Iron Age and Roman copper alloys from northern Britain.

Dungworth, David Barry

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David Barry Dungworth

Thesis submitted for the
Degree of Doctor of Philosophy
University of Durham
Department of Archaeology

1995

ABSTRACT

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David Barry Dungworth

This thesis presents the chemical analysis of over 1500 Iron Age and Roman copper alloys. Patterns evident from these analyses have enabled the nature of alloys to be reliably characterised. Iron Age alloys are almost exclusively of one type only - a tin bronze which often contains a small amount of arsenic (up to 1%). This alloy is quite distinctive when compared to the range of alloys used in the Roman period (brass, bronze and gunmetal, all with varying amounts of lead). The contrast between Iron Age and Roman alloys allows a reconsideration of many 'Celtic' items. It is now clear that the majority of 'Celtic' metalwork which survives dates to the end of the Iron Age or the Roman period (despite the traditional equation of the Iron Age with 'Celtic' material).

The most successful means of representing the range of Roman alloys used has been the three dimensional plot. This examines the relationship between two elements (in this case zinc and tin) and shows the relative frequency of the different alloy types. This 3-D plot also illustrates some general features of Roman alloying and possible recycling. There are a number of peaks in the distribution of zinc and tin contents that represent specific alloy types which were commonly produced. The largest peak relates to the commonest alloy: bronze. The second peak relates to brass and the third to copper. All the remaining analyses fall into a diffuse area between the bronze and the brass peaks, and these are referred to by the modern term gunmetal.

It is clear that copper alloys were recycled and that some care was taken over the ways in which this occurred. The lack of low zinc brasses shows that this alloy was rarely recycled on its own. If brass was recycled then it was always mixed with some bronze. The proportions of bronze and brass that were mixed varied widely as there is no distinct peak within the distribution of the zinc and tin contents of gunmetals.

The thesis uses this overall view of Roman copper metallurgy (and that derived from previous work) to examine changes in alloy production and use. The results (interpreted in the light of metallurgical theory and practice, and of wider archaeological theory and data) challenge many of the traditional accounts of chronological and cultural change, and of the deposition processes operating in the Roman period.

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Abbreviations

AAS	Atomic Absorption Spectroscopy
BMC	British Museum Coin Catalogue
cps	Counts Per Second
EDXRF	Energy Dispersive X-ray Fluorescence
EMPA	Electron Micro-Probe Analyser
nd	not detected (see Appendices 1 and 5)
ND	Not Determined (see Appendices 1 and 5)
OES	Optical Emission Spectroscopy
RIC	Roman Imperial Coinage
XRF	X-ray Fluorescence

Declaration:

No part of this work has been submitted as part of a degree by myself at this or any other University.

Appendix 2 was written in conjunction with Peter Craig, Department of Mathematics, University of Durham.

Acknowledgements

The analysis of a large number of copper alloy artefacts for this thesis would not have been possible without the co-operation and encouragement of large numbers of museum and excavation unit staff.

I am especially grateful to the following museum staff: Ian Stead and Ralph Jackson (British Museum), Fraser Hunter (National Museum of Scotland), Colin Richardson (Tullie House Museum, Carlisle) Elizabeth Hartley (Yorkshire Museum), Georgina Plowright (Corbridge, Chesters & Housesteads Roman Museums), John Prag (Manchester University Museum), Jon Pickin (Bowes Museum), Lindsay Allason-Jones (Newcastle University Museum), Wakefield Museum (Pam Judkins), Robin Birley (Vindolanda Trust), Mrs Palmer (Rotunda Museum, Scarborough), Brian Sitch and Andrew Foxon (Hull Museum), Jim Nunney (Leeds City Museum), Kevin Leahy (Scunthorpe Museum), (Kendal Museum), Richard Wellander (Edinburgh Castle), Sally Coleman (Harris Museum, Preston).

Information and finds were also provided by the following 'unit' staff: Tim Padley, Mike McCarthy and Ian Caruana (Carlisle Archaeology Unit), Ken Steedman (Humberside Archaeology Unit), Christine Howard-Davies (Lancashire Archaeological Unit), Hilary Cool and Christine McDonnell (York Archaeological Trust), Jan Summerfield and Peter Wilson (Central Excavation Unit), Robin Daniels (Cleveland Archaeology Unit).

Information (especially dating of contexts) was also provided by the following excavators: Jeffrey May, Steve Willis, Andrew Fitzpatrick, Quita Mould, John Dent, John Sills, Elizabeth Macadam, John Nolan, Peter Hill, Peter Wilson, Quita Mould, Bill Hanson, Brian Hartley, Rod Mackey, David Heslop.

Some samples were obtained from private collections and I am very grateful for the co-operation of John Casey, Tom Lord, Clifford Watts, and Philip Maw.

I would like to thank Paul Craddock, Justine Bayley, Chris Caple, Ian Barnes, and Morvan Leese for allowing me to consult their theses and other unpublished material.

Peter Craig has suffered my statistical enquiries with considerable grace and has helped to write Appendix 2.

In addition to my supervisors (Martin Millett, Colin Haselgrove, Justine Bayley, Chris Caple), a large number of people encouraged me and discussed various aspects of the research. Conversations with Richard Brickstock, Phil Clogg, Matt Ponting, and Steve Willis have been particularly helpful.

Special thanks to M.

CHAPTER 1
INTRODUCTION

This thesis is an archaeometallurgical study of Iron Age and Roman copper alloys from northern Britain. The core of the thesis consists of a discussion of over 1500 quantitative analytical results obtained through Energy Dispersive X-ray Fluorescence (EDXRF). The data have been assembled using a scientific technique, and some of the interpretation has been framed within a scientific understanding of the nature of the materials being transformed by ancient smiths. Nevertheless the thesis also aims to address wider archaeological issues through archaeometallurgy. This chapter outlines the issues to be discussed in each of the later chapters in turn, but first it is necessary to briefly introduce the theoretical approach used.

The core of this thesis is a large body of empirical data and many chapters concentrate simply on descriptions of these data. To move beyond the data to explanation, however, requires a theoretical framework. Archaeological science is in the unenviable position of having to address theoretical problems in scientific and social scientific epistemology. A detailed discussion of all relevant problems is beyond the scope of this thesis. Nevertheless my personal preferences (and theoretical stances are ultimately personal choices) do influence the tone of the thesis and the direction that the research took.

A recurring theme throughout this thesis is an attempt to reconcile analytical data with existing archaeological explanatory frameworks, in particular archaeometallurgy may be seen as a means of arbitrating between competing archaeological theories. Such an approach, however, assumes an epistemologically privileged position for scientific methods. In practice, the interpretation of scientific data depends on existing knowledge (often non-scientific). As a result many contentious issues cannot be simply resolved using the analytical data produced for this thesis. Such ambiguity may be unsettling but is the necessary consequence (some would say strength) of a post-structuralist epistemology (Hodder 1986; Shanks & Tilley 1987). Throughout this thesis I have tended to assume that any given phenomenon may have a number of different causes. The *proof* of any particular cause does not rule out others.

The analysis of archaeological copper alloys has a long history. A discussion of this history is found in Chapter 2. Most attention has focused on the origins and early developments in copper metallurgy. While some research has examined the metallurgy of later periods, most of this research has been based on fairly limited data sets (e.g.

just one site or one artefact type). The restricted nature of this information has limited the extent to which general conclusions could be drawn. It has been difficult to gauge the extent to which such data were representative of ancient metallurgy. This thesis, however, attempts to be as representative as possible through the collection of samples from a wide range of objects and sites. A discussion of the benefits and problems of this strategy are discussed in Chapter 2. The analytical results used in this thesis were obtained using EDXRF which is *described in Chapter 2 and Appendix 1.*

The interpretation of archaeometallurgical data can only be carried out in the light of the wider archaeological issues. In turn archaeometallurgy can only be seen as relevant to archaeology as a whole if it attempts to address wider archaeological issues. Chapter 3 discusses the archaeological background in Iron Age and Roman northern Britain. Issues of particular importance include the origins of the Iron Age, the 'Arras culture', the transformations which occur in late Iron Age society, the nature of the Roman conquest and occupation in the North, and deposition and the archaeological record.

Traditional archaeological chronologies based on historical sources and typological dating (especially the Three Age system) emphasise the separateness of different time periods (Bronze Age, Iron Age, Roman period) and imply that the change from one to the other was swift. Archaeological research has increasingly shown that many of these chronological changes were gradual and occurred at different times in different places. In particular it is now recognised that there are strong links between different periods of the Three Age system. In this thesis some attention is focused on the transitional periods at the beginning and end of the Iron Age.

The 'Arras culture' provides by far the largest quantities of Iron Age metalwork in northern Britain but the representativeness of this material is questioned as it derives entirely from burials. There are settlements in East Yorkshire which are contemporary with 'Arras culture' burials but there is little to mark these out as different from the rest of the Iron Age in Britain.

Any interpretations of changes in metallurgy which occur with the Roman conquest have to consider the extent to which such changes have their origins in the pre-Roman Iron Age. Since the publication of the *Romanization of Britain* (Haverfield 1912) cultural changes in Roman Britain have tended to be seen in terms of changes caused by Rome. All too often the conquered populations have been seen as passive and unquestioning. Recently some discussions have begun to admit that cultural changes at this time may be more complex. Chapter 3 closes with a discussion of depositional practices and the formation of the archaeological record. Traditionally the archaeological record has been seen as debris or rubbish that was unconsciously discarded or lost. Hill's reappraisal of the Iron Age (1994) suggests that much of the archaeological record was deliberately constructed, and that this construction was deeply influenced by the society's ideological structures.

The social organisation of production has long been of interest to archaeologists and ancient historians. The interpretation of the analytical data is influenced by the range of possible modes of production. A discussion of the various models of production which have been suggested is found in Chapter 4. Unfortunately, such models are rarely formulated in such a way that could be proved or disproved by analytical data.

The analytical results are discussed in the remaining chapters of the thesis. The Iron Age results are dealt with in Chapter 5. This includes a discussion of results from the earliest Iron Age (or latest Bronze Age), from the Iron Age proper, and from the late Iron Age. One section also considers those 'Celtic' objects (mostly stray finds) which can be only assigned a very broad date. This chapter identifies the typical tin bronze of the Iron Age which can be distinguished from Roman bronze due to the presence of arsenic in the Iron Age alloys. This distinction is of considerable importance in attempting to date many of the stray 'Celtic' finds.

The Roman results are dealt with as a whole in Chapter 6. This chapter examines the use of the three main alloying elements - zinc, tin and lead. The relationships between these three elements are also considered. The use of zinc-tin plots illustrates the inverse relationship between these two elements, while 3-D plots of zinc-tin content show the peaks in alloy distribution. Bronze and brass were the two principal alloys used in the Roman period, while the mixed, gunmetals were formed by mixing these two alloys.

Most previous examinations of Roman copper metallurgy have emphasised the links between alloy composition and typology. Chapter 7 contains a discussion of the results in terms of typology: In some cases there is a strong correspondence between the typological categories and the types of alloys used. Many of the samples analysed for this thesis, however, have not been subjected to typological analysis and so this sort of comparison is not always possible. Many of the samples are simply fragments of sheet, wire, or shapeless droplets and may never be classified in this way.

The production of a large number of analytical results requires a methodology which explicitly acknowledges the size of the data base. The use of 'metal systems' has been advocated by Caple (1986) and is discussed in Chapter 8. This approach examines the effects of recycling and attempts to examine general changes in alloy use. The 'metal systems' model, however, assumes that remelting has little or no effect on the composition of the metal which is remelted. A discussion of thermodynamics and remelting experiments in Chapter 8 suggests that alloy composition will be altered during recycling. In particular, recycled brasses will tend to lose some zinc.

The loss of zinc by molten brasses is of some importance in considering chronological variations in Roman alloys. Caley (1964) suggested that the 'zinc decline' seen in Roman brass coins indicates that brass production ceased in the later first century AD. The 'zinc decline' is reconsidered in Chapter 9 in the light of the large number of analyses of brass coins available from existing publications (especially Etienne & Rachet 1984). This chapter also examines the chronological changes in alloy use seen in the samples from northern Britain. A decline in the proportion of brass can be seen (although it never disappears), but the 'reality' of this decline is uncertain. The samples of different dates are not selected from the same sorts of sites. This lack of commensurability between the samples of different centuries highlights the problems inherent in this kind of chronological investigation.

Such problems of representativeness and incommensurability are also examined in Chapter 10 which investigates cultural variations in the use of alloys. By investigating the range of alloys used on different sorts of sites it is possible to relate alloy use to wider archaeological issues such as Romanisation and structured deposition. As brass first saw wide spread use in Europe during the reign of Augustus and appears in Britain at the beginning of the first century AD, it had been hoped that the incidence of brass would act as an 'index of Romanisation'. Most sites, however, have similar levels of brass. The one class of site which shows very high levels of brass is farmsteads - the least Romanised of all the settlement types. The high incidence of brass in this indigenous context is also seen in late Iron Age and 'Celtic' metalwork. This suggests that the indigenous population of northern Britain were not simply passive receptors of those items of material culture that Rome saw fit to bestow upon them. A range of other sites and metalwork do show very low levels of brass. These sites (burials, caves, hoards) may be united by a ritual function. It is possible that a proportion of the archaeological record has been formed through the careful selection of material for deposition, rather than unconscious discard and loss (Hill 1994).

The final chapter summarises the results of this thesis and highlights some of the problems encountered in attempting to explain the results. The discussion also includes suggestions for future research in the light of these findings.

The results obtained for this thesis are presented following a number of conventions. All of the analytical results are presented in a series of Appendices. The discussion of the results in individual chapters is often accompanied by a range of charts which summarise data. Individual analytical results are referred to in the text by their laboratory reference numbers (XRFID). All of the results are presented in XRFID number order in Appendix 5. For cross-referencing the XRFID numbers are also listed in Appendix 3 for each site examined, and in appendix 4 for each object type analysed.

CHAPTER 2
METHODOLOGY

Introduction

This chapter will outline the aims and objectives of this thesis, and the methodology used to achieve these. The aims and methods are influenced by a consideration of previous archaeometallurgical work on Iron Age and Roman copper alloys. Previous work has usually concentrated on single sites (e.g. Rabeisen & Menu [1985] on Alesia), or a single artefact type (e.g. Riederer [1974b] on needles) and interpretations based on these are of limited application. The present research project, however, has aimed to collect data from a range of different sites, for a range of different artefact types, and for the whole period being considered. In particular it was hoped that copper alloy analysis would shed light on cultural change during the Roman period (Romanisation). The chapter includes an outline of the analytical method used (further details are in Appendices 1 and 2), and ends with a discussion of the ways in which analytical data can be examined (statistically and graphically).

Previous Analytical Examination of Iron Age and Roman Copper alloys

Archaeologists are frequently interested in origins and this is reflected in the archaeometallurgical emphasis on the early Bronze Age. Nevertheless there has been sufficient previous work on later prehistoric and Roman copper alloys to warrant a discussion of this work and an examination of the approaches used. This has helped in the formulation of the aims, methods and methodology of this thesis.

Iron Age alloys

The analysis of Iron Age alloys is largely a recent phenomenon compared to the analysis of alloys of the Bronze Age. When Tylecote published *Metallurgy in Archaeology* (1962) there were only 20 or so analyses of Iron Age material available. Analyses of Bronze Age copper alloys already ran to a thousand or more (e.g. Otto & Witter [1952]) and were to be greatly expanded by the SAM programme (Junghans *et al.* 1960; 1968; 1974). This interest in the Bronze Age (rather than later periods) in part reflects a recurring interest in origins in general. This imbalance in analysis has been partially redressed in recent years, however, and several hundred analyses of Iron Age material have now been published. Most of the research in this field has been carried out by Peter

Northover (e.g. 1984a; 1987; 1991a; 1991b) who has analysed recently excavated material from a number of sites in southern England (e.g. Danebury, Hengistbury, Head, Maiden Castle) using an Electron Micro-Probe Analyser (EMPA). A range of Iron Age material in the British Museum has been analysed (using Atomic Absorption Spectroscopy [AAS]) by Paul Craddock (1986). Other analyses have been carried out by Barnes (using EMPA) on the important collection of metalwork from Hunsbury, Northants. (Barnes 1985), and by Cowell (1990) who analysed some of the objects from the Camerton collection using EDXRF.

So far Iron Age material for analysis has not been systematically collected. Craddock's analyses were of those items which were available in museums, while Northover's were those which arose from excavations where the recovery of metalworking information was not a major factor in the overall research design. I am not aware of any quantitative analysis of comparable material from the continent, with which British results could be compared. There has been relatively little synthesis of the British analytical data available but it is clear that Iron Age alloys were almost always bronzes, with little or no zinc or lead. Northover (1982b) has stressed the potential usefulness of trace elements in determining the ore sources used in the manufacture of copper alloys, while Craddock (1986) has suggested caution should be exercised.

Most ancient copper alloy artefacts contain varying levels of impurities (e.g. iron, nickel, silver, arsenic) which were not deliberately added to the metal. These are often referred to as trace elements. The major source of trace elements is probably the ore from which the metal was smelted. Ore sources are rarely pure, and often contain high levels of other metals. In some cases the metals are present as combined minerals (e.g. chalcopyrite $CuFeS_2$) and trace elements can also be present as replacement elements within these minerals (e.g. $CuAsS_2$). Those trace elements which are less volatile and less easily oxidised than copper will be carried through the smelting process into the reduced metal (gold, silver, nickel, etc). Other elements which are more easily oxidised and more volatile than copper may be carried through the smelting process depending on the smelting conditions. A great deal of the archaeometallurgical research of the last hundred years or so has attempted to relate the composition of metal artefacts to particular ore sources (Otto & Witter 1952; Junghans *et al.* 1960; 1968; 1974). This would have considerable impact on archaeological theories on ancient technology, trade and exchange if it could be achieved.

This approach has been criticised, however, for the simplistic approach it takes. It assumes that any particular ore source is chemically homogenous within itself but chemically distinct from other ore sources, and that smelting and recycling have limited impact on the chemical composition of the metal. A critique of this approach was first put forward by Tylecote (1970; Tylecote *et al.* 1977) and later followed by other researchers (e.g. Craddock [1986], Caple [1986]). There are a number of factors (the nature of the ore sources and the smelting procedures) which will complicate the simple transmission of impurities from ore to metal. Ore sources are not homogeneous - the chemical composition of the ore varies with depth and with horizontal distance at the surface (Thompson 1958: 4). Repeat smelting of ore from the same source (using exactly the same smelting technique) could therefore give rise to metal with varying impurity patterns. The transmission of trace elements from the ore to the metal also depends on the smelting procedure. An ore which is pre-roasted before smelting (e.g. chalcopyrite) would tend to lose many trace elements even before the smelting took place. Variations in the smelting conditions can give rise to considerable variations in the transmission of trace elements into the finished metal (Merkel 1991). The crucial smelting conditions are temperature, oxygen content of the atmosphere in the furnace, and fluxes. The smelting conditions can be altered by simple factors such as the type of fuel, the size of the furnace, and the types of clay used. The types of flux and furnace lining could also be responsible for *introducing* some trace elements into the metal (e.g. iron and manganese). The differing levels of purification carried out and the recycling of scrap metal from different ore sources would also tend to blur any local impurity patterns. Attempts to provenance artefacts through trace element analysis continue to be hampered by an incomplete knowledge of ore geology and the range of smelting procedures that were used (Slater 1985). Even if the necessary knowledge was available any particular trace element pattern could have a number of different causes. A recent review of the use of trace elements in the study of Bronze Age alloys (Budd *et al.* 1992) concludes that such an approach is problematic.

Roman copper alloys

The earliest analyses of any Roman copper alloys were carried out on coins (e.g. Klaproth 1799; von Bibra 1869). These showed that the *aes* coinage of the Principate was made of copper and brass. Caley (1964), and later Riederer (1974a), analysed a series of brass coins to examine changes in metal composition over time. Caley noticed a gradual decline in the zinc content of these coins (those of the early third century had almost no zinc). Caley explained this 'zinc decline' by suggesting that the Romans lost the ability to make brass sometime in the first century AD (Caley 1964: 83). Thereafter brass could only be produced by remelting old scrap metal. The extreme volatility of zinc resulted in the loss of a proportion of the zinc at each remelting stage. The number of Roman brass coins analysed was greatly increased by Etienne & Rachet (1984). Both early and late coins are, however, less well represented in the corpus of available analyses.

Smythe who carried out the earliest analysis of a range of Roman copper alloy objects (using wet chemistry) analysed a selection of objects from excavations on Roman sites near Hadrian's Wall (Smythe 1938). This work showed that a range of alloys was used (copper, brass, bronze, and gunmetal) and that the alloy composition was often well-suited to the method of manufacture (i.e. whether the objects were wrought or cast). The objects do not, however, seem to have been selected because they were in any way a representative selection of the objects excavated, but because their destructive analysis was acceptable, to excavators and curators. In addition, some of the objects may not be Roman (in two cases zinc levels are excessively high for this period). After Smythe, most analytical work examined a limited range of artefact types or just those from a single site.

