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Using mineral magnetism to characterise ironworking and to detect its evidence in peat bogs

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A B S T R A C T

An experimental approach has been used to establish whether medieval ironworking activity could be identified in peat bogs using mineral magnetic measurements. The research project comprised three elements. First, magnetic susceptibility and remanence properties were obtained for materials from an experimental iron smelt, in a furnace of medieval design, and from material collected during the excavation of the medieval bloomery at Llwyn Du in Coed y Brenin, Snowdonia. Materials sampled and measured included charcoal, aerial dust, roasted bog ore and furnace dust. A second experiment determined whether small amounts of aerial dust released from the furnace could be detected in accumulating peat samples. This was achieved by sprinkling small quantities of dust on to a constructed 'peat core' that had no detectable magnetic signature prior to the addition of the dust. The application rates used were within the range expected to fall on a peat bog located close to a medieval furnace. Thirdly, mineral magnetic measurements were made on a peat core collected close to the Llwyn Du bloomery. The results confirm that roasted bog ore, aerial dust released from and dust accumulating in the furnace after a smelt, are magnetically detectable. The aerial dust and roasted bog ore produced enhanced susceptibility and remanence signatures in the constructed 'peat core' experiments. Peaks in $IRM_{(0.88T)}$ and HIRM were measured in the Llwyn Du peat monolith and appear to correlate with a time when the medieval bloomery was operational. The results presented here suggest that it is possible to identify evidence of past ironworking in peat bogs using mineral magnetic measurements and that the signatures remain well preserved in the peat record even after burial for several hundred years.

1. Introduction

This paper forms part of an investigation to reconstruct the archaeology and environmental impact of later prehistoric, Roman and Medieval ironworking in central Snowdonia, northwest Wales. The archaeological excavations have focussed on the hillfort of Bryn y Castell, the prehistoric settlement on Crawcwellt Common (Crew, 1986, 1989, 1995, 1998), and two medieval iron bloomeries in Coed y Brenin (Fig. 1), which were operational during the 14th and early 15th centuries (Crew and Crew, 2001). Historical documents in the form of Crown rentals give useful data for aspects of the medieval iron production (Smith, 1995). In tandem with the archaeological excavations, an ongoing palaeoenvironmental study, which includes pollen, non-pollen palynomorphs, microscopic charcoal, geochemistry and magnetic measurements from six sites, has been undertaken to place the ironworking into its environmental context at both a site specific level and a regional scale (Chambers and Lageard, 1993; Mighall and Chambers, 1995, 1997; Mighall and Crew, 2005).

One strand of the research has been to investigate the use of mineral magnetism as a tool for the study of past ironworking, including geomagnetic mapping and archaeomagnetic dating of the ironworking sites. Magnetic susceptibility and fluxgate gradiometer surveys have been used at Crawcwellt and Llwyn Du to map the ironworking debris and to identify furnaces, smithing hearths and other features (Crew, 1999, 2002). Archaeomagnetic measurements have also been made to date the last firing of furnaces and dipolar signals from high-resolution fluxgate gradiometer surveys have been modelled to recover the direction of total magnetization of the furnaces as a potential dating tool (Crew, 2002).

Only a small number of studies have attempted to reconstruct the environmental impact of ironworking (Chambers and Lageard,

