The scientific study and conservation of battlefield artefact assemblages

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1.0 Introduction

Battlefields, which some of the most emotive and significant of historic sites in Europe, are now recognised as having a major archaeological dimension. They provide some of the most popular visitor attractions in Europe and are the subject of large numbers of both popular and scholarly books as well television documentaries.

The archaeological investigation of these sites has in recent years caught the public imagination, providing a new focus of interest and interpretation. Even more importantly, archaeology is being recognised as an essential tool for both the understanding of the events and for the framing of conservation management strategies to ensure the future survival of these nationally, often internationally important sites.

Traditionally the term 'battlefield archaeology' has been used, but now 'conflict archaeology' is often preferred in order to encompass smaller scale actions, siege warfare and associated sites such as prisoner of war camps. While 'battlefield archaeology' encompasses the physical evidence of both the terrain at the time of a battle and of the action, the term 'battle archaeology' is used here to specifically identify the physical evidence, in the form of artefacts scatters and stratified deposits, left by military action.

In 1995, when the English Heritage Register of Historic Battlefields was established, battlefield archaeology was not seen as a substantial concern, although the first steps in developing the subject in Britain were just underway. Today it is recognised as an important aspect of both research and heritage management for fields of conflict from the pre Industrial period. Registers, Inventories of other comparable conservation measures for battlefields are now in existence or under development in each of the countries of Britain and Ireland. More recently elsewhere in Europe countries such as Sweden, Germany, Belgium and Spain have seen parallel development of interest in battlefield archaeology. In contrast gaining recognition for the battlefield archaeology of the 20th century has proven far more difficult. Even ten years ago it was rarely seen as the prevue of professional archaeologists and heritage organisation, but this is now starting to change.

Indeed a clear division is becoming plain between the archaeological aspects of battlefields of the modern and the pre-industrial eras. They are seen to vary substantially in the character and potential of their archaeology, in the problems and potential for their investigation, and in the nature of the threats to the sites from decay, environmental change and development, and in the appropriate mitigation strategies to tackle such threats. However many common interests remain, while the transition between the two periods is in itself a major theme for research, thus it is important that they continue to be treated in parallel.

For the pre Industrial period the exact locations of battlefields are often in dispute or more often the extent and distribution of the action remains poorly understood. Over the last two decades archaeological investigation has been shown to be the key to resolving such uncertainties in military history. At the same time this research has demonstrated the enormous potential of the physical evidence from fields of conflict to contribute to the wider understanding of the evolution of the character of warfare. Battle archaeology has also been recognised as highly vulnerable because of its ephemeral nature, with the vast majority of evidence lying in the varying density and pattern of distribution of metal artefacts in the topsoil, where most have remained since the battle. Key object classes such as lead bullets and medieval ferrous arrowheads are subject to differential corrosion and loss in the soil. Battlefield archaeologists are thus starting to consider the effects of soil chemistry and the impact upon this of agrochemicals in the 20th century, and on wider agricultural practice

because it appears to be impacting in dramatic ways upon the condition or indeed the very survival of vulnerable battlefield assemblages. Related problems also exist when the artefacts have been removed from the ground, for even if stored in the most appropriate controlled conditions they can remain highly unstable and subject to ongoing decay.

Over the last decade Europe has seen major strides in the development of the methodology of investigation of battlefields of the pre Industrial era, complemented by a rapidly evolving, increasingly clear and focussed research agenda. This includes at its core the need for substantial project to systematically apply specific scientific techniques to the sites and the artefacts to provide objective data. In contrast for the modern period there remains considerable uncertainty and dispute over the objectives and research agenda and so here the key priority is be to provide a similarly focussed direction and purpose to that seen in the earlier period.

Modern battlefield-related assemblages, as typified by assemblages from WW1, provide distinct challenges to excavators, finds specialists, conservators and curators. They are complicated by the fact that the sites were fought over in living memory and so have complex personal associations for both individuals and governments, with issues of identification of individual bodies being a major concern with a direct continuity from the contemporary forensic work of the period itself. These sites provide other very specific challenges that do not lend themselves to traditional methods of finds processing and conservation. In addition to the issues related to identification and handling of unexploded ordinance, excavations of even short sections of WW1 trench produce vast quantities of metal artefacts. Industrial scale warfare produces industrial scale debris. With this type of excavation archaeologists and conservators are working with novel materials - early plastics such as the celluloid lenses in gas hoods, rubber and rubberised cloth, or the corrosion of sheet aluminium. While traditionally archaeologists and conservators have guidelines and well-established protocols for dealing with most types of excavated artefacts, there is an urgent need for new techniques and procedures to deal with these new challenges.

The present report is the result of a project run between January 2009 and March 2010, based in the Division of Archaeological, Geographical and Environmental Sciences, University of Bradford and funded as part of the AHRC/EPSRC Science and Heritage Research Clusters Scheme. The project was developed and implemented by a team comprising Rob Janaway, University of Bradford, as Principal Investigator with a specialist interest in the modern period; Dr Andy Wilson, University of Bradford, as Co-investigator; and Dr Glenn Foard, University of Huddersfield, with a specialist interest in the pre-Industrial period as Network Coordinator. In the present report Janaway has drafted the Industrial Period text and Foard the pre-Industrial period text.

The project was intended to clarify the research and conservation issues regarding battlefield artefacts of the pre-Industrial and modern periods by bringing together specialists in battlefield investigation and conservation science. In so doing it aimed to stimulate new collaborative research to address key issues and to help to develop guidance on key themes. By promoting an integrated approach to the management, scientific study and conservation of battlefield artefact assemblages it aimed to set the

study on a path by which the investigation, management and public interpretation of historic fields of conflict could be placed on a sounder scientific basis.

The project comprised a series of meetings in 2009: of a small a core group in March to refine the structure of the programme; a workshop in June when the core group and additional invited contributors explored the main themes; this enabled the organising of a **Symposium** in November, opened up to the whole archaeological and archaeological conservation community, comprising academic, professional and amateur alike. A series of speakers explored the key themes for the archaeological study of fields of conflict of the last millennium, and leading discussion of the issues.