The examination of a wide range of Mediterranean and Roman copper alloys from the British Museum was the subject of Craddock's PhD thesis (1975, see also forthcoming for a discussion of Roman alloys). This examined the changes in alloy types used in the Mediterranean world from the Bronze Age through to the Roman period. Many of Craddock's Roman period samples were taken from material found in Britain but little of this material is closely provenanced and it could rarely be closely dated. The objects analysed included a high proportion of rare artefact types (e.g. musical instruments and lamps). Craddock's survey has shown (like Smythe's work) that Roman alloy composition was often related to the method of manufacture (e.g. statuary was usually made with the addition of lead to improve the casting properties of the bronze). By plotting zinc content against tin content, Craddock showed that these two alloy elements were inversely correlated. It was suggested that intermediate alloys (gunmetals) were made by mixing brass with bronze (Craddock 1975: 221). Craddock demonstrated that brass had a fairly limited usage in the first century AD (e.g. military fittings and coins) and suggested that the administration may have maintained a monopoly over its production during the early Principate (following Grant [1946] and Caley [1964]). Craddock noted, however, that zinc was found in a greater range of artefact types in the later Empire. He suggested that Caley's 'zinc decline' was more apparent than real, that high zinc alloys may have become rarer, but that the total amount of zinc in circulation did not decrease over time.

Caple (using EDXRF) analysed a selection of copper alloy objects from a number of Roman sites in Britain (Richborough, Catsgore and Chester), and deduced that the composition of many small everyday objects was not closely controlled (Caple 1986; forthcoming). There were no clear links between alloys used and their provenance, chronology or typology. This may, however, simply reflect the limited number of analyses (less than 100) and the non-systematic selection of objects. As before, the selection of artefacts for analysis was influenced by the acceptability of their destruction. Caple (1986; forthcoming) also proposed that large numbers of analyses would enable the description of 'metal using systems'. This approach stressed that recycling was a way of understanding metal use rather than a hindrance. Models for the use and re-use of metals were developed, and gross changes in alloy use over time were explained by arguing that different alloys or elements were added to the general stock of metal. This approach is explored further in Chapter 8.

An extensive programme of analyses aimed to examine the alloys used in the production of Iron Age and Roman brooches in Britain (using EDXRF for semi-quantitative analysis of corroded surfaces, and AAS for quantitative analysis of sampled artefacts) has been carried out by Bayley (1992). Brooches were chosen because typologies and a dating framework were already in existence. Some of the brooches analysed have been shown to have distinct compositions. One of the most instructive examples is the Colchester series: A and B can be distinguished typologically as A were made in one piece whereas the spring and pin of B were made separately from the bow. This typological distinction is matched by compositional differences: group A are brasses, whereas group B are leaded bronze (Bayley 1985a). Many other brooches, however, did not seem to be made to such strict recipes. This may reflect actual ancient production (i.e. there was no need to make the brooches to a set recipe) or may reflect archaeological constraints (e.g. the small sample size for some types of brooches, or the problems involved in the typological definitions of some brooches. This is examined in greater depth in Chapter 7. Brooches were, however, the only type of object quantitatively analysed, and most brooches were made in the early Empire. The late Empire is therefore less well represented in Bayley's work. In addition, the selection of objects was not systematic: objects analysed were those which came to the Ancient Monuments Laboratory (usually) as a result of rescue excavations (mostly in southern England).

A limited number of analyses of continental material have been carried out. Riederer has published (Riederer 1974b; Riederer & Briese 1974; Laurenze & Riederer 1980) analyses of material recovered towards the end of the last century from the River Tiber (unfortunately there is no reference to a published account of the recovery of this material). The actual analyses were not carried out by Riederer and the analytical method(s) are not discussed. Riederer's results were largely considered within typological frameworks (e.g. handles, needles). The results show that while a range of alloys (copper, brass, bronze, gunmetal, all with varying levels of lead) were used to manufacture some objects, the alloy composition was usually matched to the method of manufacture. There is no close dating of any of these finds (coins from the river Tiber are dated to the full range of the Empire).

Picon and his colleagues concentrated on statuary from Roman Gaul (Picon *et al.* 1966; 1967; 1968; Condamin & Boucher 1973) and demonstrated that most statues were made of leaded bronze. Some alloys contain zinc, and in these the tin content tends to decrease as zinc increases. Some correlation was noted between the metal composition and the provenance of the statue (provenance was often just to a museum). A similar study of Gaulish statuary has also been carried out by Beck *et al.* (1985). Despite the large number of analyses, few of the artefacts have any close provenance, as most statues were acquired by museums in the last century. Dating of the statues is restricted to stylistic methods. A more comprehensive programme of analysis was carried out by Rabeisen & Menu (1985). This included the analysis of a range of metalwork (not just statuary) from the Roman town at Alesia.

The analysis by den Boesterd & Hoekstra (1965) of a large number of the vessels in Nijmegen museum (using Optical Emission Spectroscopy [OES]) showed most of these were composed of leaded bronze. Most of these vessels were imports from Italy or southern France. Lindberg (1973) increased the number of analyses of the later, local vessels which were often made from brass.

All of the analyses of Roman copper alloys discussed above have concentrated on the deliberate alloy elements (zinc, tin and lead) rather than the trace elements (see above). The trace elements in Roman alloys are generally lower than those found in prehistoric metalwork. The low levels of these trace elements makes correlations with sources much more difficult. In addition it is often assumed that trade and exchange, and recycling of old metal would have been so much more common in the Roman period (than in prehistory) and so would have destroyed any local impurity patterns. This may have been one of the reasons why the analysis of Roman material was not popular in the early and middle parts of the 20th century.

The measurement of zinc, tin and lead, however, shows that deliberate alloying techniques changed over time. In part the alloy elements are influenced by technical constraints (e.g. lead added to cast objects) but these are also likely to be influenced strongly by social and economic factors and it is the study of alloy elements that is pursued here.

Present methodology

Aims

This research project was designed to use the analysis of copper alloys to answer wider (non-technological) questions about metal use and society in general. In particular, the selection of a limited area (northern Britain) but a long period of time (from the beginning of the Iron Age to the end of the Roman period) allowed the recognition of changes in metal use over time to be recorded. This period sees considerable social and economic changes during the Roman occupation (Millett 1990). The analysis of copper alloys from this period could act as an illustration of Romanisation. In particular, the first widespread use of brass is associated with the Roman Empire (coins and military equipment). The incidence of brass could act as an 'index of Romanisation' (cf Millett's [1980] study of the distribution of fine wares in Sussex). The whole issue of Romanisation is of some importance to this research and so is dealt with in greater detail in Chapter 3. The total quantity of Iron Age and Roman copper alloy artefacts from northern Britain is very high (10,000+) and so it was necessary to select a sample which could represent that total.

Objectives

A detailed examination of Iron Age and Roman copper alloys must be based on the systematic collection of a large number of samples from the full chronological, typological and cultural range available. This can only be achieved if it concentrates on a limited area for study. The area chosen for study was northern Britain (here defined as the region from the Trent-Mersey to the Forth-Clyde). This area was chosen as it provides a wide range of settlement types. In particular, the apparent lack of Romanisation in much of the landscape of northern Britain (in contrast to the forts and few towns) implies that the degree of social change in the Roman period varied. Less substantial evidence of social and economic change might be observable, however, in more portable items of material culture - such as items made from copper alloys. For these reasons the analysis will concentrate on major alloying elements (zinc, tin and lead) rather than trace elements.

For the results of this archaeometallurgical research to have the widest possible relevance to archaeology as a whole it is essential that the samples reflect the range of available material. To this end, samples were initially selected to be representative of the archaeological record rather than restrict analysis to a limited range of artefact types or a single site. The selection of sites was initially based on a survey of published excavations.

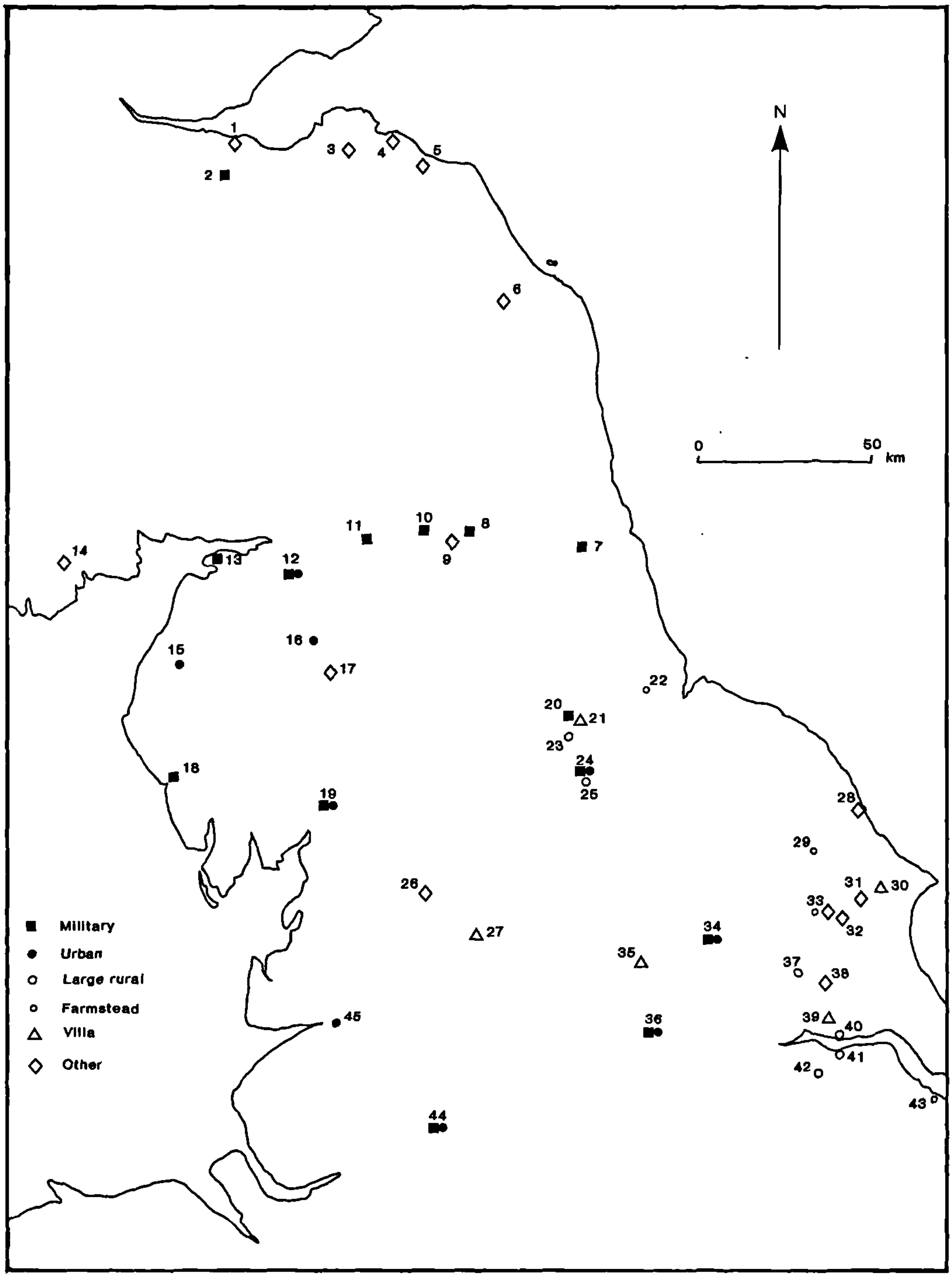

Figure 2:1. Sketch map of northern Britain showing the principal sites examined.

(**1** Edinburgh Castle; **2** Elginhaugh; **3** Traprain Law; **4** Broxmouth; **5** Blackburn Mill; **6** Dod Law; **7** Newcastle; **8** High Brunton; **9** Coventina's Well; **10** Sewing Shields; **11** Vindolanda; **12** Carlisle; **13** Biglands; **14** Carlingwark Loch; **15** Papcastle; **16** Old Penrith; **17** Brougham; **18** Ravenglass; **19** Watercrook; **20** Piercebridge; **21** Holme House; **22** Thorpe Thewles; **23** Stanwick; **24** Catterick; **25** Bainesse Farm; **26** Settle Caves; **27** Gargrave; **28** Scarborough; **29** Staple Howe; **30** Rudston; **31** Danes Graves; **32** Wetwang/Garton Slack; **33** Kirkburn; **34** York; **35** Dalton Parlour; **36** Castleford; **37** Shiptonthorpe; **38** Arras; **39** Welton Wold; **40** Redcliff; **41** Old Wintringham; **42** Dragonby; **43** Weelsby Avenue; **44** Manchester; **45** Walton-le-Dale).

This quickly showed that some sites were well represented in the archaeological record (e.g. forts) while others were less well known (e.g. farmsteads). The reasons for this are connected to the history of archaeological research and are discussed below. If the selection of sites was to be representative of the known archaeological record then I would be left with large numbers of forts and few other sites. In order to overcome this, and allow inter-site comparisons it was essential that some site categories received more attention than others.

All the results are listed in the Appendices. The analytical data are given in laboratory reference number (XRFID) order in Appendix 5. The XRFID numbers are also listed in Appendix 3 for each site examined (accompanied by description, National Grid Reference, and bibliography). The XRFID numbers are also listed in Appendix 4 for each object type examined (accompanied by bibliographical references). Figure 2:1 shows the location of the main sites which were investigated (for NGR reference of the stray finds see Appendix 3).

The sites have been chosen to cover all possible areas in northern Britain. The chronological range of the finds analysed is shown in figure 2:2. The dating of artefacts is

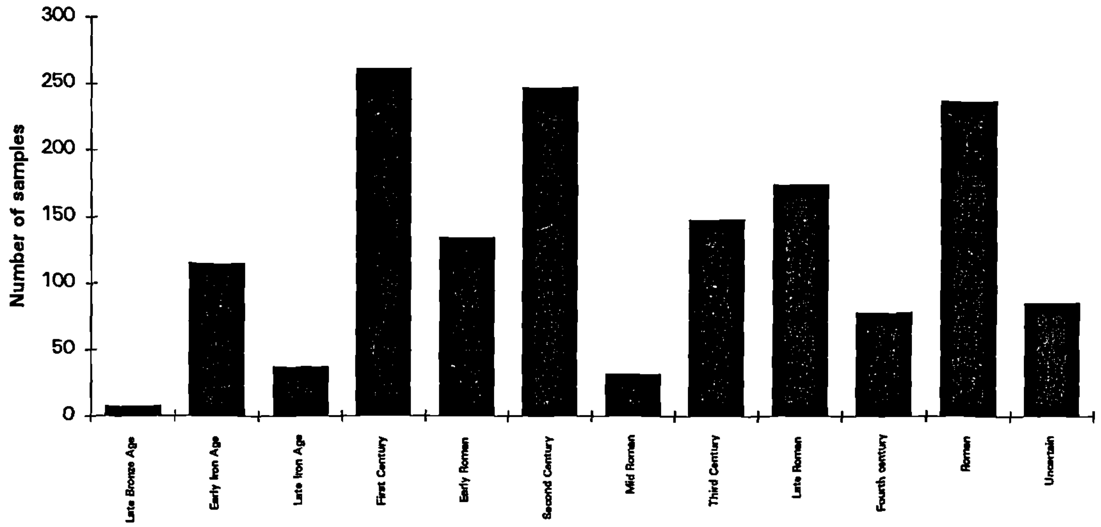

Figure 2:2. Date of all samples analysed.

not without its problems. For this research project context dating has been used as a starting point for the dating of samples. Contexts for the Roman period are usually dated by associated pottery, however, a proportion of the finds in each context are residual. In addition, the dating of pottery itself rests on associations with other artefacts. At times this method of dating runs the risk of employing circular logic. For the Iron Age dating is less precise and is often based on broad cultural similarities. Where the commonly agreed typological dating of an artefact disagreed with the context date (due to residuality) the earlier typological date was used.

In some cases the contextual or typological dating could be very precise (to a decade) and in others rather more vague ('Late Roman'). For the Roman period, samples were usually assigned to centuries (with the first century covering only the latter part of the century, after the Roman conquest). In many cases objects or contexts could only be assigned to less precise dates. Early Roman was used to cover the first and second centuries, Mid Roman to cover the second and third centuries, and Late Roman to cover the third and fourth centuries.

For the pre-Roman period context dating is more difficult. For this research project the period has been divided into three (this is discussed at greater length in Chapter 5). The first period (which may overlap with the late Bronze Age) covers the earliest possible Iron Age as seen at Staple Howe, and Castle Hill, Scarborough. The second period covers the Iron Age before any evidence of Roman presence or the presence of any Roman (or Gallo-Roman) imports. The largest contribution to this second group is made by 'Arras culture' burials. The late Iron Age covers the end of the Iron Age when there is increasing evidence of direct and indirect contact with the Roman Empire. This period also includes finds from indigenous sites from the latest Iron Age where the phase of occupation often continues into the period of Roman occupation (e.g. Thorpe Thewles and Dragonby). The final category of putative Iron Age material considered is 'Celtic' metalwork. Stylistically, many of these objects have their origins in the Iron Age, but most are stray finds and so cannot be closely dated. At least some are found on Roman military sites and production may have continued into the Roman period.

While every effort has been made to make the selection of samples as representative of the archaeological record as possible this aim has had to be abandoned where the available archaeological record can be seen to be 'biased'. The Iron Age in Britain covers at least as long a period of time as the Roman but there is far less material available for study. This could reflect differences in population and the availability and use of metal, or it could reflect differences in deposition practices and modern archaeological strategies. If sampling were carried out as a strict proportion of the available material then early Roman copper alloys would dominate this research while earlier and later periods (the Iron Age and the late Empire) would be under-represented. It was therefore necessary to concentrate on some periods in order to acquire samples of sufficient size to make chronological and cultural comparisons reliable. Further discussions of dating take place in Chapters 5 (Iron Age) and 9 (Roman).

The sites were classified into different categories (such as military, villa, farmstead). These are categories which are widely used in accounts of Roman Britain (Frere 1987; Salway 1981). These are often formed into settlement hierarchies with forts and towns at the top and farmsteads at the bottom. These assumed settlement hierarchies are used as a framework for the interpretation of copper alloy differences (see Chapter 11). Sites were initially selected from those known from published excavation reports. Those sites which had been recently published were particularly favoured as it was often possible to determine context dating for the artefacts selected. Unpublished but recently excavated sites provided a valuable source of material where contextual information was readily available.

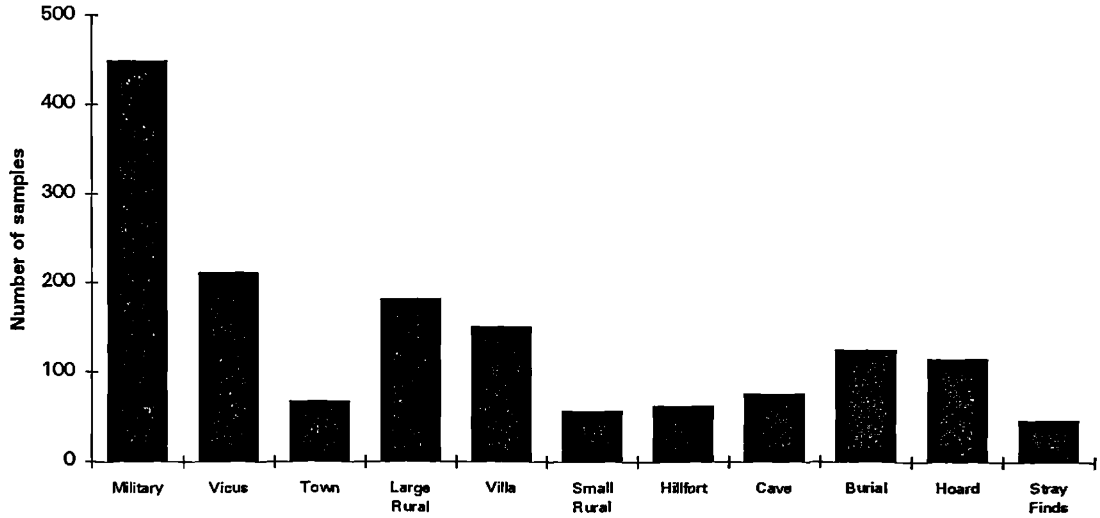

Figure 2:3. Types of sites from which samples were taken.

The range of types of sites from which samples were taken is shown in figure 2:3. The large number of finds from military sites reflects previous research into the Roman period in northern Britain which has traditionally concentrated on the military aspects of the occupation. This interest probably has its origins in the traditional narrative account of the Roman conquest derived from Roman texts. Excavations of forts were seen as important as they could answer questions about the date of the occupation of any particular fort. Forts were regarded as being relatively easy to excavate as they were regularly planned and excavation has continued to be popular as forts are relatively rich in small finds (including copper alloy ones). Occupation histories at different sites were then tied in to a narrative history derived from classical sources such as Tacitus (e.g. Dudley & Webster 1965; Frere 1987). Urban sites are less well represented in northern Britain than in southern Britain, and these northern sites have seen relatively little exploration. Small indigenous rural sites are fairly common in northern Britain and in upland areas they are often well preserved (Jobey 1982a), excavations, however, have rarely produced many small finds. This has not made these sites attractive propositions for further excavation and made the sites difficult to date. As this research project aims to examine Romanisation through copper alloys it was important to obtain as many samples from these rural sites as possible. It was necessary to include samples from rural sites that did not have any context dating, whereas sampling from military sites could be more rigorous. A list of all the site codes is given under site category headings at the end of Appendix 3.

