaded images of woodland frequently have an 'untidy' appearance, with numerous small irregularities caused by bushes or forestry detritus. Professional judgement can discount these features (although not always confidently) but at least one significant-looking mound seems to have been caused by a pile of logs. Many such shortcomings will be resolved as processing techniques are developed, and by and large, the results have been impressive. The preliminary analysis of the survey has identified over a thousand potentially significant features, none of them previously identified.

Late medieval coppice

Extensive areas of charcoal platforms and open cast mineral workings overlying coal outcrops were anticipated, but Lidar has allowed these to be rapidly mapped and added to the HER. Others features were less expected. Large areas of linear and rectilinear earthwork systems were identified, some but not all of them corresponding to historical records of late medieval coppice. Other enclosures included six sub-rectilinear enclosures which are consistent in size and form, suggesting a similar function and date.

Sub-circular enclosure with central mound: the enclosure is an earthwork, but the mound appears to be a large pile of logs

Accuracy

We have been able to ground truth the results in a few areas, and Lidar has generally accurately depicted the location and form of identified features. It has also had the unexpected benefit of facilitating navigation though the woods by showing tracks and other landscape features not recorded on maps. When we compared Lidar results with areas where conventional walkover survey had been undertaken, not only did Lidar map features with a degree of accuracy impossible to achieve without sophisticated surveying equipment, but it detected other features, particularly linear earthworks, which had not been recorded. Bumps and hollows abound in woodland, earthworks can be obscured by undergrowth and sight lines are limited. In these conditions slight features can easily be overlooked or dismissed. With the landscape-scale overview which Lidar allows, the relationships between earthworks can easily be understood and borderline features reassessed and interpreted with greater confidence.

The survey itself and the transcription of the results are just the beginning, as many of the recognised features are not yet fully understood. However, we have been able to identify and prioritise areas for further research in what was previously an almost blank canvas. Next winter we will take the project forward with a programme of ground truthing and further investigation of selected earthworks.

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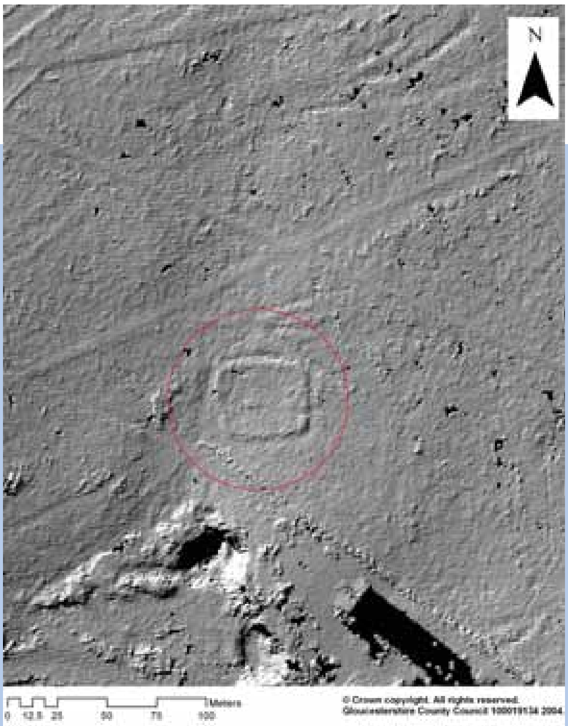


Sub-rectangular enclosure identified in an area of woodland

Shipwrecks and global 'worming'

Paola Palma

Wooden shipwrecks, piers, vessels and other underwater wooden structures in seawater are at the mercy of dynamic environmental variables, such as strong currents and tides and, if they are exposed to aerobic conditions, they may be degraded by organisms such as bacteria, fungi, molluscs and crustaceans. This has always been the case, but there is new evidence that modern climatic conditions are set to make things much worse.

Ancient attacks

The boring molluscs of the *Teredinidae* family, commonly known as shipworms, are notorious for the high level of degradation they cause in wooden objects or structures in the marine environment, in quite a short period of time. The destructive potential of shipworm to wood, especially archaeological wood, is often underestimated as the attack is difficult to detect from the outside. Internally, attacked timbers may be thoroughly honeycombed, yet look sound externally. Shipworms were a well-known problem to ancient mariners because of the damage they caused to hulls. There were many attempts to solve the problem yet sources reported that a huge number of ships were wrecked due to shipworm attack.

New species

Shipworms live in tunnels, which they dig when they come into contact with the wood surface, and here they live all their lives. Brunel took inspiration from this calcareous coating for a similar lining to the tunnel he drove under the Thames. *Teredo navalis* is probably the shipworm best known by archaeologists. It is a highly specialised bivalve, a worm-like mollusc, adapted for boring into wood. It varies in length from 150mm to 1.8m, depending on environmental characteristics. Recently, a species of shipworm called *Lyrodus pedicellatus Quatrifages*, common in more temperate climates, was recorded in British waters. This caused some alarm as *Lyrodus* causes much more damage than *Teredo navalis*.

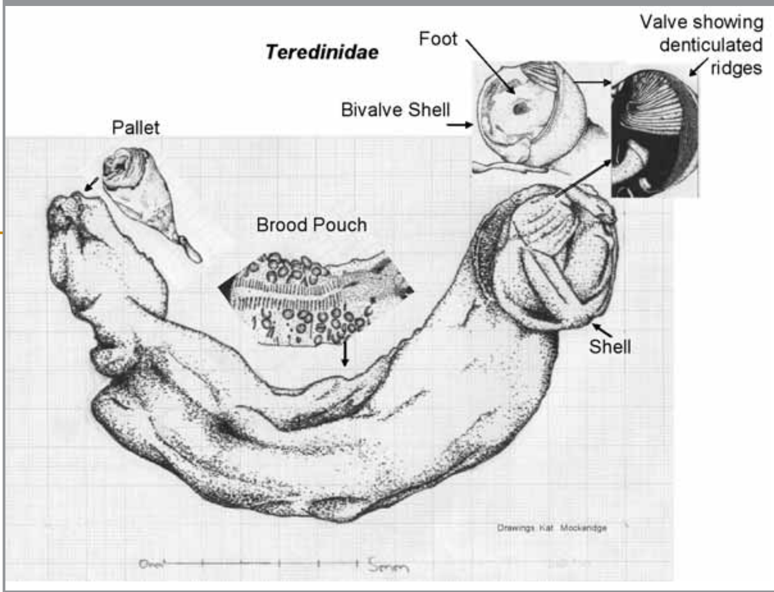
Colonisation

Lyrodus reproduces from October to May. After spawning, larvae colonise the surrounding wood after only a few hours in the water column whereas *Teredo navalis* larvae are free swimmers and may travel away from their source for up to three weeks. The obvious consequence is that *Lyrodus pedicellatus* repeatedly colonises the same timber until all wood is locally exhausted. If conditions are favourable, several generations can spawn each year, so that each individual can produce larvae from a few thousand to several millions. Evidence of this borer was recorded by the author on sacrificial samples deployed on the *Mary Rose* site in 2004/05.

On the crustacean front, the most common include *Limnoriidae* (or gribbles) and the *Cheluridae*. The attack on wood by crustaceans can be more detectable compared to the shipworm one, as the galleries excavated are at a superficial level, just on the wood surface. These galleries are narrow and sometimes interconnected and – just like the shipworms tunnels – run alongside the grain of the wood.

Warmer water

Teredo navalis has been widely recorded in waters around the south of England for a long time, whereas the presence of *Lyrodus* in British waters is thought to be a sign of global climate changes. The increase in the air/water temperatures creates the right conditions for non-indigenous species to develop and settle in areas like the south of England. Shipwrecks which are not buried under at least 0.5m of sediment are more likely to be attacked and degraded by these woodborers.



A shipworm. Drawn by K Mockeridge, University of Bournemouth (student)

Faster decay

Current research on archaeological sites (for example the Swash Channel Wreck site in Dorset) is showing the presence of all or some the species mentioned above on most sites, which makes the stability and preservation of archaeological wood very vulnerable. Authors in the past estimated the life expectancy of exposed archaeological timbers to be about ten years (eg Skowronek 1984). Judging by the preliminary results of recent research on woodborers' activity on shipwrecks in relation to changes in the environmental parameter (such as increase in temperature) this statement seems optimistic today.

In the meantime, 'silent saboteurs' are constantly destroying valuable and irreplaceable sites at a fast pace, and the more aggressive are colonising newly exposed sites. The same problems our ancestors faced have not found a solution across the centuries. Field observations indicate that degradation by marine borers needs to be investigated and constantly monitored in order to understand the threat and nature of the degradation. When this step is achieved a mitigation policy can be applied.