Outcomes

The project has led to the forging of links between specialists working in battlefield investigation of both the pre-Industrial and modern periods; scientific analysis of artefacts; artefact conservation; and site conservation management at both a national level from Britain and Ireland, and those working at a regional and local level, particularly in the Yorkshire area. It has direct outcomes in terms of specific pieces of research that have developed directly from these new links, while the discussions themselves have had varying degrees of influence upon projects which were already in development. The present text draws upon the various contributions made by the participants to provide a brief overview of the subject, the needs and the directions for future research and management.

Involvement of Scottish, English and Irish archaeologists with varied responsibilities for conservation management of battlefields has enabled dissemination of ideas from specialists to the management work in those countries. The discussions should thus have an influence the guidance on best practice for battlefield management and investigation developed in the three countries. They were also able to feed in perceived needs in relation to the implementation of effective management action. However for each country the potentials of current legislative and grant schemes vary greatly. The majority of the analysis presented here relates to England where the greatest potentials currently appear to exist, or at least the implementation is more advanced. It is hoped that as the Inventories, Registers and related initiatives are implemented in each country then the opportunities for wider management of the resource can be explored, building upon the present assessment and the initiatives now underway in England.

2.0 The pre-Industrial Period

The potential of battlefield archaeology to advance the study of warfare in the pre-Industrial period has been clearly demonstrated in Britain over the past 15 years. This began with the first application of terrain reconstruction to the analysis to the problems of military history at Naseby (1645) and was followed by the revelations of medieval warfare from the ferrous arrowheads and other artefacts and the mass graves at Towton (1461). Subsequently there has been the first systematic archaeological battlefield-wide survey, at Edgehill (1642), the intensive survey of parts of Culloden (1746), various small scale sampling of other battlefields, and most recently the rediscovery of the lost battlefield of Bosworth (1485).[1]

Methodological development has concentrated on the re-interpretation of the primary documentary accounts of battles through the reconstruction of historic terrain, and then through systematic metal detecting survey the sampling of the distribution of artefacts deposited during the action to provide independent evidence on the location, intensity and character of the action. The latter has revealed the ephemeral and highly vulnerable nature of the battle archaeology of this period, which consists primarily of spreads of metal artefacts that have lain within the topsoil since the time of the battle. All but the most stable of metals are subject to progressive deterioration in the topsoil, but the assemblages seem highly susceptible to the impact of modern agriculture, including both increased mechanical damage and aeration from tillage, and changes in soil chemistry through the effects of agro-chemicals on chloride levels and soil pH. There is thus urgent need for objectively scientific assessment to enable predictive modelling of the likely rates of decay in different contexts, and to determine what suites of mitigation measures are likely to be both possible and effective in different situations. Without such work effective conservation management measures cannot be targeted on the areas of need and the high potential of battle archaeology to contribute to the understanding of military history will be progressively degraded across many if not most battlefields over the coming decades.

Sites are also under threat from development and other land use change. This demands effective evaluation and, where the threat cannot be mitigated, then recording action to a high standard to achieve preservation by record. To facilitate this there is the need for objective assessment of the full potential of the resource and the design of more efficient methods of investigation. In addition the very reason why battle archaeology is now recoverable, the development of the metal detector, is itself enabling the rapid erosion of the resource through treasure hunting, which degrades the all important battlefield-wide distributional patterning of the battle archaeology by the removal of artefacts. It is important to establish the degree to which meaningful patterning can survive the impacts of different levels of treasure hunting on different types and periods of battle. There is even a limited threat from contamination by artefacts accidentally lost by re-enactor where battle re-enactment or other living history events are held on an historic battlefield, for after the degrading effects in the ground some reproduction artefacts may become indistinguishable from original artefacts. It is important to determine where this may become a problem in the long

[1] Foard, (1995); Fiorato, et al., (2000); Foard, (2009); Pollard, (2009); Foard, (2010).

terms in order that such activities can be restricted or removed from nationally important battlefields.

The dramatic level of the threat from all such agencies has recently been highlighted in a report commissioned by English Heritage, and has contributed to certain battlefields being identified as at high risk in their Battlefields at Risk Register.[2] Much has already been achieved in locating the battlefields, in analysing the artefacts from them, interpreting the patterning across the sites, and even in defining the first principles for the management of the resource. However it has become clear over recent years that only through the application of a wide range of scientific techniques will the true potential of these sites be fully realised and the knowledge needed for their effective management fully developed. This can only be achieved through repeatable, statistically valid, scientific research to establish characterise and then define the parameters affecting decay, loss and contamination; then finally to use this data to determine the best way in which to mitigate the threats.

Potential and threats will vary with period of battle, according to the time that has elapsed since the action, the type and material of artefacts in use during and their potential for loss during the action, and the survivability of these materials in the topsoil. Very different strategies will thus be needed on different periods of battlefield, as for example between Towton (1461) compared to Edgehill (1642). The ground conditions when the action was fought as well as the duration, scale, character and intensity of the action will also have influenced the nature and scale of the assemblage. Thus for example work at Bosworth, and to a lesser extent at other sites such as Flodden, has suggested very low densities of artefacts even at the heart of the action in comparison to the high density of artefacts seen at Towton. There may also be very different survival and processes and rates of decay on different parts of the same battlefield depending on the density of the archaeology, its vulnerability and rarity/importance, and the nature of present and past land use. Thus at Towton the survival of ferrous arrowheads is only seen in a very restricted area of the battlefield, while at Bosworth varying degrees of surface corrosion and erosion of corrosion deposits is seen on lead munitions from different areas.

Initiatives are currently being developed across Britain and Ireland to safeguard our historic battlefields. Inventories or Registers of historic battlefields are currently being prepared in Scotland and the Republic of Ireland and initial work towards an Inventory is being undertaken in Wales; conservation and investigative measures are already being implemented in Northern Ireland, while statutory protection of aspects of battle archaeology is being promoted by English Heritage as an essential enhancement of the English Battlefields Register which was established in 1995. There is thus an urgent need for soundly based scientific evidence to enable the conservation management measures to be appropriately designed and effectively implemented. The following discussion attempts to summarise the situation, to identify the main gaps in knowledge and to define how to fill them to be able to define management strategies.