Not all sites which were examined could be classified easily using the categories of site used in figure 2:3. Settlement size and form do not always conform to a 'type', and many categories tend to merge into each other. Welton Wold, North Humberside, for example, is too large to be a farmstead but too small to be a 'larger rural settlement' (such as Shiptonthorpe). For the purposes of this analysis Welton Wold was classified as a villa (Frere 1977: 383), even though the 'Romanised', rectangular building is small, short-lived and never dominates the settlement layout (Rod Mackey personal communication). The nearby site of Old Wintringham (Stead 1976) was interpreted by the excavator as a fort, even though no defences were found, and no military equipment recovered. This site has been classified as a large indigenous rural site (cf Dragonby, Shiptonthorpe, etc) for this thesis. When dealing with forts and their *vici* it is never easy to be sure where the fort stops and the *vicus* begins (and in some ways this may be a false dichotomy - the changes in late Roman barrack blocks in forts suggests that civilians may have moved into the forts [Daniels 1980]). Despite these problems of definition of individual sites this approach does seem to offer an improvement over that used previously where context has not generally been considered.

The total number of sites examined for this thesis form a small proportion (approximately 10%) of those excavated and an even smaller proportion of those known (from fieldwork, etc). There are, however, considerable differences in the 'coverage' of different sorts of sites. The number of forts examined is relatively small, and the selection of samples from those forts selected is also small (20% or less). The number of *vici* covered is small compared to the total number known but is higher compared to those known from recent excavations (approx 50%). There are only 4 possible towns known in northern Roman Britain and two of these are included. Aldborough and Corbridge were not examined because there are no recent excavations and the status of the latter site is uncertain. The category Large Nucleated Rural Sites covers all sites between towns and *vici* on one hand, and villas and farmsteads on the other. Nucleated Rural sites and villas are relatively well-known in southern Britain but are rare in the north. The 'coverage' of such sites for this thesis is therefore very high (probably in excess of 50%). Small Rural sites (farmsteads) which display little sign of Romanisation and hillforts are very common in northern Britain. The farmsteads and hillforts examined represent a very small proportion of those known (probably less than 1%). Such sites have not received as much attention as forts and towns, and so almost all excavated sites have been included. There are relatively few caves from northern Britain known to occupied in the Roman period. The examination of the Settle caves represents nearly all of the available evidence from caves. Cemeteries should be associated with every major Roman settlement but only two are known from recent excavation - Brougham and Trentholme Drive, York. Trentholme Drive was not included as the number of copper alloy artefacts recovered was very small. The hoards examined for this thesis represent a large proportion (approx 50%) of those known from northern Britain.

In order to ensure that a representative range of artefact types from each site was analysed the typology of objects was taken into consideration (XRFID numbers and details for each object type are given in Appendix 4). Sampling could not take place on the basis of each typologically unique artefact category as the number of different types (where typologies have been constructed) was too great, and in some cases there exists no established typology for classifying some Roman material. The construction of typologies has not been seen as a priority in Roman studies as they are often used by prehistorians for 'cultural' analysis, and the Roman period in Britain is frequently regarded as being a historical period. Those objects which have been the subject of typological analysis are usually those which it is hoped may serve as dating evidence (e.g. brooches). For the

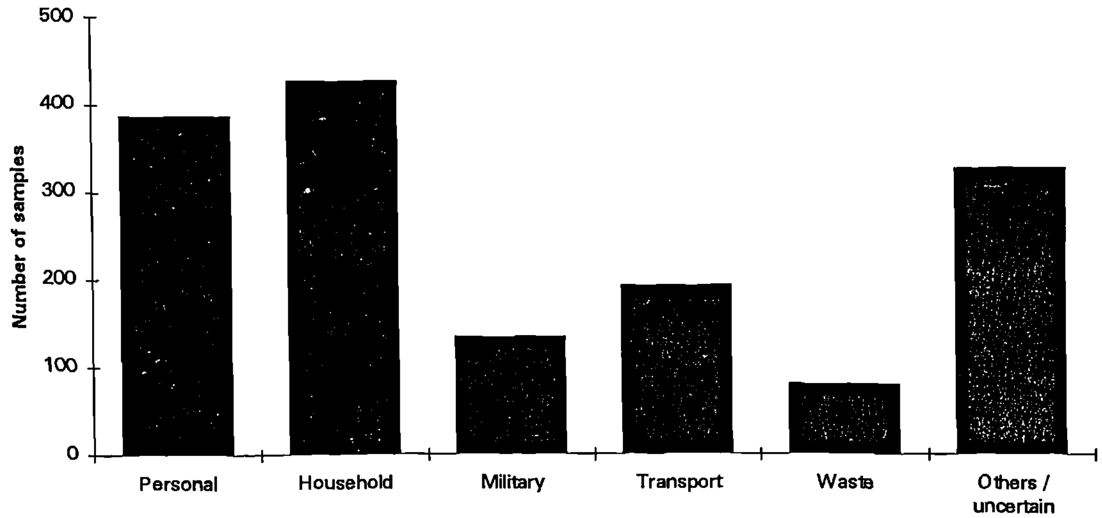

Figure 2:4. Categories of objects sampled.

collection of samples an *interim* classification of artefacts was used which assigned objects to broad categories on the basis of their perceived function (see figure 2:4). This approach has seen increasing use in the publication of small finds reports (e.g. Crummy 1983; Mould 1991). Thus, artefacts made from a variety of different materials (copper alloy, bone, jet, etc) are grouped together, e.g. all pins are dealt with in the same section by the same specialist. This approach provided a framework for the selection of samples from individual sites (especially as the number of recorded copper alloy artefacts from some sites exceeded 1000). All of the finds from a site to be examined were divided into the functional categories and (initially) a 20% sample selected from each category. This 20% sample was not used where the number of finds from a site were very large (e.g. the extensive excavation of Roman fort, town, etc, where a smaller sample was selected) or very small (e.g. farmsteads which often yielded a single artefact). The functional categories were not intended to be used rigidly (i.e. all samples evenly distributed across the six categories) but their did ensure that certain artefact types and categories did not dominate the analysed data base.

There are problems, however, in assigning objects to functional categories when the exact function of many items is unknown. There are few contemporary written accounts which describe the use of the sorts of artefacts that are dealt with here. Function is usually deduced by comparison with modern practice. In some cases, however, there are no modern parallels and function can only be guessed at. The function of some artefacts is often ambiguous, e.g. Button-and-loop fasteners have been interpreted as items of personal dress and as horse harness fittings. A large proportion of finds (such as fragments of sheet and wire) could not be assigned to any functional category. The above classification was used in the early stages of the collection of samples; however, it is a rather crude and arbitrary method of classification and proved of little further use because of the ambiguities mentioned.

While every effort was made to collect samples which illustrated all aspects of the archaeological record there remain some biases. These biases are caused by a number of different factors (such as excavation strategies, deposition environment, ancient deposition practices, ancient metal use practices). There are concentrations of sites around Dunbar, the Tees valley, and in East Yorkshire, while other areas have fewer known sites (see figure 2:1). Some artefact types are common while others are rare. It is not easy to determine which of these biases are representative of original metal use and which have arisen through depositional and post-depositional factors. Some of these biases are discussed in later chapters.

Analytical Method

The previous studies of copper alloys have used a variety of analytical methods (AAS, OES, wet chemistry, EDXRF, EMPA, etc). EDXRF was the analytical method available for this project. This method has seen relatively little use for quantitative analysis, but it is well-suited for the routine determination of alloy composition. This makes EDXRF most suitable for this research as it is the alloy composition (rather than trace element content) that is seen as most significant. Sample preparation and analysis are relatively straight-forward when compared to some other methods. Little scientific knowledge or training are required to use most EDXRF facilities and the method can be used for the routine determination of elemental composition of a range of different materials. Full details of the EDXRF method used can be found in Appendix 1. A summary of some aspects of the EDXRF method are presented here.

X-ray fluorescence has been used as a method of determining the elemental composition of archaeological materials for some decades (see Hall [1960] for early application in archaeology). A beam of X-rays is directed onto the sample to be analysed. Some of these X-rays displace electrons in the sample. The resulting redistribution of electrons in the atoms in the sample leads to the emission of new X-rays. As the electrons in any given element can only have discrete energies, the new X-rays emitted can only have discrete energies. Thus, copper always emits X-rays at 8.04 KeV. The presence of a range of different elements in a sample produces a spectrum of X-rays with different energies. The position of the peaks in this spectrum (i.e. their energies) relate to the elements present in the sample. Thus, it is possible to note the presence of most elements from a single analysis. The height of any given peak (or for more accuracy the area under the peak) is proportional to the amount of the element present in the sample. By matching the height of the peak to those derived from the analysis of known standards it is possible to determine the proportion of that element present in the sample.

EDXRF analyses the outer 0.1mm or so of a copper alloy and so the analysis of a corroded surface can be misleading. This problem can only be overcome by obtaining a sample of uncorroded metal. Two methods were used to prepare samples: mounting specimens in resin, and drilling.

The first method involved the removal of a fragment (*c*.10mm^2) of the artefact. The corrosion products were removed by Air Abrasion and the remaining uncorroded metal was mounted in epoxide resin.

The second method obtained a sample of drillings (usually 5mg) from the core of the artefact using a 1mm diameter drill (the outer, corroded drillings were rejected).

The choice of method varied depending on the nature of the material to be sampled and the wishes of the curators. Drilling has seen widest use in previous work and does only minimal damage to artefacts. The collection of polished specimens does slightly more damage but this is the only way that wire and sheet can be sampled. This method preserves samples for metallographic examination if this is required.

The analysis of the prepared specimens does not involve their destruction, and the collected specimens are kept in the Conservation Laboratory, Department of Archaeology, University of Durham for reference (except those from the British Museum and the National Museums of Scotland which were returned to the respective museums).

The EDXRF facility used was a Link Analytical XR200. The settings were as follows (see Link Analytical nd, for further details),

Voltage =	20KeV	Current =	250μA
Source =	Rhodium	Collimator	2mm
Live time =	100 secs	No Filter	

Each spectrum was deconvoluted by the computer and software provided. The output consisted of Counts Per Second (cps) data for a selected peak for each of the elements under consideration. The number of elements that could be sought in this way was limited to 20 by the software. The presence of other elements could be visually checked by looking for peaks during spectra collection. The cps data for the sought elements was converted into percentage data by calibration against 20 copper alloy standards of known composition (details are given in Appendix 1). The calibration was limited to those elements which were represented in standards.

Elements which could be calibrated:

Copper	Zinc	Lead
Tin	Iron	Nickel
Manganese	Arsenic	Antimony

The range of elements present in the standards was suitable for the type of analysis carried out here. Most attention was fixed on the changing patterns in deliberate alloy use and so the elements of most interest are, copper, zinc, tin and lead. The detection and determination of other elements would help to ensure that the results were accurate (as the results were normalised to 100%) but are rarely of much interest in themselves. One exception is arsenic which proved to be of considerable interest when examining the composition of Iron Age alloys (especially in relation to Roman ones). Cobalt has also been identified by Peter Northover (1987) as a significant impurity in Iron Age alloys but this element was not present in any of the standards available. To remedy this Peter Northover and Brian Gilmour provided samples from an inter-laboratory comparison. These samples did contain cobalt and were used to produce a calibration curve for the Iron Age samples. These samples were only made available in the latter part of 1993 and so cobalt calibrations were mostly retrospective and were not carried out on Roman samples.

Approximately two thirds of the way through the analysis of all the samples suspicions arose about the accuracy of the antimony data. Tests against samples used for inter-laboratory comparisons (kindly provided by Peter Northover and Brian Gilmour) confirmed these suspicions. The problem arose through changes made (unknown to me) to the peak striping programme for silver, tin and antimony. These three elements produce spectrum peaks which overlap. Changes in the striping and de-convolution of one will influence the others. As a result the antimony determinations are not reliable. An initial analysis of the data (made while data collection was still underway) revealed that antimony was not important in terms of the social and economic comparisons being made. For this reason no attempt was made to re-start the analysis or change the calibration of antimony and this data has not been included in Appendix 5.

Appendix 5 contains a list of all the samples in sample number order. For each sample the ten elements (Cu, Zn, Pb, Sn, Fe, Ni, Mn, As, and Co) are listed plus some archaeological information (provenance, date, type, and published reference). Appendix 3 contains a list of all the sample numbers grouped under site/provenance headings. Appendix 4 contains a list of all the sample numbers grouped under typological headings.

In later chapters reference is made to the relationship between alloy composition and the worked state of artefacts ('cast' or 'wrought'). There was insufficient time available to carry out detailed metallographic examinations of all of the mounted specimens and so the two categories are used on the basis of the overall appearance of individual artefacts. Those which have been fabricated through the bending and working of the metal in order to achieve its overall shape are classified as 'wrought'. Those which have been cast and have received no further working (except light decoration) are classified as 'cast'. In some cases a visual inspection of the finished artefact could not determine whether it had been cast or wrought.

The calculation of errors associated with the calibration of analytical data is a problem which has rarely attracted much attention in archaeological science. Appendix 2 contains a discussion of some of the problems encountered in attempting to calculate errors. This work was carried out with the help of Peter Craig (Lecturer in Mathematics, University of Durham). The error factors (at 95% probability) depend on the element being calibrated and the level of that element present. For the alloying elements (zinc, tin and lead) the error factor is usually of the order of ±1%.

Methods for Presenting and Describing Results

A variety of different methods have been used to summarise the results of copper alloy analysis. Early analysis was by wet chemistry and the number of results obtained was small. The presentation of results at this stage was purely descriptive and all results were usually given in a single table.

As physical methods of analysis became available the number of analyses increased dramatically. The Stuttgart programme (Junghans *et al.* 1960; 1968; 1974) produced many thousands of analyses of prehistoric copper alloys. This great mass of data was partitioned into a series of groups based on the levels of trace elements present. It was assumed that trace element patterns were related to the ore source used. The statistical methods used to partition the results (and the general conclusions based on these) have been criticised by Butler & van der Waals (1964) and Leese (1981: 82).

While the overall approach of the Stuttgart programme continues (e.g. Northover [1982b]), statistical examinations of data are rare. Leese (1981) reviewed the use of a variety of statistical methods in examining analytical data. She argued that 'hypothesis testing' methods (such as discriminant analysis) where data was partitioned along archaeological criteria were preferable to 'pattern searching' methods (such as cluster analysis). The latter methods may appear to offer an objective examination of data but cluster analysis is dependent on a number of theoretical considerations (e.g. variables are not correlated, clusters are spherical, the number of clusters has to be pre-determined, there really are clusters there) and it should be used cautiously (Baxter 1994). Principal Components Analysis is suitable for the examination of correlations between large numbers of variables (e.g. Van der Veen 1992), but is poorly suited to the examination of a small number of variables which are poorly correlated, and so it is not used here. In general, Leese's (1981) advice that data should be divided into groups using archaeological criteria (typology, provenance, chronology) is followed in this thesis. This approach can be used here because of the large number of analyses carried out and the availability of corresponding archaeological information.

Craddock (1975) split the analytical data into chronological groups to examine alloy composition changes over time. For the Roman period (where there were many more results, and less opportunity for chronological divisions) the results were partitioned using typological criteria (Craddock 1975; forthcoming). Thus, statues could be compared with statuettes and shown to be made of different alloys. Differences were clear at the level of simple histograms and so statistical tests of difference were not used. The series of

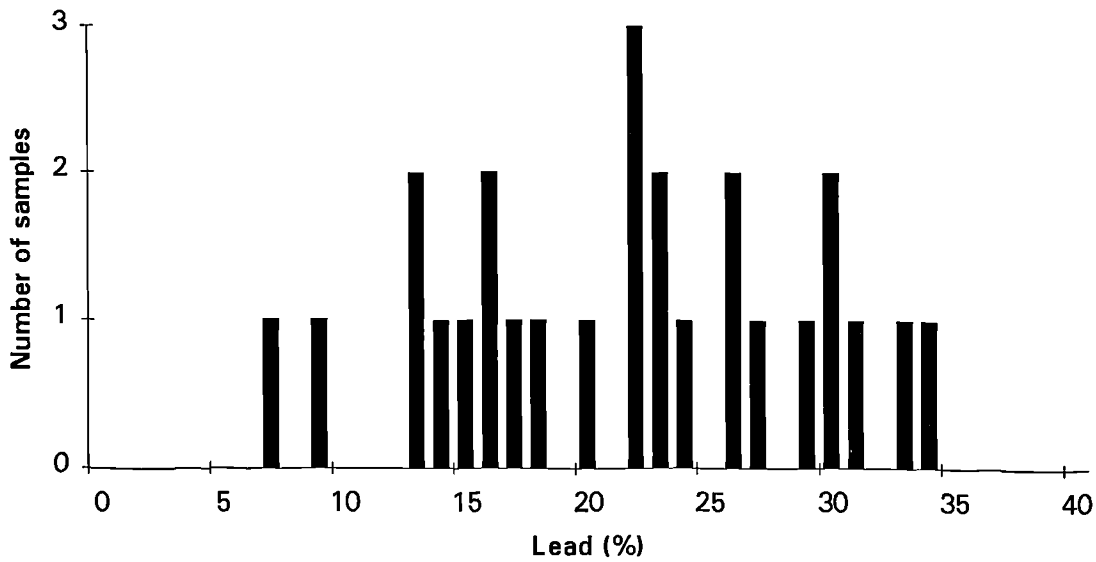

Figure 2:5. Histogram showing the lead composition of Roman statues (Craddock 1975: 159, fig 2)

analyses of Gallo-Roman statuary examined the geographical variations in the alloys used (Picon et al. [1966; 1967; 1968], Condamin & Boucher [1973]). In both of these cases differences were illustrated through the use of histograms showing the distribution of an single element. Figure 2:5 shows the distribution of lead contents for Roman statues analysed by Craddock (1975: 159, figure 2). A similar approach was used by Beck *et al.*

(1985) but the horizontal axis was logarithmically scaled to highlight variation at very low levels (<1%).

This method is most useful where the distribution of data is limited, e.g. where the data are normally distributed about a mean. In this case the calculation of the average

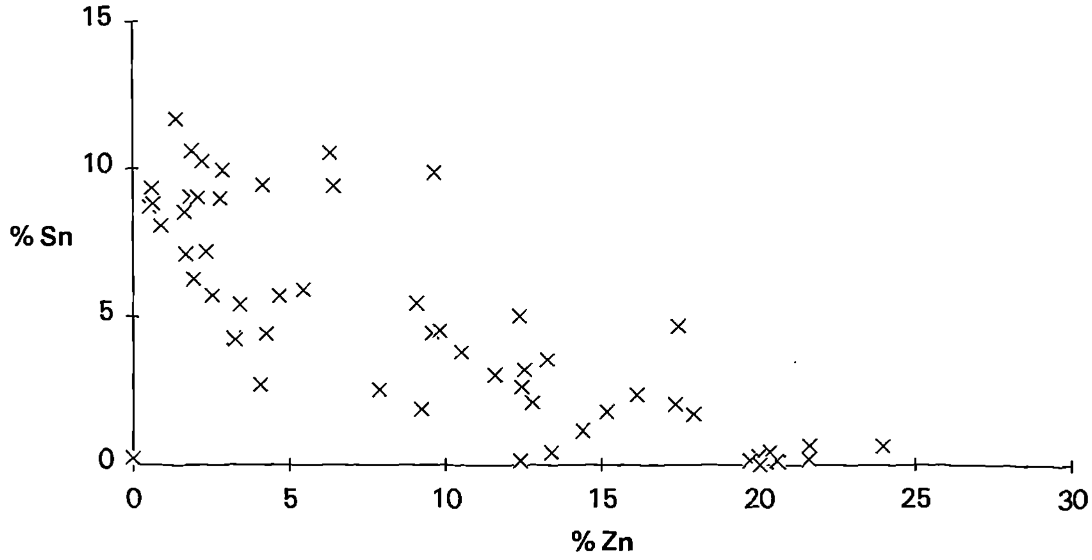

Figure 2:6. Scatter plot showing the correlation between zinc and tin in Roman alloys (Craddock 1975: 222, figure 5)

value(s) of groups can also be useful. Where the data is more widely spread mean figures can be misleading (the same mean value can be obtained from two substantially different distributions). Histograms can also be useful in comparing two groups where there is no overlap. This method is less useful illustrating examples where elements are correlated and/or groups overlap.

Craddock (1975: 222, figure 5) noticed that tin and zinc contents in Roman alloys were negatively correlated and illustrated this with a scatter plot (see figure 2:6). Scatter plots have also been used by Caple (1986; forthcoming) to illustrate differences in the alloy composition of medieval pins. Scatter plots are more useful than histograms in showing the potential relationships (and possibly any clustering) between two elements, but scatter plots do not give a very good indication of the relative frequency of a certain composition. Where large numbers of analyses are shown on a single diagram the symbols tend to blot each other out. This can be solved in part by the use of 3-D surface charts (see below). Scatter plots are also of restricted use as they can only show the relationship between two elements. The relationship between tin and zinc can be usefully illustrated through the use of a 2-D scatter plot but the possible relationships of zinc and tin, with lead cannot be seen. This can be overcome (at a cost) through the use of ternary diagrams.

