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Geophysics and geochemistry; an interdisciplinary approach to archaeology in wetland contexts

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A B S T R A C T

Wetlands are a non-renewable resource of high potential for organic archaeological deposits and palaeoenvironmental sequences. This resource is at threat from development and climate change. Only a small percentage of the identified wetlands in North West Europe have been studied with regard to their depth, stratigraphic architecture and the heritage assets they contain. In this paper several case studies are combined to show the variation of radar velocity field with different wetland sediment types. Sediment types are classified based on their physical and chemical properties. The results demonstrate how the application of geophysics can be used to identify archaeological features and interpret them within a wetland landscape. The ground penetrating radar (GPR) response and geochemical signatures given by archaeological structures and palaeolandscape features, presented here improves the quality and reliability of scientific information derived from archaeological prospection in wetland contexts. More accurate values for the dielectric permittivity of different wetland sediments have been calculated, allowing the response of GPR in wetland contexts to be predicted. Geochemical signatures associated with different sediment types and archaeological structures have also been demonstrated. Both GPR and the geochemical analysis of sediment can be employed across the dryland wetland interface bridging the gap between wetland and dryland archaeology and offers a potential to shape global debates regarding how wetland heritage is managed in the future.

1. Introduction

Wetlands are generally rich in cultural heritage due to the unique conditions of preservation (Coles et al., 1973; O'Sullivan, 1998; Van de Noort and O'Sullivan, 2006; Lillie and Ellis, 2007; Menotti, 2012). Decades of archaeological excavations suggest that remains are often fragmentary and deeply buried. This implies that many sites, especially wooden trackways and platforms, and occasionally occupation surfaces and settlements, and industrial debris remain to be discovered. The current management is deemed to be reactionary, attempting to preserve wetland archaeological sites in situ once they have already been disturbed (Chapman et al., 2009). This is costly and in many instances the optimal conditions of preservation cannot be attained or sustained (Amendas et al., 2013; Jones, 2013). Due to a less stable environment wetland deposits are less likely to be preserved in situ successfully than dryland deposits (Van de Noort et al., 2001, and Matthiesen, 2008; Milner et al., 2011). The ongoing pressure on the archaeological resource from environmental change due to development and, arguably, climate change (see Henman and Poulter, 2008), as well as afforestation, means that a shift to proactive management strategies is urgently required to aid the rapid discovery and characterisation of buried wetland archaeology.

This paper presents such an approach using geophysics, geochemical and borehole methods at higher resolution than that previously demonstrated by Utsi (2004), Bates et al. (2007) and Fyfe et al. (2010). By modelling the geochemical and geophysical signature of different targets in a variety of wetland contexts it is possible to address the general scepticism in the academic and commercial archaeological community about the usefulness of geophysics in wetland archaeology. Despite geochemistry having been used as a means of prospecting and characterising anthropogenic sediments in dryland contexts (Persson, 1997 for example), little has been done in wetlands in conjunction with archaeologists to improve understanding of the limitations of individual techniques (Haslam and Tibbett, 2004; Oonk et al., 2009; Eberi et al., 2012).

2. Materials and methods

Five sites associated with an archaeological structure or palaeolandscape were selected for this study (Fig. 1). Each contains one or

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Fig. 1. Map of North West Europe showing locations of the sites discussed in this paper.

Table 1
Details of each of the case study sites.

Site	Grid reference	Sediments	Local geology	Associated archaeology
Castlegar bog, Galway, Ireland	ING M82610 39213	Ombrotrophic and fen peat	Limestone moraine	Wooden trackway and platform structures
Annaghbeg bog, Galway, Ireland	ING M81986 37210	Ombrotrophic and fen peat	Limestone moraine	Undisturbed palaeoenvironmental sequences
Shapwick Heath, Somerset, England	NGR ST42204020	Fen peat	clays and sandy outcrops of interglacial Burtle Beds	The Sweet Track (Coles et al., 1973; Wells et al., 1999)
Caldicot, Monmouthshire, Wales	NGR ST4870088674	Alluvial clays and peat beds	Old Red Sandstones and Carboniferous beds	Wooden structures dated to the Bronze Age (Nayling and Caseldine, 1997)
Marsal, Lorraine, France	E 6°36′29″ N48°47′22″	Alluvial clays and peat beds	Lower Keuper Marl (a salt-bearing formation)	Iron Age salt workings (Olivier and Kovacik, 2006; Riddiford et al., 2012)

more sediment types that are typically found at wetland archaeological sites (Table 1). At Shapwick, Castlegar and Caldicot the case study objective was to detect evidence of trackways continuing from areas previously excavated and to improve the understanding of the local stratigraphy. Two additional case studies where the objective focused on local stratigraphy alone were made at Annaghbeg bog and Marsal, the velocity profiles are included here but for more details the reader is referred to Milton (2015).

Slightly different combinations of methods were employed at each site, from long transects covering a large area (for which data may already have been acquired, see Hodgson et al., 2009) to grids with data collected at a spacing of 0.125 m for the 400 MHz antennae and 0.25 m for the 200 MHz antennae. This is greater than the sampling frequency suggested by Historic England (formerly English Heritage) but does not meet the Nyquist limit; by sampling the grids more densely more convincing data might have been obtained. This demonstrates that while for this research the collection parameters were kept as similar as possible across all sites, in order to allow direct comparisons to be made, the approach can be much more flexible allowing it to be tailored to the sensitivity and size of the site.

At each site a grid of ground penetrating radar (GPR) data was collected using the Radan SIR20 software and GSSI hardware, utilizing 200 MHz and 400 MHz common offset antenna set up using the parameters in Table 2. At Annaghbeg and Shapwick long profiles were