[2] Foard, (forthcoming); http://www.english-heritage.org.uk/server/show/nav.19078

Potential Mechanisms to achieve Conservation Management of battlefield archaeology in the field

Designation via the English Heritage Battlefields Register is an excellent tool within the context of the planning system, but it does not bring with it a duty upon the owner to positively manage the battlefield. Environmental Stewardship could achieve this by bringing significant agri-environment resources to bear on the problem, although it does require persuading the landowner to enter the scheme. It could achieve such management whether or not an important battlefield or part thereof is or is not covered by the Battlefield Register. Interpretation and public access has been paid for under the scheme for at least one battlefields in the north east (Halidon Hill). However at present there are no specific battlefield-related options within Stewardship although some aspects, particularly of the battlefield terrain such as specific hedgerows or walls, may be eligible under other management options.

In the single payment scheme farmers are only expected to abide by conditions and so battlefields currently receive little or not protection from this. In contrast for both the Entry Level and Higher Level schemes there are cross-compliance requirement. Entry level stewardship offers management options for historic resources and as this scheme may be expected to encompass some 70% of land so there is need to extend the coverage of the scheme to encompass battlefields. For land in the Higher Level scheme which encompasses areas of battlefields of national importance, where Registered or not, then requirements for conservation of the battlefield archaeology can be implemented, as it has recently been by Natural England in consultation with the landowner for parts of the newly discovered Bosworth battlefield. However most of the options for management have never been applied for specific battlefield heritage reasons, although incidentally battlefield resources have been partially safeguarded under other historic landscape and other environmental stewardship measures.

Practical and financial implications exist for all the key mechanisms. They include shallow cultivation, reducing the tillage to 10cm, which costs only £60 per hectare, or minimal cultivation with no inversion as implemented on part of Bosworth battlefield. In contrast the cost of arable reversion to pasture is £460 per hectare, so it would need to be very carefully applied to small but very vulnerable areas.

Taking land out of cultivation would potentially have a series of beneficial effects, depending on the nature of the battlefield or part thereof. In exceptional situations, as believed to occur at Towton, it would stop the removal by ploughing and sub-soiling, of artefacts which are currently protected from direct mechanical damage and from aeration of the soil caused by cultivation, because they lie below the current plough zone in colluvial or alluvial ‘reservoirs’ where the original battlefield surface has been subsequently buried, possibly including burial beneath open field headlands; or where features open at the time of the battle, such as ditches or open field furrows, or features cut through the battlefield subsequently which have become infilled with soil wic incorporated battle artefacts. Some battlefields and parts of battlefields will have been more susceptible to this than others, depending on the mobility of topsoil, which at Towton for example appears to be very mobile, and on the degree to which the site has been subject to cultivation.

Arable reversion would stop the mechanical damage to artefacts in the topsoil caused by ploughing and other tillage equipment. However it is possible that while shallow or minimal cultivation without inversion may be very positive for the conservation of stratified deposits and for artefacts protected by secondary stratification, the use of different tillage equipment such as power harrows may actually be more destructive for metal artefacts within the topsoil as the are likely to cause far greater mechanical damage to artefacts. At present there is no data available on these factors.

What is needed is a suite of measures to be developed within Stewardship which are directly applicable to the conservation management needs of battlefield archaeology. However achieving such changes to the farming regime through Higher Level Stewardship will be dependent upon the detailed demonstration, though scientific analysis, of the threats and of the effectiveness of the mitigation measures.

Implementation: SHINE

An important step in facilitating the extension of agri-environment measures to battlefields will be to add polygons defining important unregistered battlefields and significant but non-registered areas of registered battlefields on the Selected Heritage Inventory for Natural England (SHINE).[3] The Battlefields Register already flags up the importance of certain nationally significant battlefields or parts thereof. The SHINE project aims to create a single, nationally consistent dataset of undesignated historic environment features from across England that could benefit from management within the Environmental Stewardship scheme. The project has created a methodology that allows local authority HERs (Historic Environment Records) to contribute data directly from their local record into the national SHINE dataset. The added benefit is, irrespective of whether the farmer actually decides or is persuaded to adopt a specific management option for a specific feature, by being shown on the map that feature is automatically protected from deliberate damage or removal as part of 'cross compliance' conditions. Using SHINE the local authority can define the features and how they should ideally be managed.

A second important step would be to seek the publication by Natural England of an additional Farming Leaflet for Stewardship which dealt with the conservation management of historic battlefields.

Outcomes:

As a direct result of the present project there have been detailed discussions with English Heritage (Vince Holyoak) who have pursued the matter with Natural England, who are responsible for the implementation of heritage aspects of the agri-environment schemes. There has also been influence upon ongoing discussion in the East Midlands between English Heritage, Leicestershire County Council, Natural

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[3] http://www.myshinedata.org.uk/
Sarah Poppy (Sarah.Poppy@suffolk.gov.uk) is currently the SHINE Coordinator and can be contacted at to answer any enquiries regarding the SHINE dataset or to request a password for access to the protected areas of this web site.

England and The Battlefields Trust regarding meeting the conservation needs of the newly discovered Bosworth battlefield. Both have led to identification to Natural England of the need for a research project to establish the information base and understanding to be able to define appropriate suites of measures for the conservation of battle archaeology through the agri-environment schemes. In addition English Heritage have identified to DEFRA that unregistered battlefields (like unregistered parkland) as being in need of a review to produce a GIS layer and to identify priorities.

Location and Extent of the site

In order to ensure effective management is applied to appropriate areas it is important to assess the likely extent of the battlefield archaeology, which may extend beyond the currently defined boundary of the battlefield. This may be in the form of artefact scatters, stratified deposits such as mass graves and terrain related evidence such as the evidence of former more and carrs just beyond the Registered boundary of the Northallerton battlefield.[4] For battles involving gunpowder artillery this demands an understanding of the changes in range of the artillery over time, the types of guns in use on a battle and the likely direction of fire. This will be particularly importantly for overshot munitions which, as the Bosworth survey have shown, can be a major component of the archaeological story from the late medieval period onwards.