Woodborer activity is mostly undetected until it has caused serious damage to wood that is exposed to extensive periods in seawater. So are we going into a fast path towards global ship-'worming' by aggressive borers fed on archaeological wood? We have to be ready for constant monitoring of threatened wood to detect the presence of shipworms and gribbles and the extent of their attack and degradation.

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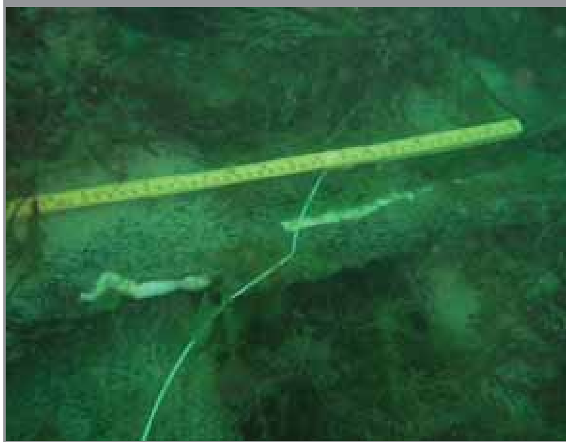
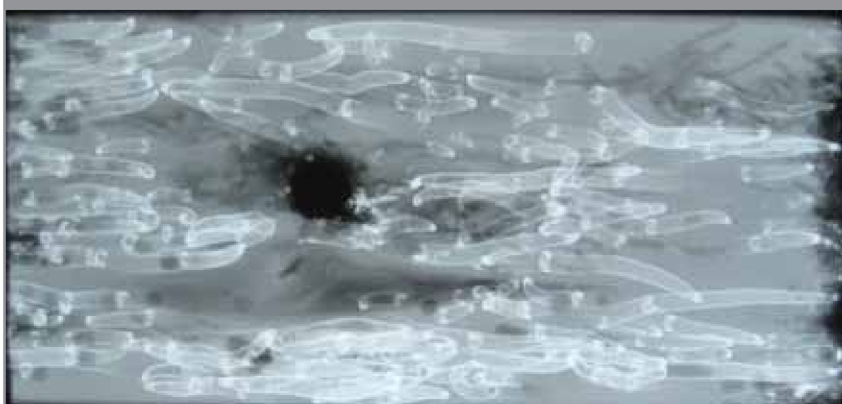


Calcareous coating of shipworm 0.5m long, on the Swash Channel Wreck. Photograph; P Palma, University of Bournemouth

Carving from the Swash Channel Wreck (Dorset) showing signs of woodborer's attack. Photograph: D Parham, University of Bournemouth



X-ray of sacrificial sample attacked by shipworms after only few months' deployment in seawater, in proximity of a shipwreck. L French, University of Bournemouth (student)

Probing the past

Free access to a non-destructive method of highly accurate analysis of materials including metal, pigments, rock and ceramic, for research purposes, can now be offered by the ISIS Neutron Facility in Oxford.

No one likes having to cut, drill, or scrape an analytical sample from an archaeological artefact, but how can we decipher the manufacturing processes of an object without doing this? For metal objects in particular, one answer lies in using neutron-based techniques. The UK Science and Technology Facilities Council (STFC) provides free access via a proposal system to academic archaeological and museum-based (not-for-profit) researchers to analyse objects and experimental samples at the ISIS neutron facility of the Rutherford Appleton Laboratory in Harwell.

ISIS – not an acronym, but named after the old river Thames, and in turn the Egyptian goddess – is Britain's spallation neutron and muon source, one of just a handful of such facilities in the world. The core research applications of ISIS are fundamental physics and molecular chemistry, but in the past few years increasing numbers of cultural heritage materials characterisation projects have been carried out successfully at ISIS. The main technique used for analysis of archaeological and museum objects is time-of-flight neutron diffraction (ToF-ND), which uses a pulsed neutron beam generated from a proton particle accelerator (a synchrotron). ToF-ND is a non-destructive 'bulk' method that measures right through the thickness of an object, producing an average result.

ARTEFACT ANALYSIS

Any crystalline material – metal, pigments, rock, ceramic – can be analysed by neutron diffraction. There are plans at ISIS to build an instrument that can quantify and spatially resolve (to a minimum of 2 mm) the bulk chemical composition of intact archaeological objects by 2010. This will use a form of activation analysis. A neutron radiography imaging instrument is also likely to be built by 2013, and is in the design stage now. These facilities will be available to use through a proposal system, just like the existing instruments.

NEUTRON DIFFRACTION

The huge advantage of ToF-ND is that a whole artefact can be placed on a large sample stage, in air, in front of the neutron beam. No sampling or sample preparation is necessary. ToF-ND is completely non-invasive and does not mark or alter the object. There is no long-term radiation. Bronze objects for example might be active for two or three days after analysis before being cleared to go. Iron artefacts are generally not active at all after analysis. It typically takes around one hour to collect a data point; multiple points can be collected across an object. This overcomes the issue of how representative traditional destructive metallography is. With conventional methods, pretty broad interpretations about early metalworking are based on one or two very small samples cut from the most conveniently accessible points on heterogeneous objects.

At ISIS, a high energy proton beam travels from an accelerator along a guide (1-2 on the diagram) and hits a small tungsten target (3) to make pulses of neutrons. The neutrons are guided down beamlines (4) to instrument stations where archaeological artefacts can be analysed

MANUFACTURING TECHNIQUES

ToF-ND determines which metal, mineral, and intermetallic compounds are present, and how much of each phase. In metals, grain orientation or 'texture' can be seen, evidence for manufacturing techniques such as casting and hammering. Sometimes it is possible to calculate chemical concentrations, by quantifying discrete phases. For instance, in steel, carbon is present as an intermetallic compound, cementite, containing 6.7wt% carbon. ToF-ND measures the cementite in a volume of steel; this value is then normalised and multiplied by 0.067 to find the bulk chemical composition in terms of weight percent of carbon. Lead added to copper or bronze does not go into solution in the copper but forms a separate (metallic lead) phase. ToF-ND produces an accurate elemental lead composition by detecting all the separate metallic lead.

CORROSION PRODUCTS

Everything that the neutron beam passes through is measured, so corrosion products, both external and inside an object, are quantified too. Each compound – eg cuprite, malachite, and tin or lead oxides in bronze – forms a distinct mineral phase. Unlike light-based methods and even most x-ray diffraction and spectroscopy, neutrons are able to completely penetrate intact inorganic objects, allowing us to measure how much of the original metal is preserved under thick corrosion layers, and to find the bulk composition and microstructure of that metal.

On the GEM diffractometer, the neutron beam can be focused to analyse a minimum area of 2mm x 2mm x the whole thickness of the object (up to around 100mm of steel for example; thicker objects can also be studied using backscattered signals). GEM is very good for quantifying the amount of grain 'texture' in a metal object. The ENGIN-X diffractometer can be focused in three dimensions, to a minimum of 1mm x 1mm x 0.5mm in depth. ENGIN-X measures residual strains and micro-strains in metal objects. If the last thing that a bronze-maker did to an object was chase over the surface with a chisel to remove imperfections and casting seams, then ENGIN-X can map this working.

The commercial user rate to do analysis at ISIS is around £10,000 per day, but so long as the results will be published in an academic/scientific journal and there is no direct profit being made, and the project team doing the ISIS work includes someone with a university (or museum or heritage trust) or a UK (or foreign) research council affiliation, the analysis is fully funded by the STFC. If you are interested in submitting a proposal to analyse artefacts, please contact the authors. Proposals are reviewed by an access panel. Once your proposal is accepted, then the analytical time is free and your travel and accommodation expenses to come to ISIS will be paid by the STFC too.

The sample stage on the ENGIN-X neutron diffraction beamline at ISIS is big enough to do non-destructive microstructural analysis of whole, intact archaeological objects (or an airplane wing spar as shown here). Photograph: Stephen Kill

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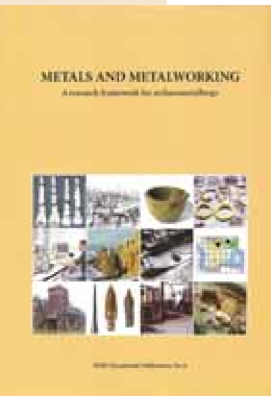
Metals and metalworking: guidelines and training

Justine Bayley

▲ 16th-century crucibles and cupels from Legge's Mount, near the site of the Royal Mint in the Tower of London. The large flask in the centre was used in distilling nitric acid which could dissolve silver, a late medieval development in separating gold-silver mixtures. Cupels used to test the purity of silver are shown bottom right. © English Heritage

Industrial residues, or slags, are invaluable evidence for manufacturing activities on archaeological sites. Production processes can be identified, the scale of related crafts and industries reconstructed and inferences drawn on a site's social and economic role within contemporary society. It has become commonplace for specialists to identify technical processes and related structures using chemical analysis of by-products and debris, and now that applying scientific techniques to archaeological questions is far more common, excavators need to know more about what is possible.

