Archaeological geophysics at Flinders University

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Introduction

Internationally, in recent decades the potential of geophysical techniques to contribute to archaeological investigations has been recognised, and these methods have become commonplace, especially in the United Kingdom and in North America. English Heritage (2008) estimates that nearly 25% of planning applications with a heritage component in the United Kingdom in 2006 included geophysics as an investigation technique. Accompanying this change, the recognition of ‘geofizz’ techniques by the general public has increased markedly, driven principally by the popularity of television programs such as Time Team. Reflecting this popularity, research in this discipline is vibrant, as showcased by journals such as Archaeological Prospection and specialist training is now provided by several universities through dedicated postgraduate degrees.

In contrast, archaeological geophysics has remained a small discipline in Australia, with limited utilisation of these techniques in academic, government and consulting archaeology. Over the last few years, however, interest in this area has expanded considerably, driven by recognition that geophysical techniques provide a non-invasive, rapid and culturally appropriate method of assisting in archaeological investigations. This change has been accompanied by a renewed interest in research in this area (i.e. Fanning et al., 2005; McKinnon et al., 2007; Stanger and Roe, 2007; Moffat and Raupp, 2008; Moffat et al., 2008; Wallis et al., 2008, 2009; Brooks et al., 2009; David et al., 2009; Gibbs and Gojak, 2009), following a long hiatus since the pioneering work of Stanley (Connah et al., 1976; Stanley and Green, 1976; Stanley, 1983) on the application of these techniques to Australian conditions.

Despite this, the provision of formal training in archaeological geophysics in order to nurture a new generation of skilled graduates has been noticeably lacking. Recognising this deficiency, the Department of Archaeology at Flinders University has established a programme in this area which aims to undertake innovative, industry-relevant research and teaching in this discipline, and complement archaeological research projects in the department. Initially developing out of informal collaborations between consulting company Ecophyte Technologies and the Department, the archaeological geophysics program has grown considerably to now be an integral, vibrant component of the teaching and research program. In this article we profile some of the recent research and teaching activities of the Department of Archaeology relating to archaeological geophysics.

Academic teaching

Teaching geophysical techniques to students whose background is humanities, arts or social sciences (as opposed to ‘hard science’ areas) requires an approach that makes the subject accessible, engaging and demonstrably practical, without compromising the quality and rigor of the content. With this in mind, archaeology students are first exposed in small measures to geophysical techniques throughout their undergraduate degree in field-based subjects such as ARCH1003 Field Archaeology, ARCH2201 Archaeological Field Methods, ARCH3303 Historical Archaeology Field School, ARCH3306 Indigenous Archaeology Field School and ARCH3304 Maritime Archaeology Field School. This usually involves geophysicist Ian Moffat participating in the topics as a member of the general teaching staff, providing practical instruction on the field use of geophysical equipment. This approach somewhat demystifies geophysics and, having lost their fear of the unknown, students inevitably seek to develop a broader understanding of how such techniques might usefully be applied in archaeological contexts. This desire is then sated with the opportunity to enrol in an intensive field topic of two weeks duration, entitled ‘ARCH8307 Introductory Archaeological Geophysics’ offered annually within the Graduate Programs in Archaeology, Cultural Heritage Management and Maritime Archaeology. In this topic students are introduced to geophysical techniques through a combination of lectures and practical sessions (see Figures 1 and 2) where they collect data using a ground penetrating radar, an electromagnetic induction device and a magnetometer from an historic cemetery and then process and interpret it to locate possible unmarked graves. A strong emphasis is placed on the practical applications of archaeological geophysics and ‘hands-on’ instruction in field settings, rather than concentrating on the physics behind the techniques or resorting to ‘show and tell’ methods of teaching. The aim is always to foster a ‘deep approach’ to learning, whereby students are encouraged to understand and apply knowledge (Gibbs, 1992; Gordon and Debus, 2002; Warburton, 2003). This subject is the only one of its kind in Australia and is particularly tailored to providing students without a geophysics background with a basic understanding of which techniques may prove useful for archaeological projects.

This subject is also available as a two-week duration short course on a fee-paying basis to non-Flinders students on an
Beyond instruction in archaeological geophysics in formal university level topics, we also offer a range of course and workshop options for students and external participants alike; these offerings change each year depending on availability of staff.

In July 2009 Associate Professor Larry Conyers from the Department of Anthropology, University of Denver presented a three day short course specialising in ground penetrating radar. Associate Professor Conyers is recognised as one of the premier practitioners in archaeological geophysics, and is the author of the well-known text book *Ground Penetrating Radar for Archaeology* (Conyers, 2004). The first day of the course was spent in the classroom, where participants were introduced to some of the theoretical principals underpinning geophysics. This included a potted history of the development of GPR technique in archaeology, drawing heavily on Larry’s own pioneering research in Central America. The emphasis was on illustrating theory using actual case studies to ensure the science does not overwhelm the beginner. Day two comprised a field survey of an historic cemetery, with Larry offering his extensive experience on survey considerations, site gridding and data collection methods. Under guidance, participants were required to collect data from the site to be used for the following day of the workshop. On day three participants went into the computer laboratory to process their data; with no prior experience, by the end of the day participants were able to grid data and produce interpretable maps of simple data.
In December 2009 as a precursor to the Australian Archaeological Association Annual Conference to be held at Flinders University, Ian will offer a professional development workshop aimed at graduate students and professionals in archaeology who wish to develop an understanding of archaeological geophysics, particularly as it might be employed in a consulting environment. The course is designed to provide participants with a considered awareness of the opportunities and limitations of geophysical methods, thereby facilitating a better result when applied in consulting and research projects.