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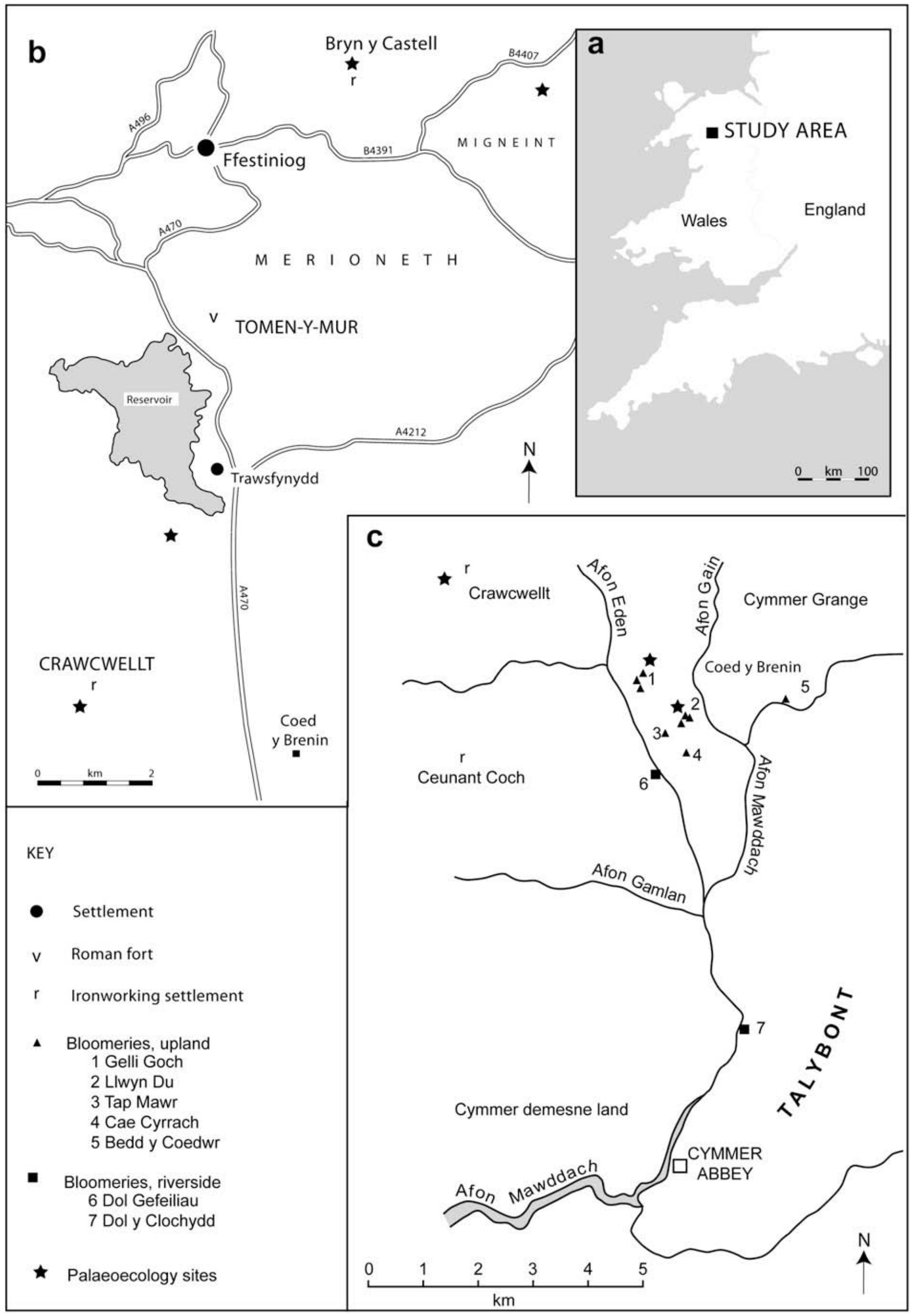

Fig. 1. Location of Llwyn Du bloomery and other ironworking sites mentioned in the text and located in the study area.

1993; Mighall and Chambers, 1997; Wheeler, 2007) and mineral magnetism has yet to be fully evaluated as a proxy for evidence of past ironworking alongside other types of data. The results of pollen and microscopic charcoal analysis from peat bogs close to the prehistoric ironworking sites have identified small scale, localised woodland clearance which may have been due to the use of local woodland for charcoal (Chambers and Lageard, 1993; Mighall and Chambers, 1997). However, other types of human activities, such as agriculture and wood use for fuel and buildings, may well have been responsible for the loss of woodland close to such sites. Identifying evidence for ironworking in the palaeoecological record can also be hampered by the scale and longevity of iron production, which can be small and occur only over years or a few decades (Mighall and Chambers, 1997). Processes internal to the sediment archive can further exacerbate the problem. For example, low accumulation rates would condense any evidence into a very small thickness of the peat core and in these circumstances it is normally beyond the capabilities of radiocarbon dating or pollen analysis to locate precisely parts of the sedimentary record which accumulated whilst ironworking was practised.

The application of mineral magnetism provides an alternative method to identify ironworking or other high temperature activity more precisely in a peat bog and may allow discrimination between competing activities to explain changes in the pollen record. In order to do so, the material used for and generated by ironworking, including ore and charcoal processing, smelting and smithing, must be characterised using magnetic parameters, which can discriminate ironworking from other anthropogenic activities or natural processes. The prehistoric and medieval ironworking process has been reconstructed in experiments based on archaeological data