The Historical Metallurgy Society's research framework ▼



Practical training

English Heritage archaeological scientists have been running practical, hands-on training days in collaboration with EH regional science advisors, and are just coming to the end of a second nationwide series. Several hundred participants have been given the necessary background to make decisions about on-site sampling and excavation strategies, and basic knowledge to understand the processes that were carried out in the past. Many have gone away with sufficient confidence to undertake their own identifications of common types of industrial debris, and to discuss options and approaches when commissioning work from external specialists.

Guidelines

To support this training we've also written two Guidelines, on metalworking (Bayley *et al* 2001) and on the use of scientific techniques in investigating industries of the Industrial Revolution (Dungworth and Paynter 2006; see p43), and are working on one on glassworking. A new fully illustrated publication with further practical information about past metalworking has been compiled by the Historical Metallurgy Society (Bayley *et al* 2008). This is effectively a research framework for archaeometallurgy, with useful information carefully summarised by specialists. There is discussion of the resources that provide evidence of metalworking – from landscapes and sites to artefacts and documents. Also included is an outline of field and laboratory methods, an extensive summary of much of what is known about metals and metalworking from the earliest times to the 20th century (perhaps the most useful section), agenda for future work, recommendations for further reading, and a full bibliography.

Practical examples

So what might be overlooked without such guidance? A recent excavation of a Roman roadside settlement recovered over three tons of slag. Thanks to a sampling strategy devised in co-operation with archaeological scientists, one building was identified as an iron smelting and smithing workshop. From its plan you can begin to see how and where the craftsmen worked, putting flesh on the bare bones of heaps of unidentified slag (Paynter 2008).

Later periods too can come up with surprises. Excavations in Legge's Mount at the Tower of London produced quantities of 16th-century crucibles in a range of sizes, and also small bone ash cupels that were used to test the purity of silver. Some of the vitrified hearth lining held further surprises, tiny gold droplets that show that this metal too was being melted. Separating gold from silver had always been a problem for metalworkers, but with the development in the late medieval period of nitric acid, made by distillation, this changed. Legge's Mount provides evidence of the new technology as there are distillation flasks rather than the parting vessels that were used on earlier sites (Bayley 2007).

Learning how to identify ironworking slags and residues at a training day in York. © Mike Hemblade

Even for the Industrial Revolution and recent periods there is a role for archaeological science in understanding and interpreting the standing and buried remains on 'brownfield' sites; a lost opportunity was the demolition in 1976 of blast furnaces at Stanton, Derbyshire.

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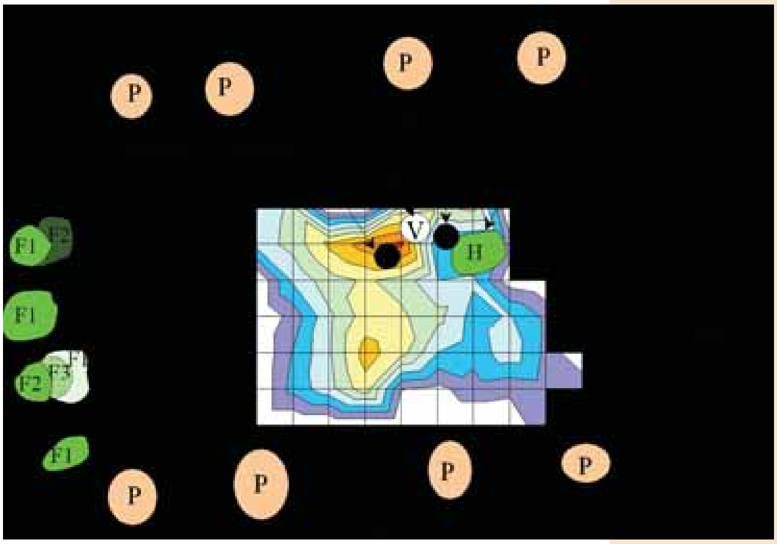
Plot of hammerscale distribution in a post-built Roman workshop at Westhawk Farm, Kent, in relation to other metalworking features. The hammerscale was extracted from soil samples collected on a grid and, as expected, has highest concentrations nearest the site of the hearth and anvil. Iron was smelted in the furnaces to the left. © English Heritage



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The blast furnaces at Stanton, Derbyshire, being demolished in1976. © David Crossley

The significance of gromps

Irregular lumps of solid iron with a rough slag surface have been reported at many early iron bloomery smelting and smithing sites. These are known to archaeometallurgists as 'gromps': pieces of metal that have not attached to the main iron bloom as it formed in the furnace. Most often recovered from slagheaps, gromps tend to be labelled 'slag', and are rarely given the separate analytical attention they deserve. Identification and metallographic analysis of gromps ought to be done as a matter of course, as these indicate what sort of iron or steel was produced at a site and then carried away.

Bloom straight out of an experimental furnace, split with an axe

Gromps (a term established by the Polish metallurgist Elsbieta Nosek) are generated during smithing as well as smelting, and are discarded with slag. They can be found in the slag assemblage of any early iron bloomery smelting site. At one small medieval smelting site for instance (Kyloe Cow Beck, North Yorkshire), where two furnaces and 4500kg of slag were identified, 240kg of slag was brought back to the lab. Around 10% by weight of this 'slag' sample were metal gromps. The weights of individual gromps generally range from 20g up to half a kilogram. Gromps survive most burial conditions extraordinarily well; so long as the outer coating of slag remains intact, the metal is protected from corrosion. Sectioning will often reveal perfectly preserved metal.

Magnetism

Well-preserved iron gromps are the colour of the slag and soil on a site; they won't have red or orange patches unless the outer coating has cracked and the metal inside corroded. They can be distinguished by their high density when compared with slag and by being strongly magnetic (it is a good idea to always check slag samples with a magnet). Smelting assemblages include other remains that are magnetic (eg slag with a lot of partly-reduced ore or iron inclusions). Iron entrapped in smelting slag regularly shows much lower phosphorus and carbon contents than the blooms or gromps from the same site, because a large volume of slag stops the reduction process. Like blooms, smelting gromps are lumps of fully-reduced metal with just a thin exterior coating of oxidation and slag. They have been raked out with the slag, and have never been worked into a semi-finished object. Smithing gromps probably form from fragments of bloom that broke off during consolidation (the first round of hammering to compress spongy solid-state iron blooms into workable billets).

Chemistry

A typical group of gromps can display a whole range of carbon compositions, from pure iron through steel to white cast iron. As with all bloomery iron, the carbon content varies even within a single sample. Finding small lumps of white cast iron on early smelting sites does not mean that the intended product of the furnaces was cast iron – with sufficient draft, even with hand-operated bellows, you can generate the equivalent of blast furnace conditions in a bloomery furnace at times during the smelt. If a furnace was continuously producing liquid metal, you would expect discarded fragments of graphitic cast iron and glassy blast furnace-type slags; such remains start to appear by the Late Middle Ages. Very high carbon steel and white cast iron gromps on the other hand have been reported from so many Iron Age to medieval production sites that they can be considered a typical rather than exceptional by-product of solid-state bloomery iron smelting. High carbon steel and white cast iron gromps are most likely to form when the ore being smelted needed particularly strong reducing conditions – for example, due to its leanness or its high phosphate content – to produce an iron bloom.

Appreciation of gromps for reconstructing ancient technological processes was previously constrained by the belief that bloomery furnaces only made solid-state (and carbon-free) iron. Cast iron structures in gromps led to them being dismissed as accidental waste products. In fact, they help to characterise the ore employed and are important indicators of the maximum operating conditions of the furnace.

Studying iron production

Finished iron objects are rarely found in metalworking areas, whether a smelting site or a smithy. Those that are found can't be said for certain to have been produced at the site. There is a disconnection between discussion of the chemistry and microstructure of iron artefacts and research on early iron production, which centres on slag analysis. Occasionally whole discarded iron blooms are analysed, but complete blooms were not so often thrown away. Lack of access to iron objects for conventional (destructive) metallographic sampling, especially finer items such as weapons, is an impediment to forming a complete picture of early iron technology. Gromps provide a common material that is readily made available for metallographic sampling.

Through analysis of gromps found stratified with the slag, another important aspect of early iron production can be studied: the ore to metal partitioning behaviour of natural alloying elements, of which phosphorus is the most significant. Gromps present the best reflection of the character of the final metal output of an iron production site.