Scientific research to underpin management

Scientific research is required to define the threats and how they can be mitigated to ensure the long term survival of the evidence in the ground and to recognise any aspects of this or specific sites or parts thereof which may not be amenable to conservation, and thus where recording is urgently required. Indeed the evidence based policy approach to implementation of the agri-environment schemes demands such a programme of research is undertaken on battlefield issues if those schemes are to be exploited to achieve some of the conservation management objectives.
It will be important to develop predictive modelling of decay to enable the grading of sites or parts thereof for likely completeness, condition and trajectory of decay.

Artefact scatters

Objective recording

In order to compare the condition of artefacts between different sites, and to begin to assess the likely trajectory of condition of the sites, it is essential to have objective measures of condition, particularly of the surface, and of the overall form of the object. As there is no existing data except a highly subjective assessment for a handful of sites, such as the lead munitions from Edgehill, there is the need to establish baseline data against which future changes in condition can be monitored. This has application both for recording and analysis for interpretation of the battle as well as for assessment of condition. The needs and significance will vary between different types of artefacts and between different materials.

Several non-destructive techniques may be viable for the recording of form and the quantification of condition. Fr example neutron diffraction recording the variation in

[4] http://www.battlefieldstrust.com/resource-centre/medieval/battleview.asp?BattleFieldId=32

crystal structure within the material may reveal evidence of stresses, which may be relevant for the analysis of the artefacts and their condition. Another opportunity may come from the integrated laser scanner and CT imaging which is being developed at Harwell with freeware to process the data. More sophisticated scientific imaging using neutron diffraction and other techniques to achieve analysis

For internal structure of some artefacts x-ray is adequate, but for others such as lead and lead composite munitions 3D neutron tomography is required. As a direct outcome of the present project a small pilot study was undertaken by Evelyne Godfrey at Harwell on an example lead composite roundshot from Bosworth and a ferrous arrowhead from Towton. Only the former provide valuable new data. As a result a bid has now been submitted for beam time on a facility in Switzerland, in collaboration between her and Glenn Foard, for the analysis of all the 25 lead roundshot from Bosworth. The intention is to determine the full potential of this type of analysis for the study of early lead and lead composite munitions.

3D whole object scanning has been examined to record the surface form of the object 3D laser scanning to record surface to better than 1mm resolution as a method of making a detailed record of the surface form of lead munition in collaboration with Evelyne Godfrey at Harwell, to provide accurate measurement of the complete object and the distribution of macro surface forms, with sections etc. Such recording will be particularly important as a record if the object is subject to future decay, as with the Towton arrowheads. It will also make the key evidence available for future research without damage to the object or removal from display, with the data being available for wide distribution for comparative study. Pilot work on the Bosworth munitions is planned to assess the practicalities of such scanning for battlefield assemblages. Though potentially valuable for all lead and lead composite roundshot it may only be practicable and necessary for a sample of more common lead bullets of the 17th century and later. It will also be important for all artefacts in a class where that class is subject to irreversible decay, as seen with the ferrous arrowheads recovered from Towton.

Another technique, tested in collaboration with Adrian Evans at Bradford for its value in the analysis and recording of lead munitions is very high resolution 3D laser scanning. This proved of too high resolution to reveal evidence of use on lead munitions but did appear at lower resolutions to yield potentially valuable objective measures of roughness which may represent the most practical way to objectively record the condition of lead munitions but also perhaps also other artefacts.

Lead projectiles

Projectiles can be of lead, iron, stone and occasionally copper. The most common projectiles are those of lead. Lead munitions are a key class of artefacts present in increasing numbers on battlefields from at least the mid 15th century onwards, which from at least the early 17th century become the dominant component of battle assemblages. In contrast to the cast iron round shot which appear during the 16th century, which do not take a signature of use, all lead munitions take a complex signature in their shape and surface form as a result of firing. Much of this important evidence of manufacture and of use (firing & impact), which is essential to the interpretation of patterning across the battlefield, is on the surface of the bullet so surface corrosion and erosion is a major problem causing data loss. Subjective

recording on assemblages from Edgehill, Bosworth and elsewhere has shown very variable condition of surface of lead munitions and indicates significant ongoing erosion on some sites or parts of sites. Indeed such analysis suggests active and accelerating erosion of previously highly stable lead surfaces is taking place even on the best preserved of battlefields.[5] Where this is allowed to proceed too far then not only is the surface evidence of the munition lost, with it the critical evidence of manufacture, firing and impact; even the calibre itself can be irretrievable.

In many soil contexts the corrosion deposits stabilise and retain the surface detail to a greater or lesser degree. But more extreme penetration of corrosion can occur due in more chemically aggressive contexts while the protective lead carbonate and cognate corrosion deposits can also be subject to mechanical erosion. The factors influencing this, including impact of historical land use and changing modern agricultural practices needs to be quantified. The decay parameters for lead are significantly different to other metals, but there has been little work to date to define the detailed processes of decay in lead bullets on battlefields. Special factors encouraging decay may also be created by the surface modifications caused where the lead surface has been in direct proximity to the gunpowder propellant on firing. Given the importance of this class of artefacts this is a major gap in knowledge. It is important to determine the reasons and speed of loss in order to enable assessment of the likely surviving potential and vulnerability of different battlefield bullet and roundshot assemblages to decay, and to determine appropriate mitigation strategies.

The mechanisms of decay need testing. It may be practicable to run accelerated corrosion tests on experimentally fired and unfired munitions, to image them and record them on the different surfaces before and then after corrosion and then abrasion action. Also abrasion tests need to undertaken on original bullets with intact corrosion deposits to see the speed and nature of decay. Another consideration to be tested as the potential to treat corrosion deposits to reveal or recover and enhance the surface detail using consolidative reduction of the lead carbonate or oxide to pure lead. This needs to be compared with the results from removing the corrosion deposits. This should establish whether surface detail is actually concealed by or wholly contained within the corrosion deposit. Until such questions are answered it will be difficult to fully assess the current condition of assemblages of battlefield munitions. There should also be assessment of the likely loss of weight and diameter due to corrosion as this will affect the accuracy of the calibre measurement of the bullets, the most fundamental of all measurements of these projectiles. This can be seen in its least and most extreme cases by comparing the calibre graphs for small arms bullets from Edgehill and Wareham.