Of course, these training programs are not designed to – nor claim to – produce students capable of undertaking commercial archaeological geophysics survey unaided after just a day – or ten – of instruction. Instead, we aim to produce students who are sophisticated and informed consumers of contract geophysical information. The courses are designed to whet people’s appetite and arm them an awareness of how and where to seek more information if archaeological geophysics is an area in which they want to expand their knowledge and training. Should students wish to develop their skills further in this area, they are encouraged to participate in the numerous geomorphological research projects (see below) undertaken every year within the department, to seek industry placements with the numerous departmental geomorphological industry partners, or undertake a research study on a suitable topic.

Research

As is true with any discipline, research should inform, and be an integral part of any teaching program (Hattie and Marsh, 1996; Deem and Lucas, 2006). Current research in archaeological geophysics at Flinders University focuses on two principal foci: an examination of the potential contribution of magnetic techniques to Indigenous archaeology in Australia, and the development of a robust methodology for the location of burials (both historic and Indigenous) using geophysical techniques.

Magnetic techniques have significant potential to make a contribution to understanding Australian Indigenous archaeological sites. Human occupation, particularly involving fire, can enhance the magnetism of archaeological sites and can be detected using magnetometry and magnetic susceptibility techniques (Marmet et al., 1999; Linford and Canti, 2001). While this phenomenon is well understood experimentally, research at Flinders is focused on locating features of interest in a field setting where logistical and financial considerations may be the principal constraining factors as to whether a technique can realistically be deployed rather than it being theoretically possible. A particular focus of this research has been on locating heat retainer hearths, which despite being ubiquitous in the Australia archaeological record and easily datable using radiocarbon and luminescence techniques, have not been the focus of significant research attention. They are typically only located after they have eroded from sub-surface contexts, at which time their integrity and dating potential is often much reduced; thus the ability to locate these features before erosion occurs would have substantial management and research implications. Ongoing research shows that a combination of geophysical techniques and high quality spatial information can provide insights into the location of these features (Figure 3). Additional research has identified the potential of a similar approach to locate burials when funerary practices involving burning occurred, as well as to provide information about the intensity occupation in rock shelter sites.

Methods including ground penetrating radar, electromagnetic induction, magnetometry and direct current resistivity have been applied to locating human burials. Most recently, the Historic Graves Project has been systematically surveying cemeteries around Australia containing unmarked burials in a variety of soil types. Cemeteries that have been included in this project to date include Albany Memorial Cemetery (WA), Encounter Bay Cemetery (SA), Meadows’ Wesleyan Cemetery (SA), Selheim Cemetery (Qld) and Pioneer Park Cemetery (SA) (Figure 4). This project aims to develop a robust methodology for locating burials in all sites, taking into account the specific site conditions. The results have been encouraging and suggest that geophysics has an important potential contribution to make to understanding and managing similar sites throughout Australia.

Graduate student research

Several Masters of Archaeology students are undertaking their thesis research on topics in archaeological geophysics. Jennifer ‘Texas’ Milani is investigating the possibilities of magnetic susceptibility mapping to image rock art covered by silica or carbonate skins in collaboration with Dr Maxime Aubert from the ANU. Matt Harder is integrating multi-technique geophysical data with archaeological data and high resolution aerial photograph using GIS from the Woolgar River Open Site 1 (a large Indigenous camping ground comprising thousands of stone artefacts and heat retainer hearths) in northwest Queensland. Archaeology Honours student Ben Keys has recently submitted his thesis entitled ‘Engrained in the Past: Using Geoaechaeology to Understand Site Formation Processes at the Gledswood Shelter 1 Site, Northwest Queensland’ in which magnetic susceptibility techniques were used to assist in understanding the anthropogenic contribution to the sedimentation history of this site.

Industry partners

The archaeological geophysics program at Flinders has been generously supported by several industry partners, who have provided equipment and expertise to support the teaching and research programs. These include TAFESA, Ecophyte Technologies, Alpha Geoscience, Ultimate Positioning and GPRtech. The benefits for these industry partners are various and include the opportunity to ‘keep their hand in’ with teaching and research, to promote their own skills and expertise to participants who are, or will be in the future, in a position to engage geophysical consultants on heritage related projects, and to network with students who may seek employment with them in the future.

Research funding

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Future directions

Ian Moffat is co-chairing a session entitled ‘Seeing Beneath the Soil: The Possibilities of Archaeological Geophysics in Australia’ with Kelsey Lowe from Coastal Environments Inc. within the Australian Archaeology Conference to be held at Flinders University from 11 to 14 December 2009. As mentioned above, a one day introductory archaeological geophysics professional development workshop will also be offered on 10 December 2009.

Conclusion

Archaeological geophysics has become a vibrant part of the teaching and research programs within the Department of Archaeology at Flinders University. If you are interested in obtaining more information about archaeological geophysics or the department in general please refer to the website http://www.flinders.edu.au/ehlt/archaeology/ or contact the authors directly.

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Author profiles

Ian Moffat is a PhD candidate at the Research School of Earth Sciences at the Australian National University and a Research Fellow with the Department of Archaeology at Flinders University. Until October 2009 Dr Lynley Wallis was a Senior Lecturer with the Department of Archaeology at Flinders University; she has recently taken up a Senior Research Fellow position within the Aboriginal Environments Research Centre at the University of Queensland. Ian and Lynley have collaborated extensively on using geophysical techniques to help understand the Australian Indigenous archaeological record.