- *expect to find gromps mixed with the slag at any iron smelting or bloom-smithing site*
- ***gromps look like slag, but will react strongly to a magnet and be unusually heavy and dense***
- *treat gromps as metal finds*
- ***soak newly excavated gromps in acetone to remove excess water, dry off and seal with an equal weight of silica gel in a plastic box***
- *weigh the dry gromps, measure L, H, and W, and take a photo with scale before sampling*
- ***prepare metallographic samples of all the gromps you find to get a clear picture of the metal that was made or processed at the site***

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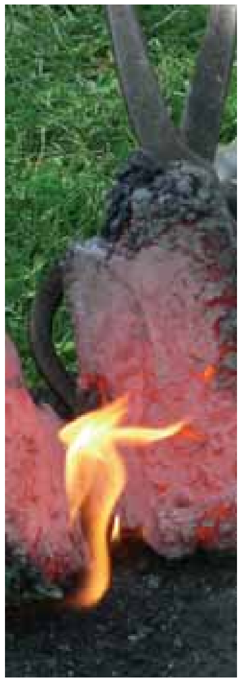

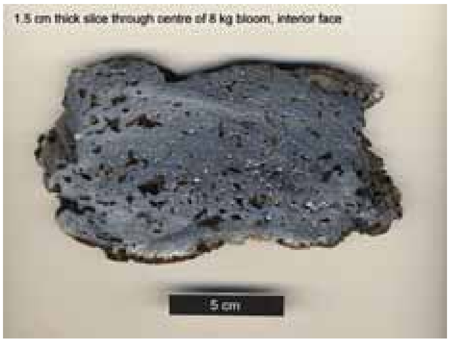

Slice through the experimental bloom, made for analysis. Gromps are smaller versions of this

Medieval iron gromp as excavated.
Photograph: E Godfrey

Same gromp cut in half.
Photograph: E Godfrey

gromps

Projet JADE: recherches sans frontières

Alison Sheridan

This year sees the culmination of a remarkable three-year, million-Euro international research project investigating the production, distribution, use and meaning of Neolithic axe heads of jadeitite (a rock composed mostly or entirely of the mineral jadeite) and other rare Alpine rocks. *Projet JADE* is funded by the *Agence Nationale de la Recherche,* and involves researchers from across Europe. Combining fieldwork, database-building and non-destructive mineralogical analysis (using reflectance sprectroradiometry), the project is revolutionising our understanding of Alpine axe heads. The project is the brainchild of Pierre Pétrequin and is the fruit of many years' work, undertaken with his wife Anne-Marie, involving ethnoarchaeology in Papua New Guinea and fieldwork high in the Alps.

In Britain, over 85% of the 140+ British, Irish and Manx specimens have now been studied by *Projet JADE*. Last November saw a marathon session, when artefacts from forty lenders were brought to the British Museum's Department of Conservation and Scientific Research, where the team had brought their analytical equipment.

Landscape of Monte Viso. © *Projet JADE*

Alpine origins

Fascination with beautiful Alpine axe heads goes back to at least 1700, when the Maxwell Stuart family of Traquair House in the Scottish Borders had a fine carrying-case made for one specimen. Antiquarian interest grew, and while some argued for a Chinese origin, one French geologist, A Damour, argued convincingly in 1881 for a source in the north Italian Alps. Damour's conclusions were based on his high-altitude fieldwork, and also on pioneering chemical analysis. While the idea of an Alpine source gained general acceptance, Damour's specific observations were to be ignored for over a century.

Magic mountains?

Geologists in the 1970s and '80s argued that makers had exploited secondary sources, ice- and river-transported blocks at the foot of the mountains. The Pétrequins were not convinced and, by systematically fieldwalking the high Alpine valleys at altitudes of 1800–2400m each year since 1994, they discovered not only the raw material but also working sites, with plentiful debitage and dateable charcoal. Two main source areas exist: Monte Viso, above Turin, and Monte Beigua, above Genoa. Additional sources of nephrite exist in the Valais region of Switzerland. The spectacular geography of the source areas makes it easy to imagine that the large, exquisite axe heads could have been attributed divine powers, coming from the liminal zone between earth and the Otherworld. A range of raw materials were used, varying in colour, texture and working properties. These include jadeitite, omphacitite, eclogite and nephrite.

Procuring and producing: extreme activities

Collection of raw material could only take place over a short period during the summer, and only initial roughing-out was done on the mountains. This roughing-out was usually by flaking with a hammerstone although, with very tough pale green jadeitite, greater control could be obtained by sawing, using thin plaques of wood, with water and sand. One partly-sawn block, from Lugrin, had been brought 200km from its source. Subsequent work was by pecking, grinding and polishing; some axe heads were given a glassy polish, which could be achieved in various ways. Experimentation has shown that it takes a thousand hours to create an axe head such as the magnificent specimen from Canterbury: sawing and grinding remove only 1.82g per hour.

Big men: big axeheads

Finished axe heads could travel great distances, up to 1800km from the source: from County Mayo in the west, to Varna (Bulgaria) in the east. But the spread was not even across Europe, nor was the date of arrival: Britain, Ireland and Denmark see the latest appearance. By collating information about dating, distribution, composition and context, *Projet JADE* has built up a picture of which sources and materials were exploited, over what periods, to make which types of axe. Earliest and latest exploitation (late 6th to early 5th millennium, and early 4th to mid-3rd millennium) was effectively for local use in north Italy, eastern France and Switzerland, as small, workaday axes. Production of large, 'socially valorised' axe heads and long-distance transport was underway by c 4600 BC, when large numbers were being procured by the menhir-erecting, massive tumulus-building elite of the Morbihan area of Brittany. These grandees had the axes re-shaped and re-polished, and exploited their phallic connotations: it is here that one finds the longest examples in Europe (up to 470mm long), and one was found placed suggestively within a stone bangle. A few centuries later, the 'Big Men' of the Varna cemetery were using these exotic treasures in a similar fashion.

Circulation, deposition, legendary biographies

While the Morbihan and Varna axe heads were probably buried soon after procurement, others circulated for long periods, and one challenge is to gauge the length, mode and direction of circulation in different regions. One intriguing issue is the date/s at which Alpine axes arrived in Britain and Ireland. While some may have been made as early as 4600 BC, it seems likely (Pétrequin *et al* 2008) that most arrived as part of the Carinated Bowl Neolithic phenomenon, around or just after 4000 BC, as treasured ancient possessions of emigrant farming groups from northern France. The axes would have been circulating within northern France, each with its own identity and legendary biography, as a product (or indeed divine being) from the 'magic mountains' far away. Analysis, matched against the project's database of 12,000 determinations, has shown that one axe head from Fife is from the same Monte Viso jadeitite block as three found in Germany; and that the Canterbury axe head was from the same block as one from Breamore, Hampshire, albeit made centuries apart. A high proportion of British and Irish examples have glassy polish. Perhaps this was applied shortly before the farmers set sail, to enhance the axe heads' magical, protective powers. In Britain, as elsewhere, many were carefully placed in significant contexts, especially in wet areas (as in the Somerset Levels, beside the Sweet Track, or in the Thames). Maybe even the decision to exploit

A block of jadeitite on Monte Viso. © *Projet JADE*

Traquair House axe head and its box. © National Museums Scotland

Axe head from Canterbury. Photograph: P Pétrequin, J Desmeulles, E Gauthier / *Projet JADE* montane, hard-of-access rock sources such as Langdale Pikes was inspired by the desire to recreate the 'magic mountain' ideology of axe production in Britain and Ireland.

An international conference in Besançon this September, followed by the Prehistoric Society's May 2010 Europa conference in Cardiff, will present key results of *Projet JADE*. For further details, see http://mshe.univ-fcomte.fr (follow 'pôles de recherche, axe 1, action 2').