In terms of recording, the overall shape and the surface detail of lead munitions are highly significant and so 3D larger imaging at both whole object level and at higher resolution will be particularly valuable. It may provide a range of accurate measurements, including degrees of deformation which cannot be adequately recorded with the standard classification measurements but which may be closely related to the impact velocity and rate of deceleration.

[5] Foard, (2008); Foard, (forthcoming)

An additional special concern when handling the large quantities of lead bullets from battlefields are the health implications for specialists working early modern battlefields (see appendix 2).

Other non-ferrous artefacts

There has been no detailed analytical study yet published for non-ferrous non-projectile battlefield assemblage. This is a high priority to both determine their significance for the interpretation of the action and to determine their condition and vulnerability to decay in the soil. There is the need for more detailed consideration of the other non ferrous artefacts from battlefields. This needs to take account of the likelihood of these artefacts relating to the troops involved as opposed to non-military casual loss and manuring distribution from villages, particularly where the land was in intensive agricultural or significant communication routes passed across it. To assess the likely military losses a study is needed of the assemblages of artefacts of different types, including buckles, strap ends, buttons etc and their likely material, to be expected from different periods, types and status of troops. Also need is a study of the probabilities of these different items being lost in action during fighting and in the stripping of bodies and other clearance of the battlefield.

Arrowheads and other ferrous artefacts

Towton is the only battlefield in Britain that has so far produced large quantities of ferrous artefacts related to a battle, although various 17th and 18th century battlefields including Culloden and Cheriton have produced small numbers of significant ferrous artefacts. The recovery of battle artefacts from Towton has been over 27 year period of survey by Simon Richardson. While mainly of non-ferrous metals, in recent years this has included the recovery of over 200 ferrous arrowheads from a very restricted area in the centre of the battlefield on the northern side of the shallow eastern section of Towton Dale. Apart from arrowheads there appear to be no other significant ferrous artefacts except for several spurs with silver providing a surface protection, although a comprehensive specialist report is still awaited on the Towton finds. The processes influencing the survival of the arrowheads and the mechanisms that may be causing their destruction have been subjectively assessed. This is based on consultation with Richardson, drawing upon his subjective impressions gained during detecting, complemented by field examination and soil sampling undertaken by Janaway for comparative purposes as part of the Bosworth battlefield survey. The arrowheads appear to be suffering rapid decay in the plough soil following incorporation into the ploughsoil from a reservoir below topsoil, which seems to be a progressive process resulting from cultivation. In large part this is probably from mass graves, which have been demonstrated in the area by geophysical survey and a trial pitting. In areas of lower density scatter they may derive from a reservoir represented by shallow survival of furrows of ridge and furrow combined with colluvial burial of the battlefield surface in the bottom of Towton Dale. In all-metal detecting there is the recovery of an average of about 1 arrowhead to 75 pieced of ferrous junk in the core area of the battlefield.

Based on examination of the Towton arrowheads, ferrous artefacts from medieval battlefields do not appear to be practicable to conserve in the long term once removed from the battlefield. Once the arrowheads are out of the ground, although it may be possible to slow the decay processes there appears no strategy which can fully arrest their decay given the condition they are recovered in at Towton. Thus it appears that

full recording is an essential requirement immediately following fieldwork. In the past X-ray recording has been undertaken by Royal Armouries as a primary record. Destructive analysis by Dave Starley using transverse and longitudinal sectioning has also been undertaken. It is important to explore the potential of non-destructive methods for such analysis. In contrast to the lead composite munitions discussed above, piloting of neutron tomography at Harwell on one Towton ferrous arrowhead produced no additional value compared to 3D x-ray imaging. Medium resolution whole object 3D laser surface scanning might prove to be of some value in producing a complementary record of the artefacts prior to further expected decay.

Survival and condition

Current knowledge of the vulnerability of different types of metals to corrosion and erosion in the topsoil and in stratified deposits needs to be extended to the new problem of unstratified battlefield assemblages. It will be important to work towards and understanding of the decay processes and rates of loss in different contexts of geology, soils and use history and of fluctuating conditions caused by hydrological factors including drainage. Also to develop predictive modelling so that the degree of threat on any battlefield or part thereof can be accurately predicted and appropriate mitigation measures developed. This will also enable the establishing of baseline data for a battlefield to enable longer term monitoring of decay and of the effectiveness of particular mitigation measures.

In order to facilitate any such assessment there is the need for a methodology of objective quantification of battlefield artefact condition for each main metal type and combination thereof.

Soil chemistry

There is at present no objective data as to artefacts condition, rates of decay or the factors influencing this. It may be possible to provide a very basic initial guide to ground conditions by reference to underlying geology and soil type, where existing data on the latter is available at the 1:25,000 scale or better. Similarly it may be practicable to assess the impact of mechanical and aeration effects by an assessment of land use history including subjective information on the history of addition of agro-chemicals. To determine whether such assessments will prove meaningful there is the need for pilot work where analysis of these factors on a battlefield is compared through sampling to determine actual soil pH and chloride levels and actual artefact condition. This should determine whether any viable data can be provided without direct soil sampling, and the degree to which artefact condition actually correlates with factors such as pH and chloride levels. There is likely to be significant variation in impact between ferrous, lead and other non-ferrous artefacts, with ‘natural’ soil chemistry as well as agricultural history. Agro-chemicals applied from the mid 20th century onwards are likely to have had a major influence on artefact condition and to have placed artefact assemblage son new decay trajectories. Fertiliser addition is likely to be highly significant factor, particularly where fertilisers contain potash.

Changes in the hydrology of sites can have a major impact on the survival of battle archaeology in exceptional cases where waterlogged conditions have existed ever since the time of a battle. Such waterlogging can result in exceptional preservation of artefacts made of organic materials such as wood, cloth and leather. Drainage leads to aeration of the deposits and typically results in the initiation of irreversible decay

processes. Surviving wetland on or in close proximity to a battlefield will therefore have a high potential. Once drained a wetland area may in contrast provide even more aggressive conditions than many other contexts, due to the development of high soil pH combined with good soil aeration.