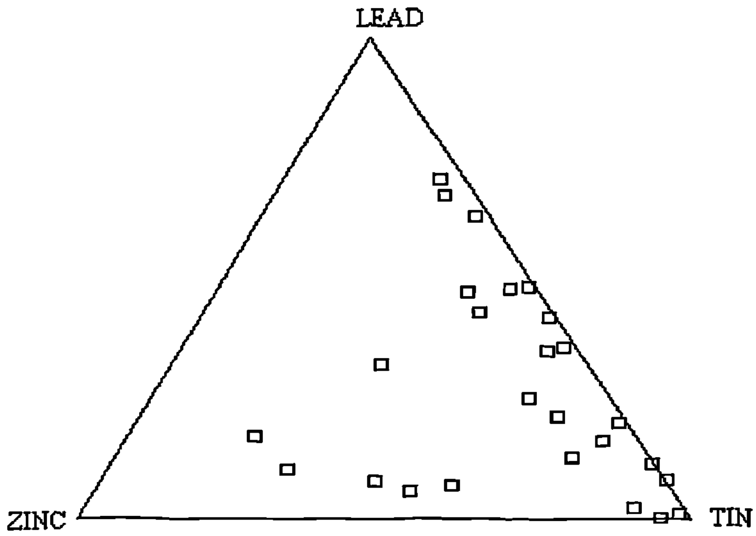

Figure 2:7. Ternary diagram showing the composition of Dolphin brooches (Bayley 1992: fig 10.19)

Bayley (1992) has presented results of brooch analyses through the use of ternary diagrams. These consist of a triangle where each side represents a single element, in this case zinc, tin and lead (see figure 2:7). Each element is re-calculated so that zinc, tin and lead add up to 100%. The bottom left corner is occupied by brasses and the bottom right corner by bronzes. Symbols nearer the top corner contain more lead. This method is the only way of illustrating all three alloy elements at once. This is achieved, however, by transforming the data (scaling so that all alloy elements add up to 100%). An alloy consisting of 95% copper and just 5% zinc would be represented by the same point on the diagram as an alloy with 75% copper and 25% zinc.

As mentioned earlier, the use of 2-D scatter plots is of limited use when large numbers of analyses are being presented. Each extra symbol plotted tends to blot out the one underneath and areas with high numbers of results appear similar to those with fewer results. This can be overcome by the use of 3-D surface plots (see figure 2:8) where the vertical axis shows the abundance of any particular alloy type. This shows that there are clusters in the distribution of alloys containing zinc and tin. One peak occurs around *c.* 9% tin (zinc approaching zero) which is the bronze. Another peak occurs around *c.* 18% zinc (tin approaching zero) which is brass. A small peak around 3% tin relates to samples of sheet metal and wire made of impure copper. The remaining results form a continuum

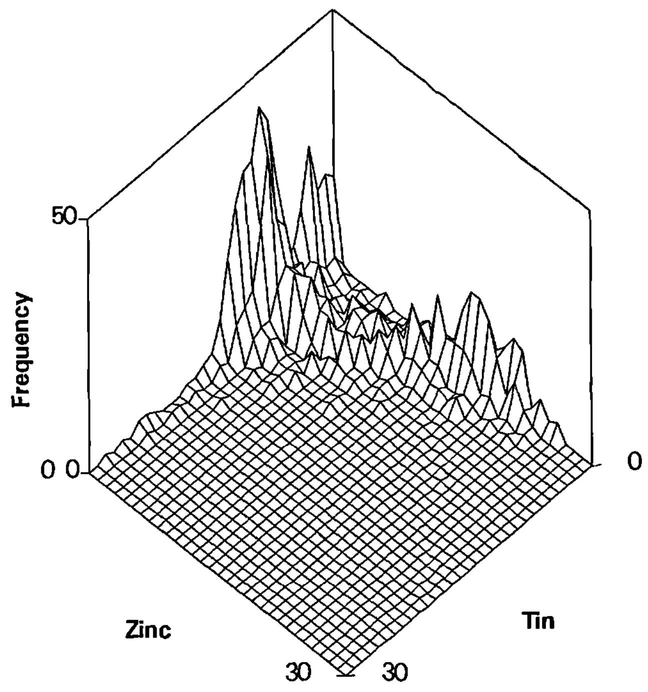

Figure 2:8. 3-D surface plot of zinc and tin contents of Roman alloys (cf figure 6:4).

from the brass to the bronze and are referred to as gunmetal. The classification of large numbers of analyses into alloy types has been used by a number of researchers (e.g. Bayley

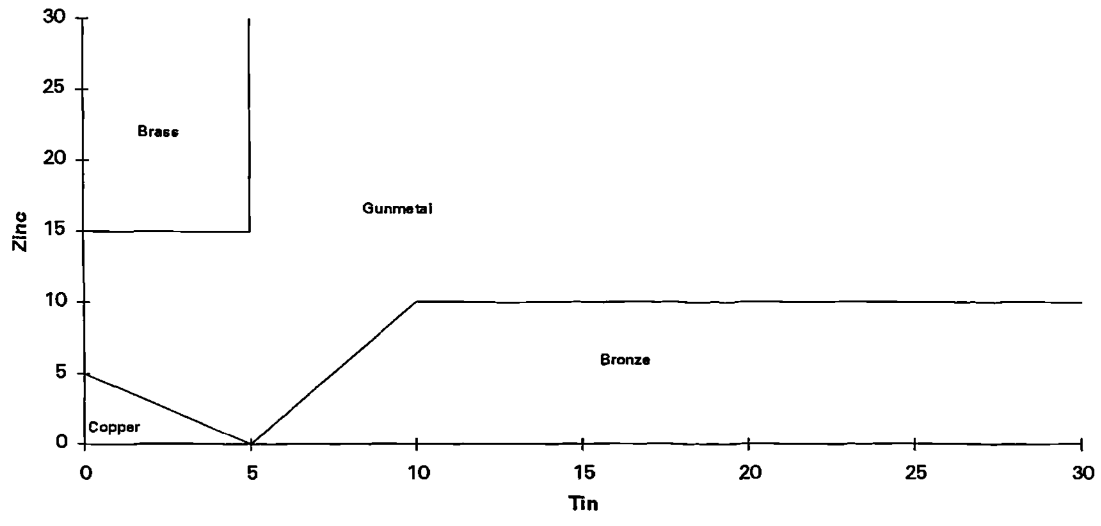

Figure 2:9. 2-D chart of zinc and tin contents, showing the boundaries of the four alloy types

[1992], Mortimer [1991]). The boundaries of the four alloy types (as shown by the peaks in figure 2:8) referred to in this thesis (brass, bronze, gunmetal and copper) are shown in figure 2:9.

This method can still only illustrate two elements at a time. The possible relationships with a third element can be examined by plotting a series of 3-D charts with different amounts of the third element (see figures 6:7-8). Those alloys with 1% or more lead are classified as 'leaded' and those with less than 1% as 'unleaded'. This distinction is useful as alloys with more than trace levels of lead can be difficult to work. There is no general agreement about what exact level of lead will cause working problems. The exact level probably varies depending on the method of working, the degree of annealing and the levels of other elements present. The choice of 1% for the leaded/unleaded distinction is broadly in line with metalworking practice.

Summary

This thesis aims to examine the range of copper alloys in use during the Iron Age and Roman period in northern Britain. This has been achieved through the EDXRF analysis of copper alloy samples to determine their chemical composition (especially the deliberate alloy elements - zinc, tin and lead). The strengths (e.g. ease of use) and weaknesses (e.g. relatively high minimum detectable level) of EDXRF reflects the overall methodology and research agenda - the most significance aspect of copper alloys is the deliberate addition of alloying elements (zinc, tin, and lead). As representative a sample of copper alloys as possible was obtained by taking samples from throughout the region and period studied, and for all the major object types encountered. While every effort was made to make the selection of samples as representative of the archaeological record as possible, selection was at times biased in favour of those parts of the archaeological record which are poorly represented. This will ensure that the results can be used to make inter site comparisons.

The methods used for examining the results will vary depending on the number of results available, the number of elements being examined at any one time, and the questions being asked. Where general trends are being followed through time or on a variety of different types of sites then classification into simple alloy types (brass, bronze, gunmetal, and copper) will be useful. Where fine differences in alloy composition (e.g. zinc contents in the 20-30% region) are being examined then bar charts or scatter plots are used. In all cases the results are compared to the archaeological background which produced the samples, rather than examining the analytical data on their own. The linking of analytical data to wider archaeological questions is the only way that such data (and conclusions) can be made relevant to archaeology as a whole.

CHAPTER 3
ARCHAEOLOGICAL BACKGROUND

Introduction

This chapter will outline some of the wider archaeological information on the Iron Age and Roman periods in northern Britain. This is not an exhaustive study but intends to outline some of the key problems which may influence the interpretation of the analyses of copper alloy artefacts. Comprehensive syntheses of Britain in this period can be found in a number of major works (e.g. Cunliffe 1993; Frere 1987; Salway 1981).

This chapter will discuss the problems encountered in identifying the Iron Age in northern Britain - some of the best evidence is found only in burials, and large numbers of sites are known only from fieldwork survey and so are undated. It is important to note that late Iron Age society was undergoing substantial change before the invasion by Rome. Nevertheless many aspects of the Iron Age landscape were products of earlier activities, and this same landscape saw relatively little change with the Roman conquest. The conquest is clearly attested in the historical record and may be most visible archaeologically through changes in (portable) material culture.

Traditional accounts of Roman Britain have tended to concentrate on an historical narrative derived from classical sources. This thesis aims to examine wider social and economic activities and so will concentrate on identifying longer-term phenomena. The narrative account of Roman Britain has been supplemented by the limited excavation of forts to determine the date of their occupation. The study of other settlements (especially indigenous ones) and their relationships with forts has not received as much attention. This section concludes with a theoretical discussion of Roman imperialism in the light of 'post-colonial' critiques (e.g. Said 1978).

The chapter concludes with a discussion of the nature of the archaeological record in the light of Hill's critique of normative approaches (Hill 1989; 1994). It is suggested that a great deal of the material remains studied by archaeologists were deliberately placed in the ground according to definite rules. This has serious implications for the ways in which the archaeological record is used as a way of representing the past.

Iron Age

An understanding of Iron Age copper metallurgy can only take place with reference to wider considerations of Iron Age archaeology. The evidence for the Iron Age in Britain is somewhat fragmentary: settlement types, material culture and burial patterns are not uniform and continuous throughout the Iron Age and across Britain. It is difficult to know what is typical of the Iron Age and what is unusual (but well preserved).

Origins

The earliest putative Iron Age evidence from northern Britain comes from Staple Howe, North Yorkshire and Scarborough, North Yorkshire. There is, however, some ambiguity to the dating of these sites. Staple Howe has produced three Halstatt C razors (Brewster 1963) and Scarborough two late Bronze Age socketed axe heads. The pottery from both of these sites has, however, been identified as Iron Age by some workers (Smith 1927; Brewster 1963; Hawkes 1959) but as late Bronze Age by Barrett (1980). Both the metal work and the pottery from Scarborough can be paralleled with some of the finds from the late Bronze Age 'hoard' from Heathery Burn Cave, County Durham (Britton 1971). The pottery can also be compared with that from Grimthorpe hillfort, North Yorkshire (Stead 1968) which has a 10th century (uncalibrated BC) radiocarbon date. This pottery is mostly plain, occasionally with thumb-impressed decoration. The ambiguity in the dating of late Bronze Age and early Iron Age sites and cultural material is illustrated in *Introduction to British Prehistory* (Megaw & Simpson 1979) where Staple Howe is discussed in both the late Bronze Age *and* the Iron Age chapters.

Both Staple Howe and Scarborough, like many late Bronze Age settlements, are enclosed. Such enclosures may have had a defensive purpose or may have reflected social relations (cf Hingley 1984). These settlements are also relatively small. This implies that society was generally organised on a small, local scale. The widespread use of typologically similar artefacts, however, shows that some links with far larger social units were maintained. The analysis of early Iron Age/late Bronze Age material is discussed in Chapter 5.

The difficulty in assigning these sites and artefacts to the late Bronze Age *or* the early Iron Age may reflect the theoretical framework for dating prehistory rather than any inherent problems in the archaeological record. The Three Age system which forms the basis for prehistoric chronologies assumes a primacy for technology and materials in dating objects and implies that each Age was chronologically distinct from the others. Increasingly researchers have noted the connections across traditional Ages. It is now widely agreed that the late Neolithic and the early Bronze Age have more to unite them than separate them. The division of later prehistory into the Bronze Age and Iron Age has been widely adopted as a heuristic device but it is widely admitted that social changes can and do occur that have little or nothing to do with technological change. The advent of iron working may not have had a sudden impact, and changes in other areas of social life may have been limited. It may be more useful to regard the whole period (late Bronze Age and early Iron Age) as a single transitional phase.

'Arras Culture'

The clearest and most abundant Iron Age evidence from northern Britain comes from the 'Arras culture' of Eastern Yorkshire (Stead 1965; 1979; Ramm 1978). Antiquarian research recovered substantial numbers of objects from burials. These objects (e.g. copper alloy brooches and horse bits) are broadly similar to those from the French Iron Age. It is only recently, however, with the use of geophysical prospection methods and aerial photography, that it has become clear that there are large numbers of Iron Age cemeteries in the East Yorkshire Wolds. The burials are highly distinctive as each is usually surrounded by a square ditch. A smaller number of burials are accompanied by a vehicle and were placed in a large pit. It is the vehicle burials that have provided most of the copper alloy finds, although simple burials are occasionally accompanied by copper alloy grave goods (pottery, animal bones and iron artefacts are more common).

'Arras culture' is often referred to in quotation marks (as here) as it barely qualifies as an archaeological culture - since it is defined almost exclusively by burials. The same aerial photography which has identified many of the cemeteries has also identified many settlements but few of these have been excavated. The settlement at Wetwang Slack, however, has been excavated and is contemporary with the burials excavated (Dent 1982; 1983). Such settlements and the structures they contain are broadly similar to those found in other parts of Britain (which do not share the same burial rite). The 'Arras culture' burial would seem to be the only distinctive aspect of East Yorkshire in the Iron Age. This raises the problem of the representativeness of copper alloys from the burials. The burials have been identified as anomalous and so why should they be taken as being representative of the Iron Age in northern Britain? Millett's (1993) study of the late Iron Age and early Roman cemeteries and settlements in St. Albans has shown that burials can be contexts for the selection of specific types of pottery and the exclusion of other types. For this reason the samples of 'Arras culture' copper alloys were supplemented by samples selected from Iron Age settlements.

The 'Arras culture' has often been taken as an intrusive element in the British Iron Age, the results of invasion and migration (Hawkes 1959). Many aspects of the 'Arras culture' funeral rites (square-ditched, and vehicle barrows) were new to Britain and so continental parallels have been sought. No one region of the continent, however, shows all of the elements of the 'Arras culture', so some have argued for a complex origin (Stead 1965; Cunliffe 1993: 78). Whimster (1981) has argued that the somewhat limited burial evidence from throughout Iron Age Britain shows the sharing of some funeral rites (positioning of the body, types of grave goods). The 'Arras culture' burials can be seen as part of a wider burial tradition and Higham (1987) has argued that the 'Arras culture' is a local development. The nature and origins of the 'Arras culture' are of considerable importance as it is the richest part of the archaeological record for the Iron Age in northern Britain.

Attempts to construct typologies using 'Arras culture' grave goods have been hampered by the lack of close parallels. The earliest British Iron Age brooches are clearly derived from early La Tène types but thereafter they undergo their own insular developments. Some of the type which appear are completely unknown on the continent (e.g. Involuted brooch). Stead argues that the Cowlam burial is the earliest of the 'Arras culture' (and the bracelet may be an import) while the Arras and Danes Graves cemeteries are probably late. Dent (1982) has proposed a sub-division of involuted bow brooches based on their size. Most of the larger involuted bow brooches from Wetwang/Garton Slack came from deeper graves. Dent (1982: 446) suggests that the deeper graves (and larger involuted brooches) are later in date. This particular typology is unfortunately of little direct use for this research project as almost all of these brooches are made of iron rather than copper alloy.

Iron Age Settlement Patterns

Many of the upland landscapes of northern Britain have large numbers of prehistoric settlements preserved as earthworks (Jobey 1982a), but many of these have not been investigated through excavation and so are not dated. The surviving evidence for Iron Age settlements in northern Britain includes hillforts, and enclosed and unenclosed farmsteads.

Hillforts have been found throughout the area of study but are relatively rare. None of the excavated hillforts of the southern part of the study area (those south of Hadrian's Wall) seem to be occupied after the early Iron Age. Almondbury, West Yorkshire, has TL and radiocarbon dates suggesting that the ditches began to fill in by 5th century BC (Varley 1976: Table 2). At Grimthorpe, North Yorkshire, radiocarbon assays of 690±130 and 970±130 (both uncalibrated BC) were obtained from bones samples from the partially silted ditch. The occupation of hillforts in the area north of

Hadrian's Wall seems to have gone on longer. Dod Law, Northumberland (Smith 1990) seems to have been occupied at least until the beginning of the Roman period. Traprain Law shows quite intensive occupation throughout the Roman period (Jobey 1976; Burley 1955; Hill 1987).

Smaller, undefended settlements are common throughout much of northern Britain (Jobey 1982a; Haselgrove 1982). In some areas settlements are integrated into a landscape of fields, enclosures and linear features (e.g. the 'ladder' settlements of the Yorkshire Wolds, settlements on the North Yorkshire Moors), and in other cases settlements appear to be isolated from other features of the landscape (e.g. West Yorkshire [Raistrick 1939]). This apparent isolation may, however, be the product of incomplete fieldwork and/or survival of remains.

Some settlements are clearly enclosed by (non-defensive) ditches, while others are entirely open. The difference may be chronological, with the enclosed settlements being earlier, and this is illustrated by the sequence at Thorpe Thewles (Heslop 1987). Some enclosed settlements do continue in use into the late Iron Age and the distinction may be socio-economic rather than chronological (cf van der Veen's [1992] distinction between type A and type B crop regimes).

In many areas the settlements that have been identified through fieldwork have not been excavated and so are not dated. The dating of earthwork and aerial photograph sites is largely a matter of guess-work. The site of Balbridie in Scotland was discovered by aerial photography and assumed to be a 'Dark Ages' elite residence because of similarities with sites such as Yeavering, Northumberland. Excavation, however, showed that the site was Neolithic (Selkirk 1980). The site of Ribblehead, North Yorkshire has parallels with other upland sites but this site was occupied in the post-Roman period (King 1978). It is not always certain which settlements begin in the Bronze Age rather than the Iron Age. In addition, many putative Iron Age settlements may continue in use into the Roman period. In some areas of northern Britain there is very little evidence for any occupation in the Iron Age (e.g. the low-lying areas of Lancashire). Small rural settlements rarely have deep stratigraphy or large numbers of finds (e.g. Coxhoe - see Haselgrove & Allen 1982) and so are not usually popular with excavating archaeologists. A detailed understanding of settlement patterns and social structures in northern Britain can only come about through programmes of survey *and* excavation.

Iron Age Agricultural Economies

Piggott's (1958) famous description of Iron Age economies portrayed two distinct farming strategies in operation in Iron Age Britain which he called the Woodbury and the Stanwick types. The Woodbury type was largely restricted to the lowland regions of southern and eastern England and was based on mixed farming with strong emphasis on cereal production. The Stanwick type which was a more pastoral economy with little cultivation was found in the upland regions of northern and western Britain. This distinction was based directly on the incidence of grain storage pits but also reflects more long-standing assumptions that the north and west of Britain are archaeologically more economically and culturally 'backward' (e.g. Fox 1932).

The characterisation of northern Britain as primarily pastoral was in part the result of a lack of fieldwork and excavation. Excavations are beginning to show that mixed farming was the norm on most northern British settlements. Both animal bones and carbonised grain were recovered from Staple Howe (Brewster 1963). At Grimthorpe (Stead 1968) many of the post hole structures were interpreted as granaries. The animal bones from both of these sites showed the exploitation of all three classic domesticates: cattle, sheep and pigs. More recently, as excavations in northern Britain have increased (e.g. Ledston and Dalton Parlours, West Yorkshire) it has become clear that grain production was more intensive than previously thought. Attempts to reconstruct the relative importance of arable cultivation and animal husbandry remain difficult, however, due to cultural and taphonomic transformations.

Detailed study of the remains of weeds associated with grain assemblages from Iron Age sites has enabled van der Veen (1992) to identify two different 'crop husbandry regimes' in the north of England. The first (type A) used intensive manuring and cultivation to obtain a high yield from a limited area, while the second (type B) used less intensive methods to cultivate much larger areas. Type A seems to be a traditional method of perhaps near subsistence farming, while type B was relatively new to northern Britain and was geared towards the production of a grain surplus.

Iron Age Britain and the 'Celts'

Piggott's (1958) models of agricultural economies owes a great deal to modern perceptions of the ancient 'Celts'. It is often assumed that most of the Iron Age inhabitants of Europe were 'Celts'. A variety of ancient and early historical sources have been used to construct a picture of 'Celtic civilisation' (Ellis 1990) which has had a great influence on the interpretation of Iron Age Europe. Recently this approach has been criticised (Aitchison 1987; Chapman 1992). The issue of the 'Celts' is an important one as it has tended to structure all explanations of Iron Age Britain (including the modes of metal production).

The fact that ancient authors (e.g. Herodotus, Caesar's *Gallic Wars*) refer to 'Celts' impinging on their world from Asia Minor to Iberia, has been taken by many modern researchers to indicate that there was an European-wide 'Celtic' culture (e.g. Dillon & Chadwick 1967; Ellis 1990). This culture has been reconstructed from archaeological evidence and various ancient historical sources. Apparent similarities between historical sources (classical and Irish) are taken as justification of this approach. This use of historical sources to illustrate Iron Age Europe is seen most powerfully in Jackson's (1964) *Window on the Iron Age,* where he argues that the Irish myths (especially the Ulster Cycle) were originally part of an oral tradition which goes back to the Iron Age. The Ulster Cycle is used to describe aspects of social life which are not easily reconstructed from the archaeology alone. Jackson has provided a framework for the Iron Age which has been widely used by archaeologists (Piggott 1958; Cunliffe 1983).