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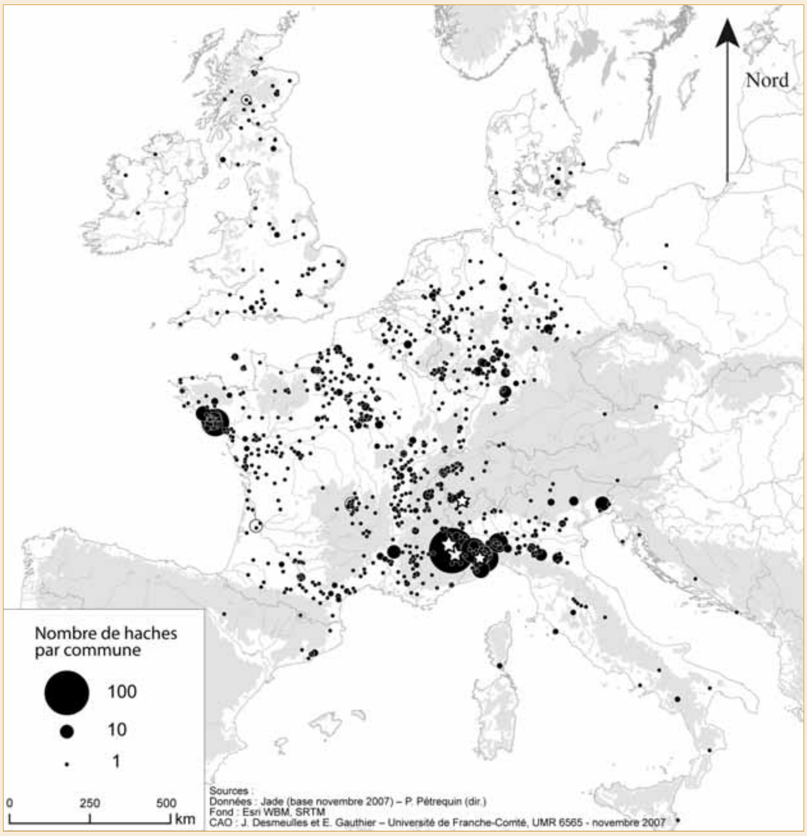
Pétrequin P, Sheridan JA, Cassen S, Errera M, Gauthier E, Klassen L, Le Maux N & Pailler Y 2008

Neolithic Alpine axeheads, from the Continent to Great Britain, the Isle of Man and Ireland, in H Fokkens, BJ Coles, AL van Gijn, JP Kleijne, HH Ponjee & CG Slappendel (eds), *Between Foraging and Farming: an Extended Broad Spectrum of Papers presented to Leendert Louwe Kooijmans*, 261–80. Leiden: Leiden University (*Analecta Praehistorica Leidensia* 40).



Distribution map. P Pétrequin / *Projet JADE*

English Heritage

English Heritage Regional Science Advisors (RSAs) provide a free and impartial 'one-stop shop', giving support to local authority curators, EH staff and archaeological contractors across England on matters concerning archaeological science. We cannot have expertise in all branches of this science but we do have a network of colleagues and can put you in touch with relevant specialists.

Professional training

An important aspect of our job is to develop and present, with colleagues from inside and outside EH, training in best practice and guidance for specific techniques. As a result, in the last nine years, we have provided training in over ninety sessions to more than 2500 people in subjects such as scientific dating, geophysical survey, conservation, archaeobotany, industrial residues, and osteology. These sessions are free to attend and are regionally based with regional case-studies wherever possible – making them accessible and relevant to their audiences. They are almost always a mixture of talks and practical work enabling attendees to appreciate the role of the specific material/technique of the day. These sessions provide CPD for attendees and also the opportunity for curators and contractors to discuss possibly controversial issues in informal surroundings, hopefully leading to better understanding. We find the days stimulating and enjoyable both to produce and to run. Given the feedback from attendees they, too, find the days beneficial and fun.

Forthcoming training sessions include *Metals and metal-working debris,* to be held at Exeter on 23 April and Bristol on 24 April. Topics will include understanding the basics of iron smelting and smithing, non-ferrous smelting, on-site sampling and relating finds to features, scientific techniques and what they can tell you, and identification of samples brought by participants. Handling sessions and discussion are integral to the day, and we even give you lunch.

Regional Science Advisors:

best practice and training

Jacqui Huntley

Best practice

One aspect of our current work is development of a training session on sampling and assessment – two areas of great concern. We are hoping to run *Sampling strategies, evaluation and assessment* sometime this Spring (see website for details). The day will cover sampling and assessment (emphasising that sampling should be fit for purpose and be integrated within a project from the start). The risks of taking too few samples during evaluation trenching and assessing too little will be explored in a practical session. Sampling is not just for plant remains, and assessment of the contents of residues will demonstrate how this can add value to a project. We will finish with a discussion of what and how materials from samples can become a more visible part of the historic environment record as far too many currently remain invisible. We are very much focusing on best practice and fitness-for-purpose (and you get lunch here as well).

Making data visible

A second important aspect is to address the issues of 'getting the archaeological science data out there and visible'. All too many of these data simply lie within intervention reports in the familiar grey literature. Whilst these reports are recorded in the Historic Environment Records, few HERs include flags as to the presence of archaeological science materials within them – Worcestershire HER is one noteworthy exception. Most data are therefore invisible unless one looks through all of the reports lodged in the HER, hardly an efficient use of time – for example in the Durham HER between 50-81% of the interventions for 2004, 2005, 2007 and 2008 had records for some aspect of archaeological science but this is not visible through the online search at all.

RSAs have therefore developed a scheme for recording the presence of this material quickly and easily at the report writing stage – somewhat akin to the OASIS form – using formalised and agreed terms now available through MIDAS. ALGAO has been part of this process throughout and we are about to go live and encourage everyone to use the scheme. The advantage of making these data accessible is that overviews and syntheses can more easily be produced, allowing better targeting and questions to be asked of any intervention – making sampling and science more fit-for-purpose on any site.

We have an up-to-date website that gives more information about the range of work the RSAs are involved with around the regions and provides our contact details. It also lists dates of current training sessions and downloadable versions of many of the EH Guidelines – http://www.dur.ac.uk/eh.rsa.

Piling and mitigation training for the North-East region - problem solving session. Photograph: Jacqui Huntley

Archaeobotany practical demonstration North-East region. Photograph: Jacqui Huntley

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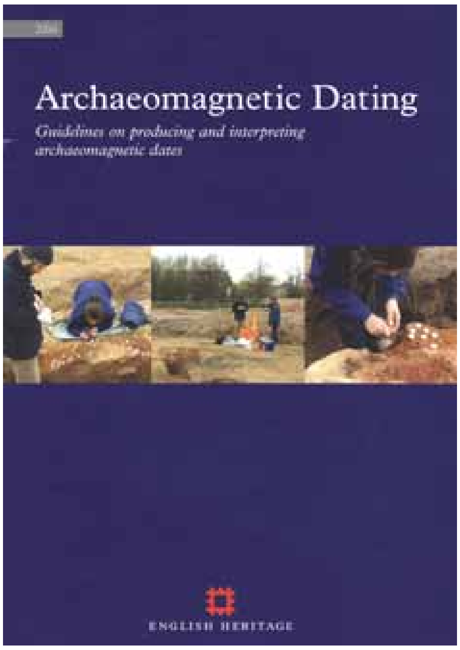
Scientific guidance from ENGLISH HERITAGE

Andrew David

English Heritage is publishing an increasing body of guidance into many aspects of archaeology, including scientific issues. These were last reviewed in *TA* in 2006 (*TA* 59, 37), but additional guidelines are now available and the programme of revised and new publications is continually being extended. For archaeological science these supplement and support the training and advice provided by the Regional Science Advisors (RSAs: http://www.english-heritage.org.uk/server/show/nav.1273) (see p40).



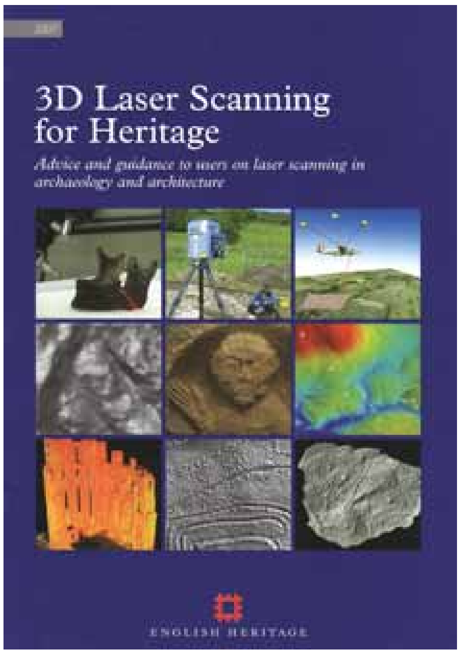
Guidance published since 2006 includes

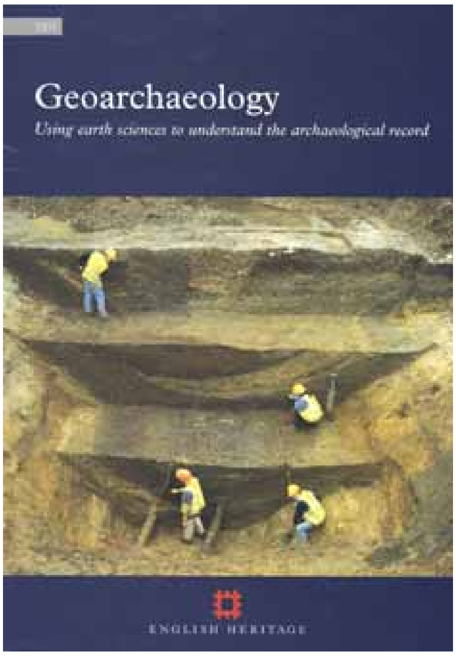
Archaeomagnetic Dating **(2006)**
(Product Code 51162)
Introduces the theory and principles behind the method which can date fired or burnt structures, and sometimes sediments; the suitability of the method is explained, with detail on practicalities such as sampling, measurement, and interpretation, illustrated by case studies, and with a glossary of terms.