There is the need for a programme of soils analysis and land use history mapping to explore the issues in relation to sampling of the condition of artefacts from the various parts of the sites. It may be possible to use 20th century artefacts to provide controls on condition to determine where the impact is primarily a result of agro-chemicals as opposed to longer term effects. Comparison should also be made with the impact on colluvially protected artefact groups in sites like Towton compared to condition of artefacts in the plough soil there. It may be possible to trace types of crop from DEFRA records for individual sites and thus predict the likely fertiliser usage in the past. Such work may enable predictive modelling as to where good and bad preservation may be expected and thus inform the needs for action to improve conservation in situ, e.g. through conversion to pasture to remove the main cause of mechanical damage and to reduce aeration; the cessation of application of agro-chemicals; or the need for recovery of samples of threatened assemblages by fieldwork.

Mechanical damage and soil aeration through tillage

Tillage has three major types of impact on battlefield artefacts. In situations where air penetration was minimised, as in clay soils, or excluded due to waterlogging because of a permanently high water table, cultivation of formerly uncultivated land or deeper cultivation of existing arable can initiate or accelerate decay by increasing oxygen penetration to the artefacts. Secondly, where there are artefacts which have escaped mechanical damage through pastoral land use, which may in some cases such as meadow or permanent pasture have continued ever since deposition or soon after, the conversion to arable will accelerate decay through mechanical damage. Thirdly, where artefacts have been protected from the impact of cultivation, and in some cases have enjoyed conditions of reduced aeration, by being preserved beneath colluvial or alluvial deposits (discussed above for Towton) which have buried the battlefield surface, then deeper cultivation may bring these into the topsoil where they become vulnerable to more rapid decay die to increased aeration and mechanical damage.

An understanding of land use history will therefore assist in the assessment of the likely condition of battlefield archaeology. Key data sets are provided by the Tithe Awards of the 1840s, for much but not all land in England; the 1930s land use mapping for the whole of Britain; and current land use as recorded in the field in 2010. Unfortunately there is no baseline data set on land use in 1994-5 for the Registered Battlefields against which to monitor recent change but the millennium vertical aerial photography survey may provide a 10 year perspective. Where there has been conversion to arable after a long period of pastoral land use the artefacts may currently be in very good condition but may be subject to a rapidly declining trajectory of condition. Thus any study will need to assess the types in use at present and, as far as practicable regimes in recent decades.

The depth of penetration and mechanical destructiveness of cultivation technology has increased significantly over the last century or more. The nature of the threat may have developed even more in recent years as a result of the introduction of power

harrows, in which the cultivators are power-driven from the tractor rather than depending on its forward motion. The latter's possible probable effects of fragmenting artefacts have been noted through subjective observation during metal detecting survey on a small number of non-battle artefacts at Bosworth and at Towton.[6] In order to implement conservation measures on such secondary stratification demands the definition and then implementation of effective reconnaissance techniques to establish where battle archaeology has been subject to such special preservation conditions and to assess their vulnerability to current agricultural practices. High resolution LIDAR relief mapping, national 1:10.000 scale geological mapping for alluvial deposits and, where available, large scale soils mapping particularly for soils developed in waterlogged conditions.

The COSMIC report on impact of modern agricultural practices on stratified archaeology provides some information relevant to this and related problems of mechanical damage to artefacts. However it did not address the impact on metal artefacts in the topsoil and so there is the need for complementary research to establish an objective measure of the impact of machinery on metal artefacts in the topsoil on battlefields and other sites. Potential may exist for a follow-up project to COSMIC.[7] The follow-up work to COSMIC undertaken by Cranfield University looked at the effects of agriculture on certain artefact classes but it did not look at the impact of cultivation on unstratified metal artefacts or the chemical impacts of modern agriculture on them. Some initial work on chemical impacts was undertaken in the English Heritage funded project at Bradford University in ???? but again this did not address the type of artefacts or the conditions seen in battlefield contexts.[8]

Different types of tillage implement and cultivation technique (including mould board plough, shallow plough, non inversion, zero till with direct drilling) may offer opportunities for appropriate minimising of threat, but their effectiveness for metal artefacts in the topsoil may be somewhat different to their effectiveness as regards stratified archaeology. Thus there needs to be a careful assessment at the ways in which such tillage options are actually achieved because it may be that some equipment is actually more destructive, as with the power harrow. Once implemented it may be practicable on pilot sites to install transponders to check on sensitive sample locations whether impact is occurring where shallow plough or non inversion has been implemented.

Artefact processing and storage

Initial processing of metal artefacts is normally undertaken by light brushing with soft toothbrush in water to remove all the soils and make the various surface attributes available for analysis. This is particularly important for lead munitions to reveal the fine details of manufacture, firing and impact evidence. Where artefacts are of ferrous material or otherwise appear to be unstable then cleaning by light brushing while dry may be undertaken. There is the need for experimentation to test current practices to ensure that significant data is not being lost as a result of these cleaning methods and whether a different balance between the requirements of analysis and the needs of conservation should be established in some situations.

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[6] Observations re Bosworth, G Foard; re Towton, S Richardson.

[7] 'Conservation of Scheduled Monuments in Cultivation (COSMIC)', for English Heritage and Defra. Oxford Archaeology 2006

[8] ADD REFERENCE – ROB/ANDY I DO NOT HAVE A COPY OF THIS REPORT.

Long term storage of artefacts also poses major concerns. Where artefacts are in private collections, or more rarely in public collections, the storage conditions may not be ideal and the artefacts may be subject to chemical and mechanical deterioration. This is particularly apparent for lead bullet collections where they are not individually packed and where any artefacts are not held in conditions of controlled humidity. Additional problems are posed by composite artefacts composed of two or more different metals leading to bimetal corrosion. This is clearly demonstrated by the lead/iron composite roundshot seen on 15th and 16th century battlefields, though here the expansion caused by oxidisation of the iron dice also fractures and blows open the lead covering at exposed dice corners.