The notion that the 'Celts' occupied most of northern Europe during the Iron Age, and that they were recognisably a 'people' has recently been criticised by Chapman (1992). The 'Celts' are occasionally discussed by ancient authors but almost never by the 'Celts' themselves. The 'Celts' were ultimately conquered and so the only accounts to survive are those of the Greco-Roman authors who were not concerned to render an accurate account of their northern neighbours. The 'Celts' are vilified as inconstant, violent, drunken, sexually deviant, cannibals, etc (Chapman 1992). These accounts have traditionally been taken largely at face value, however, they (like modern imperialist accounts of America, Africa and Asia) helped justify conquest (Said 1978). The similarities between modern imperialist and ancient accounts of 'other' peoples should alert us to ideological (not to say propagandist) nature of such accounts.

Chapman (1992) also argues that the 'Celts' were not a single 'people'. He shows that the term 'Celt' was used by the Greeks to refer to northern and western barbarians. The term was still used in the 12th century to refer to the northern and western Europeans who came on the first crusade. This undifferentiated use of the term 'Celt' suggests that it was not a term used by the 'Celts' to describe themselves. Chapman (1992) suggests that it may even have been a insulting epithet.

The use of classical and Irish accounts to construct a vision of 'Celtic' society is problematic. Classical accounts of Gallic society contain apparent contradictions as many of the accounts are not of the same period (Nash 1976: 122-3). The Irish myths were written down after the Conversion and seem to have be composed at that time. They do not seem to derive from an oral tradition (Aitchison 1987).

The idea that there was a single people who shared a common culture and called themselves the 'Celts' is no longer tenable. This is important for an understanding of Iron Age metalworking as the 'Celts' have frequently been used to explain the social organisation of such activities (see Chapter 4).

Transformations to Late Iron Age Society

The appearance of more surplus-oriented agriculture in northern Britain is only one of a series of the late Iron Age changes. This period sees the appearance of large settlements similar to the *oppida* of southern Britain (Collis 1984). Stanwick, North Yorkshire (Haselgrove 1990) and Redcliff, North Humberside (Crowther 1987) have both produced large quantities of Roman and Gallo-Roman imports. These sites may have been political centres for wide areas and may indicate increasing political centralisation in the late Iron Age.

The late Iron Age also sees an increase in surviving copper alloy artefacts. A great many of the objects catalogued by Macgregor (1976) belong to the late Iron Age or the early Roman period; few can be assigned to the early Iron Age. This apparent increase may result from changes in depositional practice - many of the objects catalogued by Macgregor (1976) were recovered from rivers, lakes, or land being drained. The deposition of metalwork in 'wet places' may have served ritual purposes (Fitzpatrick 1984; 1992; Bradley 1990).

The Roman Period

The archaeology of the Roman period in Britain shows marked contrast with the Iron Age (and the Anglo-Saxon period) in the quantity and types of evidence that remain. Many areas of Britain have little evidence of either pre-Roman or post-Roman activity. The most striking change in the Roman period is that of the material culture: the quantities of Roman artefacts deposited on archaeological sites is far greater than in the Iron Age. The sheer quantity of Roman material available for study has tended to encourage the view that this material is representative of the Roman period.

The Roman Conquest

The history of the Roman conquest of Britain and the tactics and strategies used have received more attention than most other aspects of the Roman occupation of Britain (e.g. Frere 1987; Salway 1981). This thesis, however, aims to examine wider social and economic phenomena, and so a detailed account of the invasion would be inappropriate.

The Roman conquest of northern Britain is often recounted through the use of Tacitus' *Agricola*, aerial photography and limited excavation (see Hanson 1987). Elaborate reconstructions of a single year's campaigning have been based on similarities of fort plan and the dating evidence (mostly samian) recovered from ditches. These are still closely related to the *Agricola* and can be upset by the discovery of a single new site (e.g. Roecliffe - Esmonde Cleary 1994). Millett's (1990) approach to the conquest is to view the dispositions of forts in more general terms, but particularly in relation to the pre-existing indigenous settlement and social structures. Thus, highly centralised social groups in southern England (such as the Catuvellauni and the Trinovantes) could be conquered and controlled through defeat in battle and then occupation of the nodal points in the settlement hierarchy (which coincided with the social and political hierarchy). Other territories where the indigenous power structures were less centralised alternative strategies were employed. Forts were often stationed on the borders of these territories (e.g. Longthorpe). These could act as bases for operations into new territories. Areas with highly localised power structures were conquered piecemeal and forts are found throughout these areas (the south-west, and Wales). Here defeat was less readily accepted.

The Roman conquest of the north was also suited to the existing physical and socio-economic environment. A series of forts have been found on the southern fringes of this territory (e.g. Osmanthorpe - Bishop & Freeman 1993) which could have acted as bases prior to the actual conquest of the north. A series of forts have been found one either side of the Pennines, each separated by a day's march or less. The forts are later connected by roads and some of these run over the Pennines in order to connect the two lines of advance (Millett 1990: 54). This intensive occupation of northern Britain would appear to fit in with the assumption that political centralisation was minimal in northern Britain - if the North was to be conquered then every inch of territory had to be held. The evidence of transformations in late Iron Age society in northern Britain already discussed, however, suggests that political power may have been centralising before the conquest.

Nature of the Roman Occupation

The Roman occupation of northern Britain was noticeably different from the South. Soon after the conquest, the army moved northwards leaving the South largely ungarrisoned. A number of changes occurred in the landscape of southern Britain - towns developed out of existing foci or the newly established road network, while the countryside saw the appearance of villas. After *c.* AD 71, the vast majority of the Roman army was concentrated in Wales and northern Britain. The army was stationed in a series of forts along Hadrian's Wall and the roads connecting the frontier with the southern part of the province. The road network was largely restricted to the lower-lying areas while large sections of the uplands may have had no permanent military presence. Most forts had civilian settlements, variously called *vici* and *canabae*, attached to them (Salway 1965). The usage of the terms is largely modern and here the term *vicus* is used for all civil settlements which lie adjacent to military sites. *Vici* could provide a range of services for the soldiers of the forts in return for the pay the soldiers received. More substantial, independent urban settlements are something of a rarity in northern Britain. York was granted *colonia* status (Wacher 1975: 156) and Carlisle may have acted as a *civitas* capital during the later Empire (Higham & Jones 1985). The two other more-or-less independent urban sites in northern Britain are Aldborough and Corbridge. Those civil settlements which appear outside early Roman forts but which occasionally continue to be occupied centuries later (often after the departure of the local garrison) are usually called *vici* in their early phases and towns in their later ones. It is usually assumed that the social and economic links between *vici* and forts were strong. The construction and regulation of *vici* is poorly understood (Salway 1965). Casey (1982) suggests that *vici* may have been laid out and constructed by the military authorities, while Sommer (1991) argues for more self-regulation by the *vicani*. It is likely that some (if not most) of the inhabitants of a new *vicus* would have travelled with the military unit from the last post (Casey 1982). In this way there would be a continuity of some personnel and institutions in *vici*. The possible relationships between *vici* and rural settlements are less clear. Some of the inhabitants may have moved in from the surrounding countryside. *Vici* may have acted as intermediary sites for economic and social interaction between the rural hinterland and Roman forts (Higham 1982). *Vici* could have been market places where goods and services could be sold to soldiers. Such markets would also have provided the opportunity for indigenes to obtain cash with which to pay taxes. Many remote upland settlements, however, may have had only minimal contact with the Roman world. Taxes may have been paid not on an individual basis but by a larger group (either co-operativelly or through an elite). In the later Empire the payment of taxes in kind was common (Salway 1981:336-7) but Tacitus (*Agricola* 19) makes it clear that some taxes were collected in kind in the first century AD. Many small rural settlements may not have been part of the cash-tax economy - such settlements may have always been taxed in kind.

The presence of a relatively large number of troops in northern Britain may have impeded the emergence of an indigenous elite willing to take part in Romanisation and the formation of *civitates* (Millett 1990: 100). This may explain the lack of towns and villas throughout much of the north. Existing elites may have continued to exercise control through traditional methods, e.g. the deposition of metalwork in 'wet deposits' (Bradley 1990). The analysis of 'Celtic' metalwork in Chapter 5 suggests that much of this material may have been produced after the conquest.

The vast majority of the indigenous population may, however, have continued to live in settlements little different from those of the Iron Age (see above).

Romanisation and Roman Imperialism

The Roman conquest had a considerable impact on Britain which can be seen in many aspects of the archaeological record. This record is often interpreted within a narrative framework derived from classical sources. It is argued here that such a framework is biased in favour of the Roman world and does not do justice to the archaeological record. The study of the Roman empire has been popular in most modern states which have acquired empires (not least Britain). Roman and British imperialisms have been used to help construct each other - the two are bound up with each other. Roman imperialism was used as justification for the actions and existence of the British Empire. Even more significantly, Roman imperialism has itself been constructed out of a thoroughly modern and British view of imperialism. Yet it is clear that the Roman and British Empires were very different from each other. The two can and should be studied together, but one cannot be used as a model for the other. The recent 'post-colonial' reassessments of European colonialism (e.g. Said 1978) have allowed a deconstruction of some of the assumptions of superiority behind imperialism, and attempts are now being made to re-examine Roman imperialism (Hingley 1991; forthcoming; Webster forthcoming).

Britain was one of the foremost modern colonising powers and cultivated ideological links with ancient Rome. The Neo-classical revival, the iconography of Georgian coinage and the Grand Tour are just a few of the more obvious illustrations of how Britain sought to demonstrate that it was the moral inheritor of Rome's 'civilising' mission. The forging of links gave Britain an origin myth in the classical world (Hingley forthcoming). To many the British empire was merely a continuation of (at least the ideas of) the Roman Empire. The training given to those who were to be sent out to administer the British Empire was essentially a classical education - the Roman Empire was to act as an exemplar for the British Empire.

Nineteenth century accounts of Roman Britain assumed that the indigenous inhabitants of Britain were too 'primitive' to be in any way responsible for the changes seen during the Roman occupation (towns, villas, roads, etc). It was assumed that the inhabitants of the towns and villas were colonising Mediterraneans. The indigenous inhabitants still occupied Britain but they were restricted to the simpler settlements (especially those with round houses). Haverfield (1912) suggested, however, that the majority of the inhabitants of the towns and villas of Roman Britain were not immigrant Mediterraneans but were indigenous Britons who had adopted Roman ways. Haverfield coined the use of the term 'Romanisation' to cover the range of social and economic transformations that occurred in Britain during the Roman period. This model has formed the basis for the understanding of (non-military) Roman Britain (Hingley 1991). The model has long received support from Tacitus (*Agricola* 21) which states that Agricola actively encouraged Romanisation. The idea that the Roman state was actively and deliberately involved in transforming British society has been criticised (Millett 1990: 69-75).

The Romanisation model would seem to draw more heavily on long-standing European imperialist perspectives (Said 1978) as much as it does on evidence from the past. Even when, in the post-War period, scholars have chosen to stress the active participation of indigenous elites in Romanisation (e.g. Millett 1990: 82) the view that the indigenous inhabitants were more 'primitive' tends to prevail. The shifting of responsibility for Romanisation away from the Romans and onto the 'barbarians' may reflect increasing distaste for imperialism on the part of modern scholars. The influence of conservative ideology can still be seen in the use of 'trickle down' economics. Individual wealth creation in the 1980s was given a wider social justification by arguing that the rich would spend money on goods and services. This money would then trickle down the socio-economic hierarchy to the less well off. 'Trickle down' seems to be a model for explaining some aspects of Romanisation,

> Power within the new structures brought its burdens. . . Municipal government was strongly paternalistic so some of the wealth controlled by the aristocracy was redistributed through private patronage and civic benefactions.
> (Millett 1990: 66)

One of the initial aims of this research project was to examine the introduction of brass into northern Britain. It was assumed that brass was a Roman metal and so it could only appear on indigenous sites through trade and exchange with more Romanised sites: brass would flow down the settlement hierarchy. Many inter-site comparisons of material culture in the Roman period make similar assumptions (e.g. Millett 1977; 1980). In the case of copper alloys it might be hoped that brass might act as an 'index of Romanisation'. This approach assumes that the indigenous inhabitants of Britain were passive receivers of Roman culture, and that this only took place within a framework created by Rome. Recent studies of recent imperialisms have shown that indigenous reactions can very greatly (Miller *et al.* 1989).

The recent critiques of imperialism have entailed a reconsideration of the nature of Romanisation. Ancient and modern imperialisms have often been used to explain and justify each other. In order to understand Romanisation it is necessary to know how our views have been influenced by British imperialism. We cannot construct a picture of Roman imperialism out of our understanding of modern imperialisms but we can deconstruct some existing models of Romanisation.

Deposition and the Archaeological Record

Archaeology has been defined as the study of past societies through their material remains. An often unstated assumption of most archaeological study is that the material remains are representative of the societies that created them. Material remains are often treated as if they were cultural debitage that was unconsciously thrown away (Binford 1983). A close examination of this debitage will then allow a reconstruction of the behaviour that created it. In a famous paper Hawkes (1954) argued that explanations based on archaeological data could be placed in a hierarchy (his ladder of inference). The first step from the data to explanation was to describe the technology used to create the material remains. This was the easiest step and required little or no subjective appreciation. Further steps (up the ladder of inference) moved steadily away from the data in explaining social organisation and beliefs and required more and more subjective opinion.

In a recent paper Hill (1989) has argued that such an approach needs to be reconsidered. It has long been clear that most of the remains from the Neolithic and Bronze Ages in Britain come from sites which were not domestic but played some ritual function in society. As such the remains from these sites are clearly influenced by ideology and so are not simply reflective of the societies that created them (they are not just debitage). Attempts to explain this period in prehistory have always had to address the beliefs of the societies (things high up on Hawkes' ladder). Many other periods (Palaeolithic, Mesolithic, Iron Age, Roman, etc) have, however, been assumed to be relatively uncomplicated by ideology. It is often assumed that the people of these periods were 'just like us' and so their activities and motivations can easily be understood by us. Hill, however, argues that the past is fundamentally different from the present and we cannot uncritically use modern exemplars to explain the past. The past has its own logic, and we do not automatically have a way of understanding that logic.

Hill's detailed study of deposition practices on a range of Iron Age sites in southern England has shown that a major proportion of the material remains recovered from archaeological sites were deliberately placed in the ground (see Hill 1994 for a recent summary). Most remains on Iron Age sites come from ditches or dis-used storage pits. Many of the storage pits contain articulated animal or human bodies, artefacts (brooches, etc) in pits usually come from the upper levels, and artefacts in ditches usually come from the terminals (and certain artefacts often come from just one side). This approach is now seeing wider application (e.g. Millett 1993). Clearly archaeological remains are actively created according to social or ritual rules. Hill argues that the archaeological record is highly structured and that Hawkes' ladder of inference should be inverted. Schiffer (1976) argued that the archaeological record was a transformation (cultural transformation) of the material culture as used in daily life. Hill argues that an understanding of the ideological rules behind deposition are necessary before technology and economy can be reconstructed.

The archaeological record is often taken at face value as representing the individuals and societies who created it. Archaeological remains cannot, however, be taken as passively reflecting society. The objects which survive for study are not simply reflective of technological and economic life. The archaeological record is highly structured and cannot be assumed to be representative of daily life. The differences between the archaeological record and the lives of its creators cannot be assumed to be constant. The ideological rules which structure deposition may differ within and between societies and change over time. The archaeological record has been actively and passively transformed by its creators, nature, and us.

Summary

This chapter has attempted to set out some of the archaeological background in northern Britain during the Iron Age and the period of the Roman occupation. This has not been an exhaustive account but has focused on some key issues which have considerable impact on an understanding of the metallurgy of the period and will be explored further in later chapters. The most important areas of research are;

1) Romanisation. The changes which occurred from the first century AD onwards, especially those connected with the Roman conquest of the area. Romanisation is a term which has a long history of use and yet there has been relatively little theoretical discussion (but see recent discussions such as, Millett 1990; Freeman 1993; Saddington 1991; Hingley 1991). The discussion of Romanisation in this chapter has aimed to illustrate some of the problems highlighted by the continuing debate.
2) Celts. It has long been assumed that the Iron Age inhabitants were Celts. These people are assumed to have shared a common material culture, language, and value-system across most of northern Europe in the latter parts of the first millennium BC. The simplistic use of limited written sources to construct a general view of northern European culture is shown to be unhelpful (Chapman 1992).
3) Deposition. It has long been clear that the archaeological record is only a partial record. While natural factors are often invoked to explain the preservation of some items and the destruction of others, the work of J.D. Hill (1989; 1994) suggests that those creating the archaeological record may have deliberately selected some classes of artefacts for deposition and excluded others.

CHAPTER 4
THE SOCIAL ORGANISATION OF PRODUCTION

Introduction

This chapter aims to discuss some of the models for the organisation of metalworking that have been used in archaeology. A wide variety of models are available from history, ethnography and archaeology; each has contributed to the others and so made it difficult to assign any particular model to a particular discipline.

Models for the social organisation of production in prehistoric societies have been especially influenced by ethnographic research. The social organisation of past societies have often been explained by drawing parallels with modern societies which displayed similar technologies and economic structures. The simple application of modern ethnographic evidence to prehistoric societies has, however, been largely discredited (Hodder 1982). A wide variety of forms of social organisation can be found even among modern societies which display similar technologies and economic structures. Nevertheless, the diversity of ethnographic parallels usefully illustrate some of the possible modes of production and encourages the development of models based on different value systems.

The Roman period is commonly regarded as unproblematic, partly due to the (assumed) operation of a cash economy, and so many areas of social and economic relations are assumed to be based on monetary exchange. Documentary evidence, such as the Vindolanda Tablets (Bowman & Thomas 1994), shows that coinage was used for some purposes, but the relatively low numbers of coins in circulation do not seem to have been capable of sustaining a fully monetised economy (Walker 1988). To many modern scholars, the 'Romans' also seem less remote when compared with prehistoric people. This is because modern Western culture perceives an intellectual link with the Greco-Roman world. Just as Hill (1989) has argued that the Iron Age was fundamentally different and distanced from the present, so it is necessary to view the Roman period as different and distanced.

Studies of the provinces of the Roman Empire tend to see things in extremes: Roman or indigenous. In practice the two extremes grade into each other, with the Romanisation of indigenous people and the 'provincialisation' of 'Roman' people. Even this approach is problematic as it is difficult to define either the Roman culture that is provincialised or the indigenous one that is Romanised (Saddington 1991).

It might be thought that the various models for the social organisation of production would be mutually exclusive - that there is only one correct model. The analytical results could then be used to determine which model was the correct one. Most of the models which have been proposed cannot be tested in this way. Many models are sufficiently vague to make such testing impossible. Even those models which are explicit about the details of the organisation of production will not necessarily give rise to unequivocal analytical results. A consistent alloy composition, for instance, could result from centralised production of metal, or from dispersed production (but within a common tradition - Welbourn 1985).

Having discussed the possible modes of production in Iron Age Britain and in the Classical World, the chapter ends with a discussion of the evidence for the possible modes of production in northern Britain during the period of the Roman occupation.

Models of Production in Prehistory

The various models for the social organisation of prehistoric metalworking will be considered: from the smith as a powerful, important member of society to the smith as an ordinary member of society. The range of different models proposed illustrates the difficulties of relating archaeological evidence to the modes of production. Any particular aspect of the archaeological evidence can frequently sustain a number of different models at the same time.

Smith as Priest/Warrior/King

One of the oldest models for the role of smiths in prehistoric societies is that of the smith as priest/warrior/king. Hyper-diffusionist models of cultural change (Smith 1933; Perry 1923) assumed that technological and cultural innovations (such as metalworking) were brought about by individuals travelling from the Near East to other areas of the world (e.g. northern and western Europe). These individuals were often in search of raw materials for the 'higher' civilisations of the Near East. It was assumed that they were able to take over the Neolithic societies of Europe through their technological and cultural 'superiority' (e.g. metalworking). The radiocarbon revolution, however, has shown that many of the technological and cultural changes in European prehistory did not have their origins in the Near East (Renfrew 1973).

While the idea of the smith as priest/warrior/king may have waned many still see the smith as a powerful, almost supernatural member of society. This is especially popular in 'Celtic' archaeology where many interpretations are based on evidence from Irish myths,

> The outstanding prestige of the metal-craftsman in any 'heroic' society is a normal phenomenon. The metalworker's job is a man's job, if not a god's; in Irish literature the smith, the wright, and the worker in bronze are liable to be divine or semi-divine beings.
> (Wheeler 1954: 29-30)

The pitfalls of using such sources for generalisations about 'Celtic' culture have been discussed in Chapter 3. Rowlands' (1971) examination of many ethnographic details of smithing shows that in some cases the smith may actually be distrusted and marginalised. While the smith as divine model may have retreated in recent years, it is possible that at certain times smithing was viewed as 'magical' or other.

Smith as Itinerant Worker

While the idea of the smith as 'semi-divine' has continued to be popular in some circles, the middle part of the 20th century saw the wide acceptance of a new model. Childe suggested that smiths (in the European Bronze Age at least) were specialists whose skills were restricted to a small group (e.g. Childe 1951: 25). Metalworking was a complex occupation which demanded full-time specialisation. They were socially and economically separated from the rest of society. This freedom from social ties allowed them to travel in search of work. Such itinerancy could even have been essential if smiths were to find sufficient work. Childe cited medieval tinkers as a parallel for this mode of production. The idea of itinerant smiths was widely accepted as it seemed to offer an mechanism whereby different technological and stylistic innovations could be transmitted across Europe. The itinerant smith model is no longer as popular as it was, instead, prehistoric smiths are more often seen as 'ordinary' members of society.