Guidelines on the X-radiography of archaeological metalwork (2006)
(Product Code 51163)
Provides recommendations on the minimum requirements for X-radiographic screening of metalwork from archaeological projects: why, when and what to X-ray how to make informative X-radiographs and how to view and interpret these, and how to get help (reviewed in *TA* 61, 47).

Understanding historic buildings: a guide to good recording practice **(2006)**
(Product Code 51125)
Provides clear practical guidance on the ways in which the wealth of historical evidence embodied in buildings can be gathered and disseminated. It describes requirements for recording buildings, how records are built up, the methodologies used, architectural drawing conventions, the recording levels, writing up, and how records are preserved and disseminated.

3D Laser scanning for heritage: advice and guidance to users on laser scanning in architecture and archaeology **(2007)**
(Product Code 51326)
Explains how laser scanning works, when it is appropriate, and how it can be best applied. It aims to enhance and disseminate best practice, with sections devoted to commissioning surveys, managing data, helping readers decide on their approach, and where to find out more, supported with a glossary and case studies (see www.heritage3d.org)





Science for historic industries: guidelines for the investigation of 17th- to 19th-century industries **(2006)**
(Product Code 51262)
Shows how methodologies from several different disciplines can be combined to enrich understanding of the industrial past. In particular the guidance demonstrates additional information that can be obtained by applying scientific techniques. Case studies provide illustrative examples, methodologies are outlined and selected industries summarised, together with practical advice for archaeologists who encounter the remains of historic industries.

Geoarchaeology **(2nd edition: 2007)**
(Product Code 50848)
Geoarchaeology is the application of earth science principles and techniques to understanding the archaeological record. This guidance covers common site-forming processes, the information gained from different geoarchaeological methods, and typical on-site problems; advice is offered on incorporating and programming geoarchaeology into projects, and how to get help once an excavation is in progress.

Piling and archaeology **(2007)**
(Product Code 51352)
Prepared to assist planning and archaeological officers, developers and consultants, this guidance describes piling types, the impacts of piling on archaeological remains, and how to best mitigate its effects, illustrated with case studies; a strategy is proposed for future research, and best practice is summarised.

Understanding the archaeology of landscapes: a guide to good recording practice **(2007)**
(Product Code 51320)
This document provides practical guidance on the recording, analysis and understanding of earthworks and other historic landscape features by non-intrusive archaeological survey and investigation. It describes and illustrates with numerous case studies the approaches to analytical archaeological survey, photography, drawings and reports, Levels of Survey, and the principles of archiving and dissemination.

Investigative conservation: guidelines on how the detailed examination of artefacts from archaeological sites can shed light on their manufacture and use **(2008)**
(Product Code 51411)
Aimed at archaeologists, finds specialists and museum curators, these guidelines describe and illustrate the range of assistance that investigative conservation can achieve. Richly illustrated with examples, they provide a guide to good conservation practice and indicate what project managers should expect of conservators.

Geophysical survey in archaeological field evaluation **(2nd Edition: 2008)**
(Product Code 51430)
This guidance is intended to help curators, consultants and project managers to better understand and engage with geophysical survey, helping raise consistency and quality in archaeological field evaluation. It takes a comprehensive view of current methodologies and practice, including recent technical developments, and recommends good practice for fieldwork, choice of methodologies, data analysis, presentation, and report writing.

Understanding historic buildings: policy and guidance for local planning authorities **(2008)**
(Product Code 51414)
This sets out English Heritage policy on the investigation and recording of historic buildings within the English planning framework. It provides advice on how a specialist understanding of the significance of an historic building and its constituent parts can inform a development proposal or scheme of works and assist in the decision-making process. It also identifies the need to record evidence that may be damaged or lost.

Luminescence Dating: Guidelines on using luminescence dating in archaeology **(2008) (Product Code 51431)**
See below.

Guidelines for the curation of waterlogged macroscopic plant and invertebrate remains **(2008: web only)**
Intended primarily for environmental archaeological specialists, and collections managers, these guidelines advise on the most suitable methods for the curation of small (up to about 50mm) organic remains recovered during archaeological investigations.

Guidelines in preparation include

Waterlogged Wood **(3rd edition).**

Environmental Archaeology: a guide to the theory and practice of methods, from sampling and recovery to post-excavation **(2nd edition)**

Guidance concerning the maintenance and restoration of moats, ponds, ornamental lakes and other artificial/man-made water bodies

Understanding historic areas

The Light Fantastic – using airborne laser scanning in archaeology survey

Guidelines on producing and interpreting dendrochronology dates **(2nd edition)**

Glassworking

Guidelines on the care of waterlogged leather and other sensitive organic materials

English Heritage's Research Department also publishes examples of current work through its newsletter *Research News* (http://www.english-heritage.org.uk/server/show/nav.8336) and results are widely disseminated elsewhere, including in the *Research Dept Reports Series* (http://research.english-heritage.org.uk/). Much of the work undertaken internally, or funded in partnership, also contributes to programmes of outreach, training, advice, standards and guidance.

Documents described above, and many others that cover a wide range of activities to do with the historic environment, can be located online at www.helm.org.uk or www.english-heritage.org.uk/publications. For a hard copy, contact the EH Customer Services Team at customers@english-heritage.org.uk, or telephone 0870 333 1181, quoting the relevant Product Code.

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LUMINESCENCE DATING

Peter Marshall

Luminescence dating techniques have been employed in archaeology over the last fifty years to date materials that were either heated (ceramics and burnt stone), or exposed to daylight before burial (sediments). These events release electrical charge trapped in crystals such as quartz, which starts to build up again as these crystals are exposed to radioactivity in the burial environment. The accumulated charge, which is proportional to the time elapsed since the material was last heated or exposed to daylight, is measured after stimulation by heat (called thermoluminescence or TL) or light (optically stimulated luminescence or OSL).

OSL sampling inside Silbury Hill © English Heritage

Collecting samples of sand for OSL dating, Gwithian Cornwall. © Historic Environment Service, Cornwall County Council

The age range over which luminescence dating can be used, from a century or less to hundreds of thousands of years, is particularly appealing to archaeologists. It means that it can used in situations such as

River terraces
Fluvial gravel sedimentary sequences containing Palaeolithic tools at Broom, Devon (Toms *et at* 2005) provided a site chronology and exemplified the age of sediments that could be dated (>250,000 years).

Archaeological sites
OSL dating of aeolian sand at Gwithian, Cornwall (Nowakowski *et al* 2008), in combination with radiocarbon measurements, helped to provide a chronological framework for interpreting activity at the Bronze Age site.

Brick buildings
The realisation that fired clay bricks could be dated by luminescence (Bailiff 2007) has significantly increased the potential for phasing and dating the construction of medieval and post-medieval brick structures.

English Heritage's luminescence dating guidelines, by Geoff Duller, are designed to establish good practice in the use of luminescence dating in archaeology. They provide archaeologists with the tools to assess whether luminescence dating will provide useful chronological information for their site, an introduction to the science behind luminescence dating, sections on the practicalities of collecting samples, collaborating with laboratories and understanding results, and a series of case studies.