Protocols for finds handing and analysis have been developed here by integrating work previous work with new documents and are present in the appendices. They cover:

- analysis of lead munitions
- health and safety issues for handling of lead
- storage of metal finds

Treasure hunting and other artefacts removal

Removal of artefacts will have occurred on a very limited scale, particularly for large items such as swords, though chance discovery. Where land was in cultivation in the centuries since a battle up to the mid 19th century there may have been a limited number of the small artefacts removed by ploughmen.[9] The impact of such losses from the assemblages is likely to be minimal.

With the introduction of effective metal detectors for recreational treasure hunting in the 1970s there was been a dramatic rise in artefact removal on some battlefields. Anecdotal information indicates that the impact has been highly inconsistent both between battlefields and on different parts of the same battlefield. It appears likely that in almost all cases it is legal detecting not night hawking that represents the overwhelming mechanism of destruction. Most importantly, at present there is almost no record of where detecting has taken place, the intensity thereof, where the artefacts now are, or any record of the assemblage.

While there remains a good degree of continuity of land ownership and tenancy over the last 30 years, or with the potential that former owners and tenants may still contactable, there is a potential to establish where a significant intensity of metal detecting has occurred. It may also be possible to track down at least some of the detectorists and work with them to record the finds they have collected and to establish, to some degree where the artefacts came from. The longer this problem remains unaddressed then the more difficult it will become to determined what may have been lost from our battlefields, and then representativeness of the evidence that is recovered in future survey will not be known hence seriously reducing the potential for interpretation. The greatest significance will be where it can be established, as with almost all of Bosworth and Edgehill battlefields, that there has never been any unrecorded metal detecting. Such sites can then provide a secure

[9] Foard, (1995)

Importance of sites like Bosworth and the core of Edgehill is that they can provide baseline data on intact density and patterning. There can then be comparison with sites where there has been removal in poorly recorded and non systematic amateur survey, as at Naseby and Marston Moor, and others which have seen removal by treasure hunting where some record of removal and of the assemblages can be established by working with the detectorists. Such work, if approached through objective, statistical analysis may enable general principles to be established for the assessment of how representative surviving artefacts scatters may be on different battlefields. The impact will vary not only with the intensity of removal by detectorists, it will also vary with the character of the battle archaeology. This is particularly clear for transitional period battlefields (1450-1600) because of the low numbers of lead munitions, as seen from the intensive survey of Bosworth which has yielded just 25 lead roundshot and hand cannon bullets to date. At Pinkie treasure hunters have worked the battlefield for many years and it is possible that the pattern of lead and lead composite roundshot has been serious degraded, though this remains to be seen what is recoverable.

The level of damage to the distribution pattern by removal of a percentage of the assemblage needs to be assessed. This demands a statistical approach exploiting existing methodology from other fields. We can provide control data if we can develop an objective assessment of capabilities of existing detectors and use permanent pasture areas within battlefields to test for biased survival based on teh depths and calibre of bullet, the deeper and smaller being more difficult to locate. Then use battlefields unaffected by treasure hunting to give a baseline of survival. For this a combination of ‘lost’ sites like Bosworth and those where detectorists have always been excluded from all or specific parts of the site as at Edgehill.

Currently for arrowheads and other ferrous artefacts this is not, at least in theory, a significant problem in that treasure hunters normally work in non-ferrous mode. However ferrous artefacts are regularly recovered incidentally, through failures of the detector discrimination, and normal the detectorists will remove those items and dump them in the hedgerow. As significant ferrous items from battlefields are highly corroded and not easily identifiable so important items may well be removed and dumped.

Current guidance on recreational metal detecting is provided by English Heritage and specific guidance on battlefield survey with metal detectors by the Battlefields Trust. If control of metal detecting on Registered battlefields is to be implemented in the future through statutory controls requiring licensing, and if control of detecting is to be effectively implemented through stewardship on these and other battlefields, then it is important that clear guidance appropriate to battlefields is defined. The needs on battlefields are substantially different to many other contexts because of the nature of the archaeology and the paramount importance of pattering which requires recovery using systematic survey methods.

The potential to minimise the impact of illicit metal detecting by arable reversion, minimal or shallow tillage under Stewardship needs to be assessed. The current penetration of typical VLF (very low frequency) detector is relatively shallow, particularly for small objects. Therefore retrieval of the artefacts in the upper levels of the topsoil by systematic survey and the halting of cultivation which redistributes

artefacts through the topsoil column, bringing finds up from lower levels, may make it possible to protect a percentage of the artefact assemblages. So if detecting, official or illegal, removes the artefacts from the upper part of the soil column, if there is no redistribution by cultivation so the artefacts lower in the soils column will remain far less vulnerable to recovery, at least with currently practicable detecting equipment likely to be used by night-hawks and other treasure hunters

An assessment of the efficacy of this approach needs testing, including testing of metal detector capabilities. This must extend to the potential impact of the introduction of high specification detectors with much deeper penetration, especially the new generation of PI (pulse induction) detectors which have a vastly increased penetration but currently typically only work in all metal mode. Such research will also be highly significant in determining the effectiveness of battlefield survey in recovering a representative sample of battlefield assemblages, and in determining the percentage sample of the total population that this represents. Such data is essential in defining best practice guidance for battlefield survey. It will be important to have such objective data periodically updated as detector technology improves, so changing both the archaeological potential and treasure hunting threat potential. This raises the final element of metal detecting survey – the failure at present of most archaeological contractors to implement current best practice in battlefield survey, which in large part is due to the lack of fully developed and consistent guidance from the battlefield archaeology specialists. In part this is a result of the lack of objective data on survey efficiency. The other element is the inconsistency of survey strategy applied on the same battlefield by different contractors, as most clearly seen on Pinkie battlefield. What is ideally needed for each battlefield is a battlefield-wide research strategy which defines the appropriate framework for all work on that site, a framework that should then be reviewed before any new survey action and reconsidered when the results of that are available. Such a document would also encompass the needs of conservation management through Stewardship and any licensing measures as well as controls implemented through the planning process.