Smiths as 'ordinary' members of society

Rowlands (1971) seminal paper on the social organisation of metalworking uses a variety of ethnographic parallels to show that in may societies smiths are only part-time specialists. For much of the year they engage in agricultural activities in the same way as other members of society. Metalworking is largely restricted to agriculturally quiet times of the year (e.g. after the harvest or before ploughing/sowing starts). Metalworking is then a supplement rather than the only source of livelihood for smiths. In contrast with the earlier (archaeological) views of smiths, this model suggests that smiths were not particularly high status individuals (in some instances smiths are actually low status members of society). Rowlands' model for production differed most from Childe's in the explanation of the relationship between smiths and the rest of society. While Childe saw smiths as outside normal society, Rowlands saw smith as normal members of society with obligations, duties, and benefits just like other individuals.

Rowlands argues that this model of production is the most appropriate for Middle Bronze Age Britain (Rowlands 1976). The ethnographic examples were, however, all taken from utilitarian iron working in near subsistence economies. The manufacture of bronze items in later prehistoric Britain does not seem to have been related to any subsistence need. Bronze was used to manufacture brooches, sword and shield fittings, vehicle fittings, etc. Many of the objects are intricately decorated and it is widely believed that the objects were used for personal display (especially for competition between elite members of society). Production of such bronze objects would only be essential for the elite members of society who would have used such objects to construct and maintain their social positions.

Whether metal objects are essential for economic or social survival, control of their production can be a source of power. In the examples given by Rowlands (1971) a number of societies place social constraints on metalworkers to prevent them exploiting their monopoly over production. In other cases smiths are prevented from taking a full role in society, in extreme cases smiths are regarded as being 'unclean'. Welbourn (1981) discusses the social standing of smiths amongst the Marakwet where smiths have worked for some time. Here they are seen as full (even privileged) members of society, while the other groups in Kenya treat smiths as 'inferior' members of society. It might be thought that societies were in general distrustful of new technologies/crafts and that craft workers would only be fully integrated after many years. Such generalisations, however, cannot hope to do justice to the full variability found in human societies. In the same area Islamic groups have had smiths for many centuries but they are poorly regarded (because it was a smith who betrayed the Prophet).

Redistributive Models - Smith as part of a retinue

Both Childe's and Rowlands' theories on the modes of production for prehistoric metalworking contain elements which are attractive for a discussion of copper alloy working in Iron Age Britain. Childe and many others have maintained that metalworking is a specialist activity which can only be carried out by full-time metalworkers. They do not take part in subsistence activities but work at their craft. This can only be possible if society can produce an agricultural surplus to support such activities. The agricultural surplus is then redistributed to the craft workers. It is often suggested that the role of elite members of society is to organise such redistribution. The medieval world again provided a parallel where each noble household would have a range of retainers who could provide specialist services. The retinue model incorporates Childe's ideas on smiths as specialists and Rowlands' ideas on the necessity of maintaining social relations (embeddedness). In terms of fine metalwork production the retinue/redistribution model has been used by a number of researchers. Fox (1958) assumed that Iron Age smiths in Britain were organised along these lines. Champion (1985) uses the redistributive model when discussing the organisation of production in central Europe during Halstatt D. Here the elites are seen as essential in obtaining many of the non-local raw materials.

'Celtic' metalwork has usually been regarded as 'fine metalwork', suitable for show and in some cases unsuitable for actual use (e.g. the Battersea Shield would not have made a very good shield (Stead 1985). Iron Age elites may have maintained their positions of power through the ownership and display (and perhaps destruction) of such fine metalwork (Fitzpatrick 1984; 1992; Bradley 1990). A cynical view of the redistributive model would point out that it is designed entirely for the benefit of those who control it.

The redistributive model has been used by Cunliffe (especially with regard to Danebury) as a general model for Iron Age society and the role of hillforts (Cunliffe 1983: figure 94). This assumes that craft activity was undertaken by specialists retained by elite members of society. Such activity took place where it could be monitored, such as the presumed elite residences - hillforts. More recent critiques of hillforts as elite residences and the bases for production are discussed below.

Workshops and Schools of Art

The fine ('Celtic') metalwork of Iron Age Britain required considerable skill in its manufacture. Objects are often densely decorated with complex curvilinear designs which would have required considerable pre-planning (Megaw & Megaw 1989). Even 'plain' artefacts often required a high degree of technical skill (e.g. the production of sheet metal for cauldrons down to 0.1mm thick). The artisans responsible for this work would have had to spend a long time learning their skills (although it was not necessary for such work to be full time or continuous). Some metalworking may have taken place in workshops where an older smith could have taught 'apprentices'. Megaw (1985) warns that while 'we' might see many items of 'Celtic' metalwork as masterpieces this is no proof that the producers or consumers saw them as such. Equally hazardous is the use of the term 'art'. The nature and significance of the products of such metalworkers are often seen in terms of post-Renaissance views on the artistic freedom and individuality of artists.

> the Celtic artist-craftsman . . . was credited with a sacred character and therefore had full scope to exercise his imaginative gifts.
> (Brailsford 1975: 8)

This reflects modern Western views on art. Such views ignore the widespread ethnographic literature concerning 'art' which shows that production takes place within a highly structured social world and for social purposes (Megaw 1985; Layton 1991). 'Celtic Art' may not have been produced to be consumed in the way art is consumed in the modern world.

While each 'Celtic' copper alloy artefact is unique, some share stylistic elements and this is sufficiently distinctive for some scholars to group them together and suggest that they were the products of workshops (Fox 1958; Spratling 1972). Thus the lipped terret has commonly been referred to as the Arras-type terret. Such schools of art may have arisen because smiths were retained by elite members of society who would use fine metalwork items (e.g. the Battersea Shield) for display in peer group competition. The smiths would all live and work under the watchful eye of their patrons. A group of smiths could then pool their knowledge and skills. The group may have worked under the control of a single metalworker who could impose an art style on all the workshops products. Many stylistic changes are explained as resulting from the migration of a single metalworker from a distant school/workshop. Fox (1958) identified a number of different schools of art in Iron Age British art. Spratling (1972) concentrated on Fox's 'Eastern' and 'Western' styles but also suggested that there may have been a great many more schools of art. The identification of common stylistic elements in 'Celtic' metalwork and relating these to their geographical distribution has continued to be a popular method of examining this material by some researchers (e.g. Kilbride-Jones 1980). Ideas about the operation of workshops and their production of items to distinct styles have been developed in parallel with the assumption that such metal work was made specifically for elites by artisans retained by those elites.

Criticism of hillforts as elite residences and centres of craft production

Hillforts are one of the most highly visible remains of the British Iron Age and have always featured large in explanations of the society. Cunliffe (1983) detailed a model for Iron Age society where the hillfort acted as a central place (Grant 1986). This model was based in part on evidence from the excavation of the Hampshire hillfort of Danebury (Cunliffe 1983). More recently this model has been criticised using evidence from Danebury in comparison with other settlements in central southern England. There were no marked hierarchies in the size or form of domestic structures at Danebury which might be expected if elite members of society lived at the hillfort. Various studies of the artefacts from Danebury and other (non-hillfort) sites in the area also show that there is little distinctive about Danebury (Haselgrove 1986; Collis 1985; Hill forthcoming). Most relevant for this study is the relative lack of metalworking evidence at Danebury. This is in stark contrast with the small farmstead at Gussage All Saints, Dorset (Wainwright 1979) where a considerable quantity of metalworking evidence was recovered. The quantity of mould debris suggests metalworking at a very high level (Spratling 1979). The site of Weelsby Avenue, Grimsby (Sills & Kinsley 1990) provides a more northerly example of intensive metalworking at a small farmstead. This suggests that craft activities were not concentrated at hillforts.

Sharples (1991) suggests that Maiden Castle hillfort was the base for a more egalitarian society. Maiden Castle could have acted as a store for the agricultural wealth of the local polity and as a ('corporate') symbol for the polity (for more egalitarian interpretation of Danebury see also Stopford [1987]). The symbolic importance of hillforts may be born out by the presence of over-elaborate entrances.

Smiths and *oppida*

The later Iron Age saw the emergence of a new settlement type in temperate Europe - the oppidum (Collis 1984). The term does tend to be used as a catch-all to cover many different types of settlement but at least some seem to display some urban characteristics (including specialist production such as metalworking). Collis (1971) also suggests that the high incidence of copper alloy (as opposed to precious metal) coins at *oppida* show that commercial transactions took place at such sites. It is possible that smiths entered into economic rather than social relationships with their customers/patrons.

While most *oppida* in Britain have produced evidence for metalworking (including Stanwick, North Yorkshire [Spratling 1981]), Collis's arguments for the operation of a cash economy in the late Iron Age (Collis 1971) have not been universally accepted (Hodder 1979). Iron Age coins may have not been used as tokens of monetary exchange but as tokens in social exchange and as means of wealth storage. The actual purpose of Iron Age coins is perhaps of limited importance here as almost none have been found in northern Britain. A few sites in Humberside have produced some Corieltauvian coins but the total number of coins is small and most were struck from precious metals (Allen 1961).

Circuit model

The criticisms of Cunliffe's model of Iron Age society with hillforts acting as central place may be accommodated if the concept of central place is replaced by the idea of the central person. Charles-Edwards (1989) has suggested a model of social organisation for early Anglo-Saxon kingdoms where kings were central persons who maintained their social position through the redistribution of goods and services provided by other members of society. It is assumed that the infrastructure of society was insufficient to store or transport agricultural produce and so the king and some of his retinue moved around the kingdom on a circuit so as not to be an excessive drain on the resources of any one region. Such a model could be applied to Iron Age societies: agriculturally unproductive members of society (such as smiths) could move in a circuit around the polity.

Specialisation and standardisation

Welbourn (1985) discusses the relationships between the form of material culture and the scale of production. A conventional paradigm of prehistory assumes technological and social progress with time. As the scale of production increases it is assumed that standardisation occurs. Welbourn, however, challenges this view and argues that standardisation can arise without central control of production. Just because modern mass-production leads to standardisation is no reason to assume that all cases of apparent standardisation are accompanied by an increase in the scale of production, control of production and division of labour. Apparent standardisation can arise through the wish to show a shared interest (e.g. membership of the same social group). Welbourn points out that standardisation is often taken as evidence of specialist production. It is often assumed that producers who were widely dispersed could not make a standardised product (e.g. Champion 1985).

Archaeological evidence for modes of production in Iron Age Britain

Most of the Iron Age settlements excavated in Britain have produced little or no evidence of copper alloy working. The archaeological evidence for metalworking in Iron Age Britain is dominated by Gussage-All-Saints (Wainwright 1979). This settlement consisted of a number of circular buildings, post-built structures, and dis-used storage pits, all surrounded by a ditched enclosure. This type of site is typical of the Iron Age in many parts of Britain. One of the storage pits, however, contained an enormous quantity of metalworking debris. Most of this debris consisted of crucible and investment mould fragments and this has been intensively studied by Spratling (1979) and Foster (1980). The mould fragments had been used to produce large quantities of horse harness (50 sets). The scale of production was clearly very high and the equipment produced would have been far beyond the direct needs of a single small farmstead such as Gussage-All-Saints. At first Spratling suggested that the production was carried out by an itinerant smith (Wainwright & Spratling 1973: 124-6) and that metalworking was not normally carried out at Gussage-All-Saints. In the final report, however, he argued that 'It hardly seems likely that the metalworking industries of later prehistoric Europe were organised on such a casual basis' (Spratling 1979: 141) and (following Rowlands [1971]) he suggested that smithing was a regular part of the Gussage economy, used to supplement agriculture (1979: 144). The specialist production of such a large quantity of fine metalwork could also be explained according to the retinue/redistribution model. Gussage could have been the residence of a middle ranking member of the elite (cf Cunliffe 1983: fig 94). Alternatively the evidence at Gussage could be explained in terms of the circuit model. The artisans could have been full time metal working specialists who were supported by a number of different agricultural settlements. They would travel around the different settlements so as not to be an excessive burden to any single settlement. This arrangement could have been co-operatively agreed by all involved or imposed by an elite who 'owned' the products of all the labour involved (agricultural and metallurgical) and arranged the work and re-distributed the products for their own benefit.

The evidence from Gussage-All-Saints is of great importance but it can be interpreted in a number of different ways. This is not helped by the unusualness of the site. Most Iron Age settlements have produced little or no evidence of metalworking. The sheer quantity of metalworking evidence makes Gussage unusual. The restricted evidence for copper alloy working in northern England (compared to iron working) was interpreted by Haselgrove (1982) as reflecting the centralisation and control of copper working. The as yet unpublished site at Weelsby Avenue has also provided large quantities of mould and crucible fragments (Sills & Kinsley 1990). Here the debris was preserved in the ditches surrounding the settlement.

Spratling (1979: 141) comments of the fragile nature of most copper alloy working debris. The ceramics used in copper alloy casting (moulds and crucibles) have usually been strongly heated and so are weakened. Such debris should only survive where it has been quickly buried (as at Gussage) and so is the exception rather than the rule.

J.D. Hill's work on the influence of ideology on deposition in the Iron Age suggests that 'we cannot take evidence from Iron Age sites at face value' (Hill 1994). The vast majority of the surviving evidence was carefully selected and deposited deliberately. Hill also suggests (personal communication) that the metalworking evidence from Pit 209 at Gussage fits in with other evidence for the structured nature of deposition. At both Gussage and Weelsby Avenue the non-ferrous metalworking is concentrated near the entrance to the enclosure and on the left hand side. Metalworking at Sutton Common is also concentrated at the entrance (Parker-Pearson personal communication). At Gussage the large quantity of metalworking debris in Pit 209 was mirrored by large quantities of ferrous scrap from a pit on the right hand side near the entrance (J.D. Hill personal communication). The highly structured nature of the archaeological record in the Iron Age raises serious problems about the representativeness of the archaeological record. If some artefacts were carefully selected as being appropriate for deposition then the surviving copper alloy artefacts may not be typical of those which were produced and used.

Conclusions

Most Iron Age settlements have produced little or no evidence for the production of copper alloy artefacts. The evidence for production is dominated by Pit 209 at Gussage-All-Saints. This is in many ways a 'freak' survival and it is difficult to know to what extent it is representative of metalworking practices in Iron Age Britain. The surviving evidence has been selected and distorted by a number of depositional and post-depositional factors. Nevertheless, the few cases where substantial quantities of debris has survived suggests that (at least on some occasions) substantial quantities of copper alloy items were produced within a relatively short period of time. It takes, however, a considerable leap of faith to move from this observation to the suggestion that copper alloy production lay in the hands of a few specialists. The failure to find a single satisfactory explanatory framework for the social organisation of production of copper alloy objects in Iron Age Britain may result from the fact that a number of modes of production existed,

> Celtic art (or crafts) in particular is neither susceptible to the construction of any single model to explain its development or distribution nor should one readily exclude any such model because of its seemingly only partial application.
> (Megaw 1979: 49).

Some production may have been carried out by specialists while some may have been carried out as one-offs by non-specialists. Large numbers of similar objects do not necessarily imply large-scale production in a single workshop (Welbourn 1985).

Models of Production in the Roman World

Introduction

The Roman conquest of Britain led to a variety of changes and continuities. In part Roman Britain (including its modes of production) was the product of the Iron Age and in part it was the product of the classical Roman World. Before examining the modes of production in northern Britain during the Roman period it is necessary to consider production in the ancient, Mediterranean world. The economy of the ancient world has long been of great interest to classical historians and archaeologists (Rostovtzeff 1957; Finley 1985; Hopkins 1978; Garnsey & Saller 1987; Love 1991). The models put forward to explain the social organisation of production in antiquity are discussed below. The place of money in the ancient economy is discussed as this is of considerable importance to some of the models. The position of the army is something of a special case and is considered separately. All of these discussions concentrate on the early Roman period and so a final section discusses the later Roman Empire.

The Classical World of Cities and Factories

Studies of the ancient economy have traditionally been based on literary and sub-literary evidence. This provides us with a model of production in the classical, Mediterranean world. Archaeological evidence has been used less often and inevitably focuses on durable materials (especially pottery), even though Jongman (1988) has pointed out that production of archaeologically invisible items (such as clothing) probably occupied a more prominent position in the ancient economy.

The social relations of production in the ancient world have long interested ancient historians and archaeologists. The following discussion cannot be comprehensive and so draws heavily on a recent synthesis (Love 1991). Modern views on the ancient economy can be divided into the 'modernists' and the 'primitivists'. The 'modernists' (Oertel, Frank and Rostovtzeff) have assumed the operation of a capitalist economy. Oertel (1934) argued that at least some production occurred in 'manufactories' where large numbers of workers were brought together under a single management. Oertel assumed that goods were mass-produced, a process which was helped by labour specialisation. Frank (1927) argued that while most production took place in small artisan shops and items were sold by individual producers, the factory system did emerge on occasions. Rostovtzeff (1957) used differences in architecture between Rome and Pompeii to argue for differences in the modes of production. At Pompeii, most of the houses were of the *atrium* type and so production could only be on a fairly modest scale. In Rome, one the other hand, the architecture is characterised by large tenement blocks. Rostovtzeff (1957) saw tenements as possible sites of production on a factory scale. Both Frank and Rostovtzeff used the Arretine fine ware industry as an example of a mass-production enterprise. The number of workers and the volume of production were undeniably large. The 'modernists' all shared the same view of the ancient economy as essentially similar to the modern one. Factors such as the optimisation of profits, division of labour, market economics and consumer-led production were all assumed to be of considerable importance in the operation of the ancient economy. The existence of factories has been suggested for the production of Campanian bronze vessels (Frederiksen 1959: 109), largely on the basis of stamps on finished vessels (especially P. Cipius Polybius). Actual, excavated evidence for factories is unknown. The use of terms such as factory and market when describing the ancient economy, inevitably carry with them associations from the modern capitalist world. The situation is not helped by the varying meanings attached to the term 'industry' by archaeologists. The 'primitivists' (Love 1991) would argue that the evidence for production in the ancient world does not support the idea that the ancient economy was essentially capitalist.

Hasebroek (1965), one of the leading 'primitivists', argues that production in the ancient world was mostly small-scale and does not deserve to be described as 'industry'. Production took place in workshops rather than factories. In particular, Hasebroek denied the operation of capitalistic methods and assumed that production remained essentially a craft activity. Love (1991: 119) describes Loane as essentially cautious on the question of the scale of production but most of Loane's (1938) arguments are directed at Rostovtzeff's analysis of architecture and she could, for the most part, be described as a 'primitivist'. Loane argues that Rostovtzeff's links between architecture and modes of production are simplistic. Even the large-scale second century re-plannings in Rome do not include factories. Instead, the markets are dominated by small booths and stalls run by individual artisans. Inscriptions on tombstones presented by Loane show the predominance of independent workers. While slaves in Rostovtzeff's postulated factories would have been less likely to be recorded on tombstone, Loane argues that if the factories had existed they would have forced the individual artisans out of business (one of the few occasions where Loane admits the presence of something approximating to a market economy). Loane acknowledges the presence of a few large-scale enterprises (e.g. bakeries) but points out that these were mostly run by or for the state, and often involved the exploitation of a monopoly.

While the 'primitivist' position seems attractive and has been widely adopted (Finley, Hopkins, Garnsey & Saller, Millett, etc), few attempts have been made to explain in detail how production was organised. One account is based in part on Weber's account of the ancient economy (Love 1991; Hopkins 1978). Love stresses the importance of the *apophora*, a situation where a slave could be involved 'in a craft or trade in a semi-independent fashion and to a certain degree along business lines' (Love 1991: 133). Such a system could account for the apparent preponderance of small shops and workshops in Roman towns identified by Loane (1938). The *apophora* system is also linked to the *peculium* - 'a fund which slave-owners permitted their slaves to hold, and within certain limits, to deal with as if their own property' (Love 1991: 134). This system allowed aristocratic patrons the necessary social distance between themselves and commercial activity but let them profit by it (Hopkins 1978: 126). It is not clear how much of the profits of the *apophora/peculium* system belonged to the slave and how much to the owner, but Love suggests that the slave may have retained a substantial proportion so as to finally buy his or her freedom. Such a system had the benefit over many others in that it provided a motivation for the slave. Love stresses,

> the importance of semi-autonomous business activities conducted on a wide scale by slaves, activities in which the *peculium* functions as a kind of investment fund. [. . .] The *apophora* system was in all probability most extensive an integral part of the Roman economy.
> (Love 1991: 140).

While Love's account of the ancient economy offers much there are some problems. Love (1991: 115) criticises Frank and Rostovtzeff's view of the Arretine ware and other industries as large-scale mass-production. He suggests that the evidence for factory style production is largely circumstantial, but he does not consider Peacock's (1982) discussion of pottery production. In particular, Peacock (1982: 123) argues that slaves did not play a major role in the Gaulish samian industry. Certainly these two industries produced large quantities of pottery, but stamps show that slave workers were common in Italy but rare in Gaul.

The *apophora* system may have been important in many Mediterranean cities it is not clear whether it operated in the northern provinces. The northern provinces may have seen more production in the hands of non-slaves. Key to the relevancy of the *apophora/peculium* system is the number of slaves in Roman Britain. The epigraphic evidence for slaves in Britain is fairly minimal, although more freedmen are recorded (Birley 1979).