The guidelines (Duller GAT, 2008 *Luminescence Dating: Guidelines on using luminescence dating in archaeology*, Swindon, English Heritage) can be downloaded from http://www.helm.org.uk/upload/pdf/luminescence_dating.pdf

For a hard copy, contact the EH Customer Services Team at customers@english-heritage.org.uk, or telephone 0870 333 1181, quoting Product Code 51431

Peter Marshall
English Heritage Scientific Dating Team

Bailiff IK, 2008 Methodological developments in the luminescence dating of brick from English late medieval and post-medieval buildings, *Archaeometry* **49**, 827-51

Nowakowski JA, Quinnell H, Sturgess H, Thomas C, and Thorpe C, 2008 Return to Gwithian: shifting the sands of time, *Cornish Archaeology* **46**, 13-76

Toms PS, Hosfield RT, Chambers JC, Green CP, and Marshall P, 2005 Optical dating of the Broom Palaeolithic sites, southwest Britain, *Centre for Archaeology Rep* 16/2005

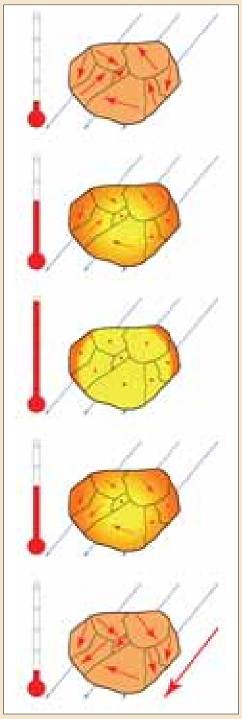
Sampling a brick for OSL dating. © English Heritage

Magnetic moments in the past

Cathy Batt

Zoe Outram taking archaeomagnetic samples from the Upper House at Hamar, Shetland (Viking Unst Project). © S Dockrill

The University of Bradford and English Heritage have just launched a project to develop archaeomagnetic dating for application in UK archaeology, with funding from the AHRC Knowledge Transfer Fellowship scheme. Previous research has established a methodology for using measurements of the past magnetic field of the Earth for dating archaeological materials in the last 4000 years in the UK, and this project will realise the potential of this research by developing its practical application in UK archaeology.



The scientific basis of archaeomagnetic dating of fired materials. Initially magnetic domains within a sample are magnetised in random directions that cancel out. As the sample is heated the domains demagnetise. On cooling, the domains remagnetise in a direction close to the prevailing ambient magnetic field, resulting in a net magnetisation in the sample which reflects the field at the time of cooling. Linford, P 2006 Archaeomagnetic dating: Guidelines on producing and interpreting archaeomagnetic dates: English Heritage

Archaeomagnetic dating has great potential for establishing archaeological chronologies: it dates fired clay and stone, for example hearths, kilns, ovens and furnaces which occur frequently on archaeological sites; it dates the last use of features, providing a clear link to human activity and is potentially most precise in periods where other dating methods, such as radiocarbon dating, are problematic. There is increasing interest in using archaeomagnetic dating as part of the suite of chronological tools available to archaeologists, but it has yet to be adopted routinely. This is partly due to a lack of accessible information allowing evaluation of its suitability in specific archaeological circumstances and partly because there is no coordinated, centralised record of existing archaeomagnetic measurements.

This project will address these deficiencies by developing a web-based resource and database which will collate all existing UK archaeomagnetic data and allow the user to address specific questions, such as the expected errors in a particular period, the suitability of specific types of features and the existence of previous studies in the same region or on the same type of feature. The project combines academic research at the University of Bradford with the expertise of English Heritage in developing best practice within the English archaeological sector.

The project is at its early stages and progress will be reported in *TA*; in the mean time, if you would like further details please contact Cathy Batt (C.M.Batt@Bradford.ac.uk) and Zoe Outram (Z.Outram2@Bradford.ac.uk), University of Bradford.

Cathy Batt
Senior lecturer in Archaeological Sciences
Archaeological Sciences
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For more on EH guidelines on thermoluminescence dating see Peter Marshall, previous pages.

Archaeological Geophysics: from field to archive

IfA BURSARY

Tom Sparrow, Chris Gaffney and Armin Schmidt

As large-scale geophysical surveys increase documenting and archiving this resource is increasingly significant. With technological advances in geophysical instrumentation, especially the integration of GPS and Multisensor platforms, large landscape surveys are increasingly practical and increasingly data rich. Whereas a couple of years ago only one dataset would have been collected at a site, multiple datasets are increasingly collected in one 'sweep' using cart and sledge-based platforms and, as data collection moves from traditional gridded data to grid-less, previous metadata becomes a data set in its own right.

Anecdotal evidence from curators and planning departments indicates that despite the increase in practitioners working in archaeological geophysics, the quality of archiving needs to be improved. An IfA Special Interest Group into geophysics set up in 2008 (p8) has a subcommittee reporting on archiving issues, a welcome addition to this topical debate. IfA has already acknowledged the need to train practitioners via a Workplace Learning Bursary: *Archaeological Geophysics: from field to archive*, hosted by University of Bradford.

One driver for the host institution was recent donation to the University of the Time Team Geophysical Archive (TTGA) by GSB Prospection Ltd. The TTGA, as an archive, has great value for academic research but also will promote geophysics to the wider community. One aim of the Bursary is to increase access to this resource.

The process of collecting high-quality data, reporting and archiving is an increasingly important, but as yet rarely formally taught, aspects of modern geophysical survey. There are few specialists in this area; some academic departments provide only research training whilst few commercial practitioners have time to accumulate information on best practice for long term archiving. The IfA Learning Bursary seeks to redress this balance by looking at the 'what's and why's' of current practices by geophysical contractors, Archaeology Data Service (ADS) and national heritage groups, looking at a range of geophysical data.

Technical skills will be combined with training in requirements for data management. This will enable documentation and archiving for archaeological geophysics to become a streamlined practice. This in turn will lead to more transparent and accessible data that will enable better integration with future geophysical and archaeological research. By developing archival databases and GIS repositories for the TTGA and other University of Bradford geophysical datasets, efficient, effective and useable strategies for archiving can be formulated.

Tom Sparrow
IfA Work Learning Bursary holder

Chris Gaffney and **Armin Schmidt**
University of Bradford (Host Institution)

IfA Workplace Learning Bursary Holder, Tom Sparrow, during a detailed GPR survey at Caerwent, south Wales. Photograph: J Adcock, GSB Prospection Ltd

New Journal

THE HISTORIC ENVIRONMENT: POLICY AND PRACTICE

Roger White

A new twice-yearly peer-reviewed journal from Maney Publishing, *The Historic Environment,* will be launched early in 2010. The aims and scope have been developed with the interests of IfA members in mind, and it will be a publication for those who investigate, research and manage the record of human impact on our world, whether this is as a practising commercial archaeologist, built environment conservationist or researcher based in an academic institution. How people have coped with the changing natural environment in the past, and have adapted their societies to these changes, are real issues of concern in today's environment. This new journal will engage with these broad issues, looking at historic landscapes in a holistic fashion, but will also work down to a finer level of understanding on historic buildings, archaeological sites and artefacts in their setting. The approach takes on board the increasing perception that sites, objects and landscapes cannot be viewed in isolation but need a broader and less rigidly demarcated approach. We have much to learn from the many diverse disciplines within our sector and thus the journal will be concerned with the practice of historic environment conservation as opposed to purely theoretical understanding.

We are currently assembling an editorial team that can provide the knowledge and practice required to cover such a broad remit. The breadth required is both geographic – we have members on the editorial board from the British Isles, continental Europe, North America, the Caribbean and Australia – and disciplinary. Thus we have specialists in the built environment, in excavation and its practice, in the maritime environment, and in monitoring and defining procedures in all fields covered by the historic environment remit. We hope that the journal will provide a mechanism for putting forward and debating best practice in all aspects of work in the historic environment, and will enable those working in the sector to develop across traditional boundaries. The Journal will be published in both print and online formats and will form essential reading for all archaeological practitioners including those involved in building conservation – contractors, consultants, curators, researchers, students and fieldworkers – whether professional or voluntary. As an authoritative learning resource, it will form core reading for postgraduate courses and continuous professional development programmes (CPD). We also fully intend that it should be lively, interesting and as challenging as the environment in which we all work.

We now invite contributions to the journal (the deadline for submissions for the first issue is 1 September 2009). Submissions and expressions of interest should be directed to the editor, Roger White: r.h.white@bham.ac.uk. Notes for contributors will be available shortly but are based on the *MRHA Style Guide* (www.style.mrha.org.uk).

Institute for Archaeologists members will be able to subscribe to the journal through their annual membership renewal at an attractive discount on the usual subscription.

Fro more information and to keep up to date with all the latest developments visit www.maney.co.uk/journals/hen.