Mass graves and other stratified battlefield archaeology

Osteology is a well developed field or research, especially with regard to the 20th century. There is a high potential for study of mass graves to yield valuable information on military action and warfare in general, through study of pattern of trauma on bodies from graves in different parts of a battlefield, or from different battlefields of the same period, and through the study of major differences in the patterns of trauma and other attributes on battlefields of different periods. The potential may have been complicated by the fact that in some cases bodies were transferred decades later from the battlefield mass graves to consecrated ground, so in assessing the potential of mass graves on a particular battlefield this needs to be taken into account. However the most consistent influence on condition will have been damage or destruction of mass graves through cultivation, not least because many mass graves appear to have been shallow, and this represents a continuing threat as demonstrated by appearance of fragmentary human remains on the surface.[10]

For the effective implementation of conservation management of mass graves on battlefields it is essential to effective techniques to locate the sites. To date only a

[10] pers.com. Simon Richardson.

handful of mass graves have been identified and past attempts at prospecting for mass graves has not been effective. Even at Towton initial geophysical survey failed to find the mass graves in the centre of the battlefield. They were only finally revealed after chance discovery of human remains during metal detecting. The exact location was then intensively surveyed with geophysics and indistinct features potential features identified which were then confirmed by small scale test pitting.

What is required is a programme of scientific research to establish the most effective suite of geophysical and related techniques in different situations. In order to effectively target any such prospecting will require analysis of the relationship of the documented action with the reconstructed terrain, complemented by survey of the battle archaeology, seeking to establish whether and if so how the battle archaeology can enable targeting of the geophysical prospecting. A pilot research programme to test several known and suspected mass graves with a battery of different techniques, to establish their efficacy, has been defined in collaboration with Peter Masters of Cranfield University for an MSc student dissertation, to be implemented in 2010 under the supervision of Peter Masters and Glenn Foard. This will include testing of magnetometry, ground penetrating radar, soil chemistry (phosphaste analysis) and related techniques on several known and possible mass graves of the 15th and 17th centuries on English battlefields. It may also prove possible to test the sniffer dog method on the same grave sites, to test the potential which has been suggested by informal experimentation reported in a paper to the Bradford Symposium by Neville Sharp., provide Suitable sits for such investigation are sites for testing are Naseby, Edgehill and East Stoke. The latter provides an earthwork mass grave in pasture, which is currently scheduled as it lies with the rear of closes of a medieval village. This range of sites would enable the methods of mass grave identification to be trialled in the full range of land use contexts and histories of destruction to establish vulnerability, degrees of ongoing damage and potential for effective management.

Conservation measures

Mass graves, as they are intentionally man made features can be subject to statutory protection through scheduling. Once scheduled then it would be theoretically possible for English Heritage to remove class consent for cultivation, although this would demand a new initiative on battlefields be instigated. Towton represents the best example in England where demonstrated mass graves are suffering demonstrable ongoing erosion. The case should be developed there as a model for future management elsewhere in England. This might be complemented by the implementation of arable reversion through Higher level Stewardship to enable payments fro arable reversion.

3.0 The Modern period

This section is currently in preparation by Rob Janaway.

4.0 Appendices

Appendix 1: Guidance on the processing and storage of metal artefacts from early modern battlefields

Appendix 2: Health and Safety guidance for working with lead munitions

Appendix 3: Guidance on the recording of late medieval and early modern lead munitions

Appendix 5: Management issues in Wales

This note has been provided by Jonathan Berry, CADW as he was unable to speak at the Symposium.

Mr Brian Malaws at the Royal Commission on the Ancient and Historical Monuments of Wales (RCAHMW) recently completed a project to identify all known and alleged battlefield sites in Wales in order to provide information for depiction on Ordnance Survey printed and digital mapping products. These battlefield sites were largely identified from secondary historical sources. Approximately 170 battlefield sites were identified, but only a much smaller subset of sites could be located with a high degree of accuracy and were subsequently proposed to the Ordnance Survey for map depiction.

Against this background, Cadw began considering the establishment of a Battlefields Register for Wales. In December 2007, the Ancient Monuments Advisory Board (AMAB) for Wales agreed that Cadw should commence work on the consideration of sites that might be included on a Register of Historic Battlefields in Wales. A Battlefields Steering Group was established, drawing its membership from Cadw and the RCAHMW. Work to date has produced a draft definition of ‘battles’ and ‘battlefields’ in a Welsh context, together with the creation of draft criteria for inclusion on the proposed register and a methodology. It is likely that our current thinking on definitions of 'battle' and 'battlefield' will differ somewhat from the definitions adopted by EH and HS.
The Welsh Assembly Government's Minister for Heritage, Alun Ffred Jones AM announced recently that Cadw will undertake a consultation on the establishment of a Register of Battlefields in Wales in spring 2010 as part of his Strategic Statement on

the Welsh Historic Environment. We are currently engaged in preparatory evaluation work before undertaking the public consultation. The preparatory evaluation work comprises of the commissioning of primary historical documentary research on fourteen battlefield sites that will be used as a pilot group of candidate sites to test the draft battlefield definition and registration selection criteria. The work will also identify a list of primary documentary sources (English, Latin and Welsh languages) to inform the detailed assessment of the future candidate sites. Border Archaeology was commissioned to undertake the historical documentary research and draft battlefield reports have been received for the following battlefield sites:
Mynydd Carn (1081)
Crug Mawr (1136)
Maes Gwenllian (1136)
Coleshill (1157)
Painscastle (1198)
Pilleth (1402)
Campston Hill (1404)
Craig-y-dorth (1404)
Grosmont (1405)
Pwll Melyn (1405)
Twthill (1461)
St Fagans (1648)
Carregwastad Point (1797)
Newport Rising (1839)

It is anticipated that colleagues from the RCAHMW will undertake archaeological survey work on a small number of these sites in due course. The RCAHMW will utilise archaeological and historical research to test the proposed criteria and methodology against two or three candidate sites from different periods. The combined results of the historical research and archaeological field survey should enable Cadw and RCAHMW to start defining the location, extent and boundaries of battlefield sites with much more precision. If the methodology is successful, it is our intention to extend this activity to other candidate sites in due course.
The results of the study will be considered by a battlefield advisory panel (yet to be appointed), which will make recommendations to Cadw concerning which, if any, sites should be included on the Register. The final phase of work will focus on the establishment of the Register by Cadw, if appropriate.

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