Money in the Roman Economy

The above discussion of the organisation of Roman industry has largely concentrated on the 'classical' world. It cannot be assumed that models based on the Mediterranean world can be transferred uncritically to northern Europe. Central to the appropriateness of classical modes of production for the North is the role of coinage. 'Modernists' would argue that money clearly functioned as a means of exchange in Mediterranean cities and so acted as a stimulus to 'industry'. This view has also been extended to Roman Britain, 'the introduction of a large-scale, regular and consistent monetary system ha[d] . . . an enormous influence on the growth of commerce' (Frere 1987: 305). Such a view is, however, challenged by the 'primitivists', 'there is real doubt as to the extent to which Britain had a monetary economy in the first century' (Salway 1981: 660). This view is put even more strongly by Crawford,

> in the Northern provinces coinage was little used as a means of exchange. [. . .] coinage will have served mainly as a store of wealth and as a (compulsory) method of paying taxes
> (Crawford 1970: 45).

Coinage was issued by and for the state, for military and political ends - the needs of 'consumers' were not considered (Jones 1964: 441). This is clearly seen in the state's disregard for problems arising during cash shortages (Finley 1985: 196). Reece (1984) has suggested that copper alloy coins were not issued to help commerce but to assist in the 'reclaiming' of gold and silver paid out to soldiers and civil servants. The possible use of coins as a medium of exchange would seem to be a by-product of its original purpose. The close examination of coinage from Bath by Walker (1988) suggests that for most of the early Roman period there was not enough coinage present to sustain a cash-based market-economy in Britain. Walker's calculations even suggest that there was insufficient coinage present to pay the Roman soldiers in Britain (a recent paper by Howego [1992], however, suggests that quantitative examinations of coins must be treated with caution).

On the face of it the apparent shortage of coinage in Roman Britain argues against large-scale capitalistic production and commerce. Nevertheless, cities of the ancient Near East had long maintained trade and commerce without coinage and the 'primitivist' position stresses the non-capitalistic nature of ancient industry and trade. Thus, the lack of a universal, effective means of exchange in Roman Britain may not have hampered large-scale production. It will, however, have been a great barrier to the establishment of a capitalist economy.

Production of Roman Army Equipment

A number of different models have been put forward to account for the production of Roman military supplies. Most lie between two extremes: either the army made all of its own equipment, or it was all made by civilians and sold to soldiers on an individual basis. A variety of sources of evidence (literary, sub-literary and archaeological) have been used to support particular views. The evidence, however, does not give categorical support to either view. This may be because the organisation of production varied across time and space. Most of the discussion will concentrate on the early Empire.

The view that military production lay in the hands of civilians was put forward by MacMullen (1960) in a study of the inscriptions on pieces of armour. Many of these inscriptions consist of personal names and attest to private ownership. The existence of a succession of names shows that some armour was passed on to a succession of soldiers. MacMullen (1960) admits that the succession of owners could arise through a retiring veteran selling his equipment to a new recruit or through the army re-issuing its own equipment. The inscriptions alone will not answer the question so MacMullen turns to other forms of evidence. The existence of tombstones recording the existence of civilian arms manufacturers and sellers leads MacMullen to state that,

> The main source of supply for arms in the earlier Empire was small shops and dealers. Fine armour beyond the call of duty could be ordered by the military swell from local artists, or was hawked about in camps.
> (MacMullen 1960: 25)

Some of the other evidence presented by MacMullen, however, seems to contradict this view. Ancient accounts and papyri (MacMullen 1960: 23-4) show that the army issued equipment to soldiers, and deducted the cost from their pay, and expected equipment to be handed in when veterans retired. Breeze (1982) also uses the same evidence to show that soldiers' pay was deducted for weapons and they could sell their weapons back to the army on retirement or death.

It would seem clear that the army was concerned about the equipping of its soldiers, the source of the equipment, however, is less clear. The army may have manufactured its own arms, or they may have been bought from civilian manufacturers. Vegetius' account of *fabricae* implies that army units should be self-sufficient(e.g. MacMullen 1960; Bishop & Coulston 1993). The *fabrica* was under the command of a *praefectus* who was responsible for the manufacture and repair of a variety of weapons and equipment. The work of soldiers in *fabricae* are attested by a range of literary sources (e.g. Bowman & Thomas 1983: No 1).

Small courtyard buildings at the centre of forts have often been identified as *fabrica* buildings (Bishop & Coulston 1993: figure 133). The evidence for production in these buildings, however, is usually slight. A more common form of evidence for production in forts (although circumstantial) is 'hoards' of scrap metal, such as the *lorica segmentata* and other fittings from Corbridge (Allason-Jones & Bishop 1988; Bishop 1989a). It is usually assumed that such 'hoards' are stocks of scrap metal awaiting remelting/re-forging (Bishop 1985a; 1989a). The survival of such hoards may often be due to changes in troop dispositions and the abandonment of forts (Bishop 1989a; Allason-Jones & Bishop 1988; Pitts & St Joseph 1985) The large quantities of scrap metal from Castle Street, Carlisle (McCarthy 1991) suggest that metalworking may have taken place in or near the fort. Other evidence for metalworking in forts (such as crucibles, blanks, and miscastings) have also been found on occasion. Such evidence from Roman forts in Germany has been reviewed by Oldenstein (1974) who concluded that *fabricae* were involved in the repair of equipment rather than the production of new items. (Oldenstein 1974; 1985). Allason-Jones (1994) has suggested that small-scale metalworking may have been a common activity in military establishments along Hadrian's Wall.

Bishop (1989a) argues that the army would have retained ownership of equipment and that the *fabrica* system was capable of meeting most if not all repair needs. There may have been small-scale private production of high-status items but 'there was no large-scale private industry in the west' (Bishop 1989: 13). An alternative view is presented by James (1988) who suggests that the army in the early Empire was too mobile to be involved in the production of its own equipment. James is reluctant to see arms manufacture under the control of civilians because of legal constraints against civilians bearing arms and because the state needed to ensure the supply of equipment if the army was to be effective. James concludes (1988) that arms manufacture was carried out by the state (a system which later gave rise to the late Roman factories of the Notitia Dignitatum).

One model for the production of Roman military equipment which is not generally discussed in any detail is contracting. It would seem that during the early Empire the army had neither the time nor the resources to engage in large-scale arms production. Nevertheless, the Empire had a clear interest in ensuring that the army was well-supplied with the necessary equipment to undertake military actions, and it was involved in issuing and reclaiming some items. Moreover, tombstone attest the existence of civilian arms manufacturers. It is possible that contracts were entered into with civilian manufacturers for the supply of equipment and that production may have taken place on a large-scale. Army contracts have frequently been cited as the reason why so much coarse pottery from southern England is found on military sites in northern Britain (Gillam 1973; P.V. Webster

1972). Contracts may have been organised at the level of the individual unit or at a higher level (e.g. provincial - see Evans 1991). The evidence of intensive metalworking outside the Roman fort at Colchester (Niblett 1985) has been interpreted by Webster as possible evidence of civilian manufacture for a military contract (G. Webster 1985). Evidence on a similar scale has now been recovered from the Gaulish town of Alesia (Rabeisen 1990) where moulds for horse harness fittings of Flavian date have been found.

The above discussion of the possible modes of production for military equipment in the early Empire have included a wide range of models. These are not always compatible but,

> it is not necessary to insist that production was either the preserve of some centralized authority, or farmed out to vast numbers of civilian craftsmen, and it is a mistake in equipment studies to treat the Empire as a single, culturally homogenous entity.
> (Bishop & Coulston 1993: 184).

It is quite possible that a number of different modes of production occurred together at the same time. Some equipment was certainly made by civilians. Some of the staple items (such as blankets, tunics, and spears) may have been procured by the army or state through state contracts, while some of the finer items (e.g. inlaid dagger sheaths) may have been made by individual artisans and sold directly to those soldiers who could afford them. The legionary *fabricae* were also quite capable of carrying out many simple repairs. Finally, the ability of individual soldiers to make and repair their own equipment should not be underestimated. The technology and skills involved in manipulating copper alloys should not be seen as the exclusive preserve of specialists (as they are in modern society). Very little of a soldier's time is spent actually fighting. The remaining time could be filled by carrying out small-scale manufacture of items of equipment (Allason-Jones 1994). One of the Vindolanda tablets (Bowman & Thomas 1983: No. 38) also shows that individual soldiers could obtain some items privately from their family.

The Roman army may illustrate the range of the modes of production in the rest of the Roman world. There may have been a wide diversity to the forms of social organisation of production: some work taking place at an individual or family level largely for the needs of the individual or family, while other work may have been carried out on a far larger scale.

Later Roman Empire

The debates over the scale of the Roman economy and the possible role of capitalistic production and a cash-economy have mainly taken place in relation to the early Empire. It is commonly agreed that the later Roman economy saw a higher proportion of production and exchange taking place within embedded social relationships. There seems to have been a decline in long distance trade but this may not have been symptomatic of a general decline in the economy - Whittaker (1983) argues for a localisation of production and exchange. The state seems to have taken direct control over the production and distribution of many of the basic commodities that it required. Raw materials and foodstuffs for its dependants (workers, soldiers and civil servants) were levied. Labour was also levied to carry out public construction projects (Jones 1964: 839). Other workers were hereditarily tied to posts in large factories (some of which produced military equipment). The Notitia Dignitatum lists *fabricae* (factories) which were apparently devoted to specialist and large-scale production of military equipment. The *fabricae* were organised along frontiers and in respect to provinces and dioceses (James 1988). More specialised factories were situated in regions where they were needed (e.g. heavy horse armour factories are found only in the eastern provinces). The positioning of the factories illustrates Whittaker's point about the localisation of production and exchange (Whittaker 1983). The development of these state-controlled factories is seen by James (1988) as a gradual evolution from earlier, similar modes of production, but is seen by Bishop & Coulston (1993: 188) as a more fundamental shift reflecting the third century economic crisis (inflation and an unstable currency). The Notitia does not actually mention Britain in its list of fabricae and so it is unclear whether or not the system operated in the province.

Production mediated through appropriation, barter and direct redistribution may not have been limited to state enterprises. Whittaker (1990) suggests that similar social relations may have organised production in 'small towns' (Whittaker 1990). Some 'small towns' may have been 'private', set up by and for a largely rural elite who lived in villas (largely using the evidence from Belgium [Whittaker 1983: 171; 1990]). Jones, however, suggests that the presence of state factories and levying did not necessarily kill off individual private production and trade (Jones 1964: 839). Small-scale production may have continued in many smaller settlements (Jones 1964: 847) while urban artisans were organised into *collegia* (Jones 1964: 858). Such *collegia* were hardly trade unions as they 'were useful to local and imperial authorities for the collection of a range of taxes and for the imposition of compulsory services' (Jones 1964: 858).

It is ironic that the later Roman Empire is a period where the economy was becoming increasingly embedded in social relations but the volume of coinage was finally increasing to levels which could sustain a cash-based exchange system (Whittaker 1990).

Evidence for Production in Roman Britain

Northern Britain during the period of the Roman occupation would have been the product of both the Iron Age past and the intrusive Classical World. Some aspects of each world may have melded with the other, some will have been extinguished by the other and some will have existed side-by-side. This view can be seen in this extract from Frere's (1987) *Britannia*,

> The manufacture of bronze objects in Roman Britain was carried on at two distinct levels. On the one hand, we have craftsmen, no doubt mainly based on the towns and on the larger vici of the north, who manufactured objects in classical taste, though in provincial style. At first such people will have been immigrants in the main, but the very large quantity of material, as well as the artistic standards show that Britons soon learnt the necessary skills. . . Most of the finer examples of the bronze-smith's art, of course, were imported from Italy or Gaul but British craftsmen copied imported models to the best of their ability. Distinct from these, there still existed rural or itinerant craftsmen in the north and west trained in the old traditions of the native bronze industry of Celtic Britain. Bronze fittings for wooden tankards or buckets, and cauldrons for brewing or for seething meat [. . .] remained in demand among highland zone households which continued the Celtic way of life.
> (Frere 1987: 279-80)

The remains of copper alloy production in Britain are widespread but slight (Bayley 1992). Such evidence usually consists of a few moulds, crucibles or casting debris (this last category could also arise accidentally through generally burning). This sort of evidence could be produced by casual, part-time industry and rarely gives any indication of large-scale working. While many thousands of Roman brooches survive (and many more must have originally been produced) very few brooch moulds have so far been found (Justine Bayley personal communication). In a few cases, however, more imposing evidence, in the form of actual workshop buildings and the remains of fixtures has been recovered. Such workshops have been noticed at Verulamium (Frere 1972), Catterick (Wilson forthcoming), York (Ramm 1976), Heronbridge (Hartley 1954), and Caerleon (Zienkiewicz 1993: figure 13). At these sites whole rooms were given over to copper alloy working. The archaeological features which survive are furnace bases and collection trays (features cut in to the ground to collect and recover filings produced during working).

Other, above ground features, such as benches and anvils, can only be surmised. Nevertheless the patterns of debris and the positions of the collection trays do show that a number of different artisans worked together in the same room. Such features have so far only been found on military and urban sites.

The status of workers in the workshops mentioned above is not known. There is very little epigraphic evidence relating to metalworkers in Britain. One example from Malton,

> Good Luck to the genius of this place!
> Good luck to you, young slave, in running this goldsmith's shop.
> (RIB 712)

could be accommodated by the *apophora* system described above. There is, however, no certainty that the majority of the workers employed in copper alloy workshops in Britain were also slaves. The low proportion of slaves recorded in Romano-British inscriptions suggests that slaves were the exception rather than the rule. Birley's (1979) survey of the epigraphic evidence in Roman Britain suggests that slaves were not as common as in the Mediterranean.

The above survey of the evidence for the production of military equipment has identified a number of different possible modes of production. The same may be true for the production of civilian equipment. This also finds a parallel in Peacock's (1982) ethnoarchaeological approach to Roman pottery production. Peacock has identified a number of different modes of production: household, nucleated (both urban and rural), and 'giant'. Such an approach could be used to suggest a variety of different modes of production for copper alloys. The literary evidence for the production of bronze vessels (e.g. Campanian vessels) and the large number of surviving vessels (Boesterd 1955) suggests the existence of large-scale production sites. The archaeological evidence for the workshop buildings discussed above suggests the existence of establishments with several workers. The common metalworking evidence recovered from a great many sites consisting of a few mould or crucible fragments could be the remains of occasional production activities. Such occasional work may have formed a considerable proportion of all copper alloy production if it was carried out on many sites.

Romano-Celtic Production

Frere's (1987: 279-80) discussion of metalworking cited above also highlights the problem of recognising the Roman or 'Celtic' elements in the finished objects. Many items of the Iron Age material culture have been labelled as 'Celtic' (Leeds 1933; Macgregor

1976; Megaw & Megaw 1989). The extension of an originally linguistic label to cover most of the people of northern Europe in the Iron Age has been criticised above. Nevertheless, the use of the term 'Celtic' to refer to an 'art' style has become fixed in the literature. In this context, 'Celtic' commonly refers to items decorated in a stylised curvilinear manner, often incorporating motifs from the natural world (e.g. plants and faces) into geometric patterns. Collingwood showed that many items of material culture from the Roman period in northern Britain also display 'Celtic' decorative features (Collingwood 1930a). Many of the 'Celtic' objects catalogued by Macgregor (1976) were found on Roman military sites rather than on indigenous settlements. 'Romano-Celtic' items were seen by Collingwood (1930a) as having been produced by the indigenous Britons for the new Roman market. It is difficult, however, to simply assign decorative motifs to ethnic groups, as material culture can embody a range of meanings (Hodder 1982). In particular, 'Romano-Celtic' art could have been produced by indigenes for themselves, or for 'Romans', or by 'Romans' for indigenes or themselves, or some combination of these (Allason-Jones 1991).

Summary

This discussion of the modes of production in Iron Age and Roman northern Britain has examined a range of social relations of production. The partial and distorted nature of the archaeological record makes the drawing of definitive conclusions difficult. The limited nature of the evidence allows the suggestion of a number of different models for the social organisation of production. At times these different models may seem to come into conflict (essentially the contrast between large-scale organised production and small-scale craft activity). I would suggest, however, that a number of different modes of production were in operation at the same time.

The common recourse to a single explanatory framework may reflect the common assumptions of modern scholars. It is often expected that there is a single rational explanation for a given phenomenon. Such an approach may appear particularly attractive in archaeometallurgical research where scientific experiment and analysis can demonstrate the validity of statements about the nature of metals. The use of such a simplistic approach to explaining social organisation in the past should be avoided.

CHAPTER 5
IRON AGE

Introduction

This chapter will describe the results of the analyses of Iron Age copper alloys from northern Britain. The chapter is divided into four sections, covering the origins of Iron Age copper metallurgy, the Iron Age proper, 'Celtic' metalwork, and finally the end of the Iron Age and the beginning of the Roman period. The archaeological distinctions between the three chronological phases (and one cultural phase) are at times a little vague but the analytical results do show important changes in metal use through the Iron Age. The earliest Iron Age covers evidence from the late Bronze Age-early Iron Age transition period. The late Iron Age covers the period during the first century AD when Roman contacts and influence are suggested by the presence of continental/Roman imports. As the Roman conquest of Britain was a long drawn out, and not entirely successful exercise, the late Iron Age is here taken to include objects and sites which were in use after the start of the Roman conquest, but in spheres relatively uncontrolled by Rome (i.e. settlements remote from Roman towns and forts). The comparison of 'Celtic' metalwork with the Iron Age results reveals that most was produced in the late Iron Age or after the Roman conquest.

The analytical results are reproduced in this chapter (and later chapters) as summary tables and charts. The full details of the analytical results can be found in Appendix 5. Individual results are referred to by their laboratory reference number (XRFID number). All the results in Appendix 5 are in XRFID number order. A break down of results by site is given in Appendix 3, and by object type in Appendix 4.

Late Bronze Age/Earliest Iron Age

Considerable attention has been devoted in previous archaeometallurgical research to the examination of the early phases of copper alloy use (e.g. Junghans *et al.* 1960; 1968; 1974). This section examines the origins of Iron Age copper metallurgy and its relationship with late Bronze Age metallurgy (Brown & Blin-Stoyle 1959; Northover 1982a). The basis of prehistoric chronologies is the Three Age system which assumes the primacy of technology as a means of dating. There is, however, no certainty that changes in technology will always occur in step with changes in social organisation. It is now widely agreed that the distinction between the late Neolithic and the early Bronze Age is somewhat artificial. While technology does change the forms of social organisation seem to continue. It is suggested here that these two sites belong to a transitional period rather than to the Bronze Age *or* the Iron Age.

In order to examine the origins of Iron Age metallurgy in northern Britain, a small number of samples were taken from sites dated to the transitional, late Bronze Age/early Iron Age, period. The two sites available for analysis were Staple Howe (Brewster 1963) and Scarborough Castle (Smith 1927), both in North Yorkshire. Only 8 samples were taken so these are shown in Table 5:1 (rather than in charts).

XRFID	Site	Object	Cu	Sn	Pb	Zn	Fe	Ni	As
2029	Staple Howe	Razor	90.93	8.65	0.40	nd	nd	nd	nd
2030	Staple Howe	Chisel	90.85	7.08	2.00	nd	nd	0.05	nd
2031	Staple Howe	Razor	85.01	9.79	5.12	nd	nd	0.08	nd
2121	Scarborough	Armlet	99.72	nd	nd	nd	0.07	nd	0.20
2124	Scarborough	Gouge	80.47	13.65	4.87	nd	0.48	0.07	0.45
2127	Scarborough	Axe	92.54	4.45	2.91	nd	nd	0.09	nd
2128	Scarborough	Casting Jet	93.94	1.96	3.85	nd	nd	0.08	0.17
2130	Scarborough	Axe	68.58	8.29	22.64	nd	0.05	nd	0.33

Table 5:1. Late Bronze Age/Early Iron Age results (nd = not detected)

The collection of bronze objects from Scarborough were recovered during the excavation of the late Roman signal station. They were found lying on an old land surface adjacent to pits containing early Iron Age pottery (Smith 1927: 179) and so may not be closely associated with the pottery. Stylistically, the bronze objects belong to the late Bronze Age, while the pottery has been dated to the early Iron Age (Rutter 1959; Cunliffe 1993: 67-8) and the late Bronze Age (Barrett 1980). The reliability of the 'context' of the bronze objects is compromised by XRFID 2122 and 2123 (see Appendix 5), the two heavy (harness ?) rings found with the other bronze objects. XRFID 2122 and 2123 both contain high levels of zinc. The mixed alloy (containing zinc, tin and lead) used for these objects is typical of this type of object in the Roman period (see Chapters 6 and 7). These two rings probably relate to the use of the hill in the Roman period as a signal station (Frere & St. Joseph 1983: 82-3). The excavation account (Smith 1927) does not make clear how far below the Roman levels the bronzes were found.

There is only slightly more consensus over the dating of the artefacts from Staple Howe (e.g. Megaw & Simpson 1979, deal with the site in both late Bronze Age and Iron Age chapters). The pottery from the site is dated to the early Iron Age, the copper alloy objects find closest parallels with typologically Halstatt objects (usually dated to the late Bronze Age in Britain), and the radiocarbon dates support either an early Iron Age or late Bronze Age date.

Most of the objects (Table 5:1) are tin bronzes (with the addition of varying amounts of lead). Late Bronze Age artefacts are usually made from leaded bronze (Brown & Blin-Stoyle 1959; Northover 1982a) while Iron Age objects only rarely contain appreciable amounts of lead. Zinc was not detected in any of the samples and is rarely found in other Bronze Age or Iron Age artefacts. The one pure copper artefact (XRFID 2121) is an armlet with overlapping terminals. The object was probably wrought rather than cast and the low alloying element content would be well-suited to this method of manufacture. Arsenic was present as an impurity in half of the samples. This is broadly analogous to the results obtained from Iron Age results (discussed in the next section). Only one of the objects had a substantial proportion of iron present. Low iron levels are a feature of Bronze Age alloys, but iron is a regular impurity in Roman and later alloys. Craddock & Meeks (1987) suggest that the change in iron levels reflect a change in smelting methods. Early prehistoric copper may have been produced by a low temperature non-slagging smelting method, while Iron Age and Roman copper was probably produced by a tap-slagging method. This conclusion is supported by the work of Pollard *et al.* (1991) which shows that the presence of arsenic in early copper indicates a low temperature (and slag-free) smelting method.