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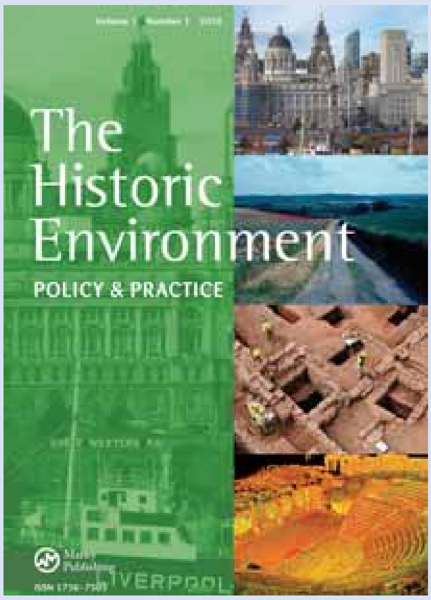

New members

ELECTED

Member (MIFA)
Emily-Jane Brants
Ross Dean
Michael Donnelly
Denise Druce
Quetta Patricia Kaye
Steven Lawrence
Louise Loe
Douglas McElvogue
Cecily Spall
Rebecca Stacey
Nicola Toop
Julia Wise

Associate (AIFA)
Kate Brady
John Cook
John Duffy
Glen Foley
Kathryn Grant
Claire Hallybone
Paul Harris
Steve Hickling
Anna Hodgkinson
Victoria Lambert
Brynmor Morris
Javier Naranjo-Santana
Lucy Norman
Louise Parkinson
Christina Robinson
Louise Turner
Mark Winter

Practitioner (PIFA)
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Peter Burge
Jodie Ford
Karen Hudson
Jan Janulewicz
Sarah Lane
Rupert Lotherington
Lucy Maynard
Vanessa Oakden
Kenneth Owen
Meirion Prysor
Johanna Roethe
Peter Spackman
Tavis Walker
Allen Wright
Edward Youngson

Affiliate
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Alexandra Coyne
Elizabeth Danner
Rupert Ellis
William Harding
Olivia Harper
Edward Higginbotham
Rachel Lindemann
Monika Katrin Lowerre
Charlotte Malone
Sheryl McKimm
David McNally
Rachel Nicholls
Fiona Sharrock
Linda Theaker
Dylan Williams
Sarah Louise Woodget

Student
Britt Alexandra Baillie
Bianca Ball
Peter Bidmead
Susan Birks
Timothy Carter
Patricia Day
Miguel Dias
Gary Lee Duckers
Markus Dwyer
Jonathan Dye
Sally Ford
Lynn Fraser
John Gates
Claudia Gouveia
Karl Hanson
Eileen Hoey
David Hunter
Martin Mawby
Adrian Messenger
Janis Mitchell
Giuseppe Morale
Daniel Mosley
Tanusree Pandit
Benjamin Raffield
Clare Rainsford
Rachel Sharland
Mary-Anne Slater
Ana Sousa Vaz
Charlene Steele
Susan Stubbs
Jacqi Townsend
Katherine Travers
Peter Turner
Alex Tye
Poppiti Vincenzo
Aimee Waller
Adam Wears
Nicholas Zorzin

TRANSFERS

Member (MIFA)
Jim Brown
Louise Brown
Nicholas Crank
Candice Hatherley
Joanna Higgins
Richard James
David Norcott
Michael Roy
Ian Suddaby
Ingrid Ward
Michael Wood

Associate (AIFA)
Christopher Clarke
Jason Clarke
Jane Harrison
David Hibbitt
Matt Nichol
Guy Salkeld
Mikael Simonsson

Practitioner (PIFA)
Markus Dylewski
Kevin Mooney
Melanie Partlett
Diarmaid Walshe

New members (continued)

TRANSFERS (cont)

Affiliate

Graham Aldred
Rachel Baldwin
Adam Barker
Steven Black
Rosalind Broadley
Tom Burt
Jill Campbell
Leigh Campetti
Carla Cassidy
Ashley Coutu
Rachel Cruse
James Doeser
Deirdre Doherty
Andrew Donald
Michele Drisse

Affiliate (cont)

Joanne Dyson
Sarah Elliott
Tara Fidler
Charis Gates
Elfreda Gibson-Poole
Josephine Gist
Georgette Gormley
Heather Hamilton
Annie Hamilton-Gibney
Janelle Harrison
Nicola Herson
Dylan Hopkinson
Gillian Hutton

Affiliate (cont)

David Jackson
Peter James
Natalie Kershaw
Alexandra Latham
Emma Lawler
James Lawton
Margaret McCartney
Helen Meadows
Julia Meen
Roisin Miskelly
Marion Mittelstaedt
Neil Morris
Elizabeth Murray

Affiliate (cont)

Catherine Neal
Darren Parr
Rosy Phillipson
Steven Price
James Rhodes
Roger Roper
Ken Saito
Eleanor Simonis
Meg Sims
Robert Skinner
Heather Smith
John Smythe
Timothy Southern
Angharad Stockwell

Affiliate (cont)

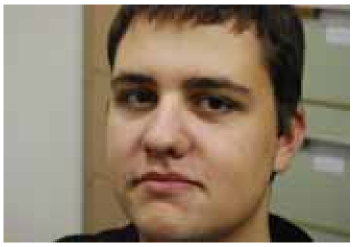
Shanna Streich
Timothy Tyler
Sophie Unger
Camessa Wakeham
Richard Walsh
Philippa Whitehill
Joanna Wilkins
Jane Wilson
Duncan Wright

Members news

Alex Rose-Deacon *PIFA 5088*
I trained initially in historic buildings analysis at ARCUS, before going on to take the job of Head of Historic Buildings at Pre-Construct Archaeology Ltd, London. There I was lucky enough to act as a built heritage specialist on such projects as the 2012 Olympics and the King's Cross Regeneration Scheme. I now run my own business, offering historic buildings analysis to clients within the commercial archaeology industry. As a freelance historic buildings archaeologist I offer a variety of services, from desktop assessment to top-level historic building recording, input on conservation plans and environmental impact assessment.

Interested readers can find out more at my website: www.buildings-archaeology.com.

Alex Rose-Deacon



David Hunter *(Australian)Student member 5963*
The year after I finished high school, I had a year away from studying and worked at the school maintaining the archives. The school was on a historical site, and a lot of my time was spent prospecting the school fields for remnants of the earlier settlement. This prospecting led to an interest in geophysics, and I soon developed my own resistance meter and carried out a survey of the field. In 2008, I began studying Archaeology at La Trobe University (Melboume), and in the same year was involved in several high-status digs, including Glenrowan, the site of the infamous Kelly Gang siege of the late 19th century. This year, I will continue my studies in archaeology, and plan to major in archaeological prospecting.

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Obituary

Angela Simco BA *MIfA 178*
1952-2008

Angela Heather Simco, who died of cancer on 29 December 2008 at the age of 56, grew up with the modern archaeological profession and made her distinctive contribution to it. A member of the Institute from 1984, she was a familiar figure at annual conferences.

Angie was brought up in the Bedfordshire village of Clapham, notable for its prominent Saxo-Norman church tower which she was later to record during conservation repairs and in whose churchyard she is buried. Her interest in archaeology stemmed from joining a group of able and highly motivated local sixth-formers who were the core volunteers in training excavations at Elstow Abbey and rescue excavations at Bedford Castle in the late 1960s.

After graduating from the London Institute of Archaeology in 1973, Angie joined what was to become the Conservation and Archaeology Section in Bedfordshire County Planning Department. Initially involved with rescue threats, she excavated a Roman villa farmstead site at Newnham east of Bedford, but the main thrust of her public service career was curatorial. She guided the fledgling Sites and Monuments Record with characteristic thoroughness and the serious sleuthing skills required to order the inherited and often tortuous historiography of major heritage assets. Her definitive publication on *The Roman Period* in Bedfordshire (1984) set an early example of what a well-stocked SMR could support; it includes a characteristically irrefutable deconstruction of inflated visions about unsubstantiated Roman roads. Perhaps her most important contribution was a methodology for the care and repair of Bedfordshire's historic bridges, devised in the best traditions of what we now know as 'informed conservation', firmly but tactfully guiding sometimes over-enthusiastic highway engineers. Her book, with Peter McKeague, on *Bedfordshire's historic bridges*, explaining the method and the bridges, is another standard work.

After leaving Bedfordshire County Council in 1992 for a greater involvement in the work of her local Bedford church, she set up her own sole-trader consultancy in Archaeological Heritage Management. This allowed her to follow her main interests, describing herself on her well-presented website (www.angelasimco.co.uk/), as 'a landscape archaeologist at heart … with a particular interest in researching the development of the historic landscape'. Several woodlands surveys in south and east Midlands counties married documentary research and field survey. For English Heritage's Monuments Protection Programme she prepared documentation on Clay Industries, much admired as a model of its kind. She undertook assessments of landscape character and archaeological resources for her former employers, together with projects for data enhancement and systems migration in what had been a genuine Historic Environment Record before the term was invented. There were two episodes acting as an Inspector of Ancient Monuments in English Heritage's East Midlands Region, and continued consultancy advice on the repair of accident damage to Bedfordshire's historic bridges.

A reserved personality (though an enthusiastic and skilful hockey player), preferring to keep her powder dry until the problem at hand had been fully scoped, but then expounding the way forward with meticulous clarity, Angie exemplified many of the best qualities of archaeological professionalism. She is a sad loss to her friends and colleagues.

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Angela Simco