The above analyses show similarities between Scarborough and Staple Howe and represent an apparently uniform picture. The results as a whole also show a range of similarities with *both* late Bronze Age results previously published and with the Iron Age results discussed below. The use of a leaded tin bronze is almost universal in the late Bronze Age, while arsenic is a common impurity in Iron Age alloys. This reinforces the idea this period should be seen as a period in its own right.

Iron Age copper alloys

Introduction

This section considers the Iron Age itself (as distinct from the earliest part of the Iron Age where there is overlap with the late Bronze Age, and from the late iron Age where there is overlap with the Roman period). In southern Britain this period is often referred to as the Middle Iron Age. The Iron Age objects were selected in the first instance from 'Arras' culture burials (Stead 1979). These showed the widespread use of tin bronze with arsenic as a common impurity (although, unlike earliest Iron Age ones there is little or no lead). In order to give the results a wider relevance objects from Iron Age settlement sites were also selected. These also showed the widespread use of tin bronze with arsenic as a common impurity. Dating settlement occupation and associated finds to the pre-Roman Iron Age can be difficult. Many of the sites examined continued to be occupied into the Roman period, e.g. Thorpe Thewles phase III covers most of the Iron Age but seems to end in the early Roman period (Heslop 1987). Where there was room for doubt, finds were classified as late Iron Age and are dealt with in the next section.

The present analysis of a range of 'Celtic' metalwork (Macgregor 1976) showed that some of this is made of the same 'Iron Age' alloy and these objects are included here (e.g. Piggott's class II swords [Piggott 1950]). A few other finds are included in the Iron Age analyses (e.g. a mini terret from Piercebridge which is typologically identical to those from 'Arras culture' burials, and has the same chemical composition).

The find spots and types of artefacts analysed are shown in Table 5:2. The

	Brooch	Armlet	Sheet	Wire	Horse Harness	Swords	Misc	Debris	Total
'Arras' burials	**9**	**10**			**37**	**2**	**11**		69
Stanwick, Tofts	**4**							**2**	6
Dragonby	**4**		**1**				**4**		9
Weelsby Ave	**1**		**3**	**4**				**12**	20
Broxmouth							**2**		2
Stray finds					**1**	**3**	**2**		6
Total	18	10	4	4	38	5	19	14	112

Table 5:2. Distribution of analysed Iron Age finds in northern Britain

analytical results from a range of 'Arras culture' burials (Arras, Burton Fleming, Cowlam, Danes Graves, Kirkburn, Rudston, Sawdon, Wetwang/Garton Slack) are collected together here. It can be seen that there are more samples from the 'Arras' burials than all the other sites put together. In addition the types of finds found differ. While over half of the objects found in burials are items of horse harness, these are almost never found on settlement sites. The occasional horse harness fittings found on settlements (e.g. Huckhoe [Jobey 1959]) usually date to the late Iron Age or Roman period. The evidence from Weelsby Avenue consists mainly of debris from metalworking but this is rare at other sites.

Alloying in the Iron Age: Tin

Previous workers (especially Craddock and Northover) have established that Iron Age copper alloys are almost exclusively of tin bronze. Levels of lead and zinc (common as alloying elements in the Roman period) are very low in Iron Age alloys (see below). Figure 5:1 shows the distribution of tin content in Iron Age alloys analysed for this thesis.

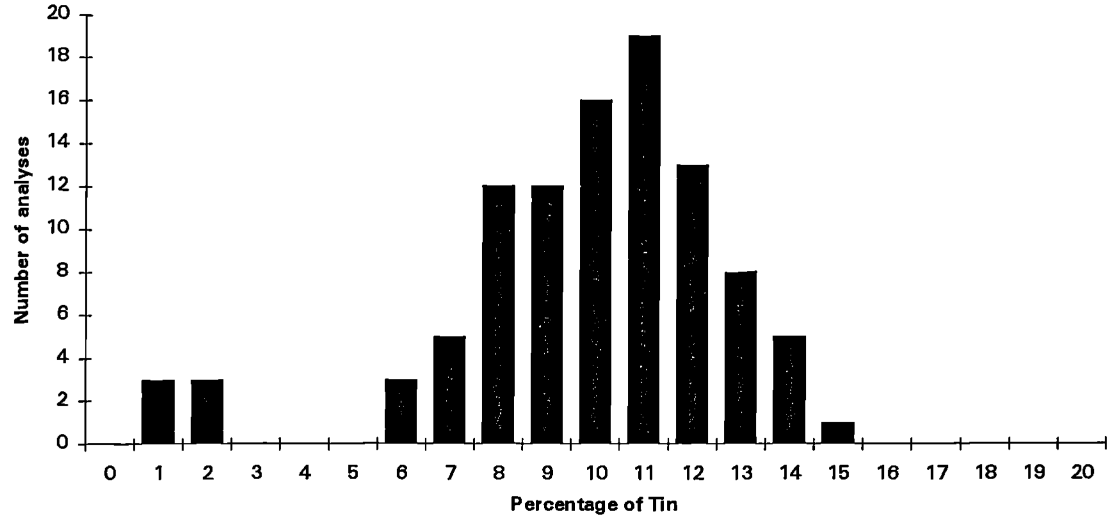

Figure 5:1. Tin content of Iron Age copper alloys (from northern Britain)[1]

The overall distribution is nearly normal around 11% and may suggest the widespread

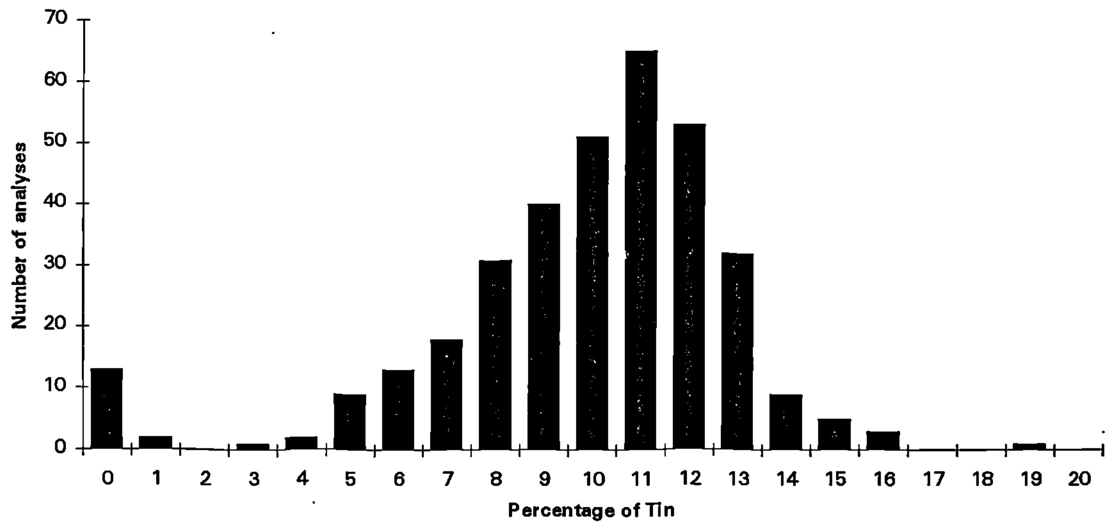

Figure 5:2. Tin content of a range of Iron Age copper alloys (previously published results) (Source: Barnes 1985; Cowell 1990; Craddock 1986; Northover 1984a; 1987; 1991a; 1991b)

[1] All barcharts used in this thesis were produced using the Excel computer spreadsheet programme. The labels for the individual bars are given as single numbers (in the case of figure 5:1 as 0, 1,.2,.3, etc). Each bar actually represents a range of compositions (in the case of figure 5:1, 0-0.999, 1-1.999, 2-2.999, 3-3.999, etc).

use of a 'standard' alloy type. This overall distribution is similar to that found in previously published Iron Age copper alloys analyses (figure 5:2). The data in figure 5:2 is published in Barnes 1985 (Hunsbury, Northants), Cowell 1990 (Camerton hoard), Craddock 1986 (various stray finds from Britain and Ireland), Northover 1984 (Danebury, Hampshire) Northover 1987 (Hengistbury Head, Dorset), Northover 1991a (Maiden Castle, Dorset), Northover 1991b (Danebury, Hampshire). A few of the Hengistbury Head results are unreliable (they were obtained from corroded samples) and so are not used here.

The overall distribution of tin contents shown in figures 5:1-2 is nearly normal

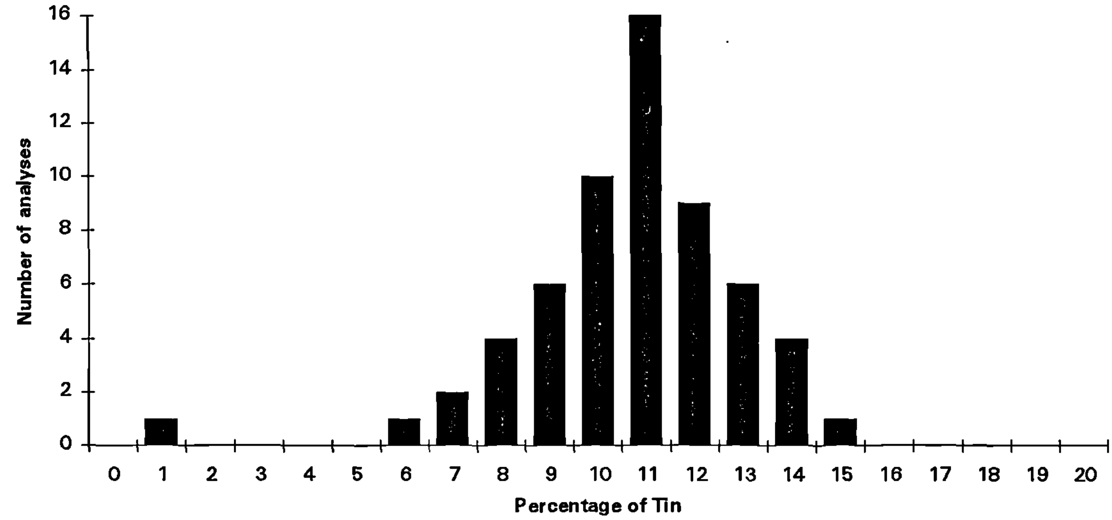

Figure 5:3. Tin content of cast copper alloys (from northern Britain)

but is not exactly symmetrical about the mean value. A closer examination of the

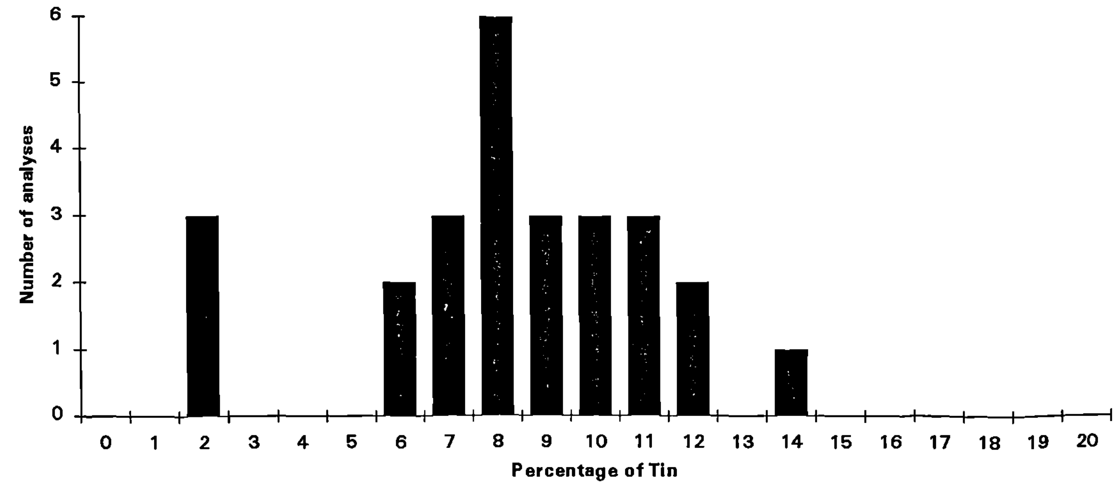

Figure 5:4. Tin content of wrought copper alloys (from northern Britain)

results obtained for this thesis (as shown in figure 5:1) shows that cast objects (figure 5:3) tend to have higher tin levels (mean = 11.2%) than wrought ones (figure 5:4. mean = 8.8%).

The lower tin content of wrought objects would have made them easier to work (this can also be seen in the comparison between the lead content of cast and wrought objects - see below). This may be seen as evidence for the sophistication of the Iron Age smiths. It shows that they had a good empirical understanding of the properties of the alloys they used (even if their understanding was not based on a knowledge of elements), and they selected there alloys accordingly. It is even possible that they could manipulate the composition of the alloy (perhaps through weighing the copper and tin and mixing according to 'recipes'). The lower tin content of the wrought objects may, however, be accidental rather than deliberate. Wrought objects cannot be satisfactorily be made from high tin alloys as they tend to break if worked. Therefore attempts to make wrought objects from high tin bronzes would be more likely to end in failure. Such failed objects may be melted down as scrap and re-used. The lower tin content of wrought objects could be an indirect result of physical metallurgy. It is relatively straightforward to recognise the differences in tin and lead content, it is less easy to know to what extent it was deliberate.

Alloying in the Iron Age: Lead

The lead content of Iron Age alloys (shown in figure 5:5) is generally low.

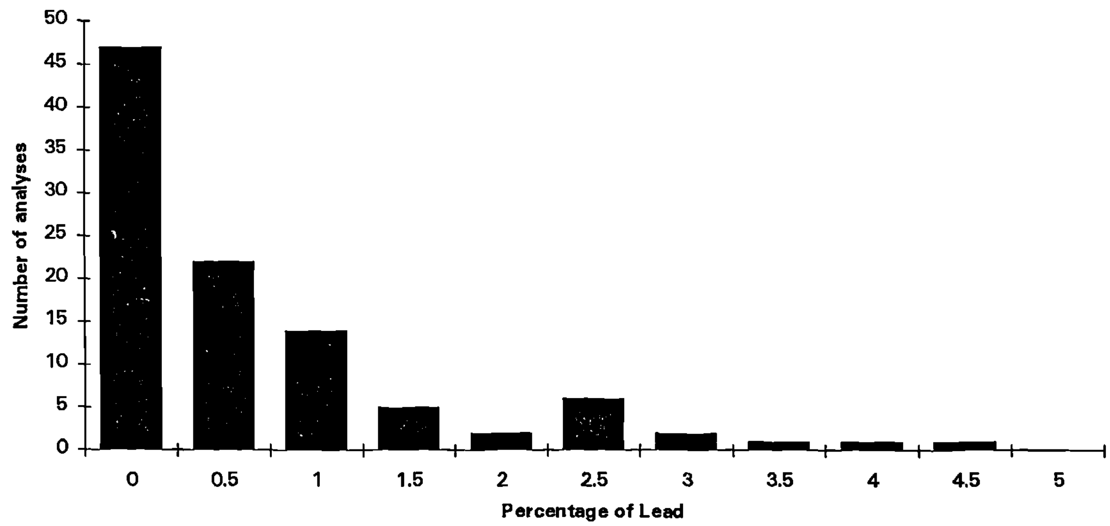

Figure 5:5. Lead content of Iron Age copper alloys (from northern Britain)

The mean lead content is 0.9%, and three-quarters of all alloys have less than 1% lead. Such low levels of lead are probably impurities in the metal. This contrasts with the late Bronze Age (Northover 1982a) where almost all objects have several percent or more of lead present. The lower lead levels in Iron Age copper alloys make it unlikely that recycled Bronze Age scrap was a significant source of metal in the Iron Age. It also contrasts with the Roman period (see Chapter 6) where although many objects have low levels of lead a small proportion have quite high levels (up to 40%). Those few Iron Age objects which have moderate levels of lead are usually cast objects (see Table 5:3). While 31% of all cast alloys have 1% or more lead only 19% of wrought

	Less than 1% Lead	1% lead or more
Cast	69%	31%
Wrought	81%	19%

Table 5:3. Proportions of objects which are leaded and unleaded.

alloys have more than 1% lead. A small addition of lead to the copper alloy would reduce the melting point and increase the fluidity of the alloy, and so reduce the chances of producing a flawed casting. The difference in lead content between cast and wrought alloys might indicate the sophisticated understanding of the copper smiths, but might, like the tin contents, be an inevitable outcome - leaded alloys are more likely to break when worked.

Alloying in the Iron Age: Zinc

Copper alloys containing zinc (brasses and gunmetals) are common in the Roman period (see Chapter 6), but are almost entirely absent from Iron Age copper alloys (see figure 5:6). The few exceptions can be divided into two groups: those with

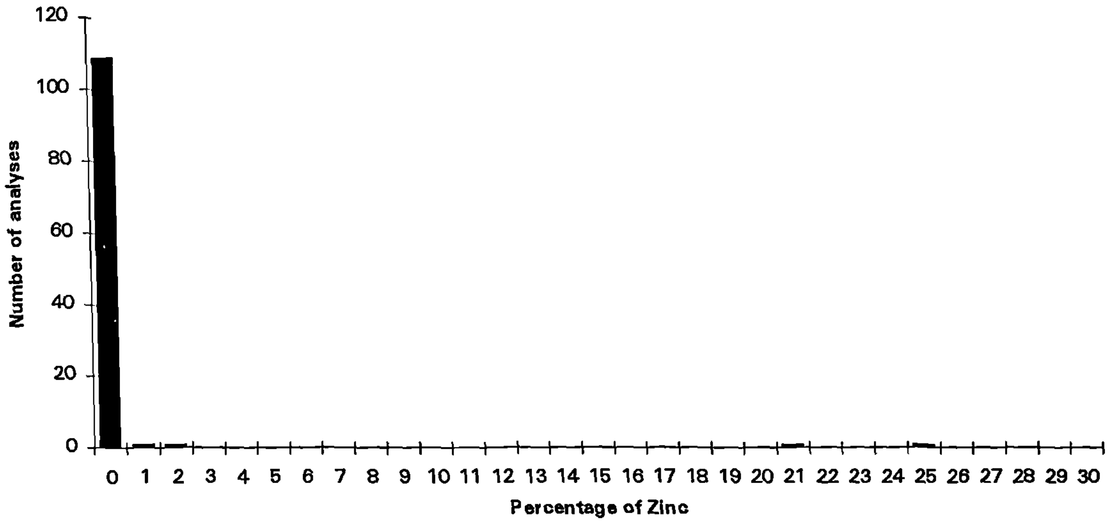

Figure 5:6. Zinc content of Iron Age copper alloys (from northern Britain)

high levels of zinc (usually over 15%) where this was a major deliberate addition, and those with low levels of zinc (under 5%) which may be impurities rather than deliberate additions. The former group includes 2 brooch spring and pin fragments from Dragonby (XRFID 1711 and 1728). The fragments appear to come from simple one piece La Tène III brooches (e.g. Nauheim derivative). This type of brooch is found in Britain and on the continent and was being produced before the Roman Conquest of Britain. Some Nauheim derivative brooches were made of brass (Bayley 1992). These samples, therefore, may be imports to northern Britain and not relate to traditional copper alloy production. Alternatively the objects may be intrusive to the Iron Age contexts within which they were found. At Dragonby the context from which most of the Iron Age objects came from (Field Number 3) also contained a Headstud brooch (XRFID 1731) usually dated to the late first century and early second century AD. There are no high zinc brasses from secure Iron Age contexts in northern Britain, and it is suggested here that high zinc alloys are not a normal feature of the Iron Age in Britain. The use of zinc alloys in Iron Age and 'Celtic' objects is discussed in the following section on the late Iron Age.

The second group of Iron Age copper alloys which contain low levels of zinc (XRFID 1667, 1729, 1851, 1863, 1871, and 2228) may also be intrusive to the Iron Age contexts within which they were found. Alternatively, the zinc may be an impurity in the alloy. This may either result from the use of scrap containing small amounts of (imported ?) brass, or from the use of copper ores which contain zinc (this last possibility is discussed by Northover [in Musson, Northover & Salter 1992] in relation to Iron Age copper alloys from the Welsh Borders).

Impurities in Iron Age alloys: introduction

Copper smelting aims to recover copper from copper ores (oxides, carbonates, etc). Inevitably this is rarely 100% efficient - some copper is lost in the slag. Similarly other metallic elements present in the ore may be reduced with and dissolve into the copper. These other metallic elements are impurities in the smelted metal. The level of such impurities depends on the levels of impurities in the ore (and other materials present during smelting such as the slag and the furnace lining), the smelting conditions, and the degree of metal purification. The interpretation of these metal impurities is fraught with difficulties, in particular, the equation of impurity patterns in a metal object with a specific ore source is difficult. Northover (1982b; 1984b) has attempted to use these metal impurity patterns to determine the source of metal used in the Iron Age. While impurities tell us something about the production processes, our ability to interpret impurity patterns is hampered by a lack of knowledge about the mineral sources and the smelting procedures. The impurities that are seen by Northover as most useful are cobalt and nickel. Craddock & Meeks (1987) have suggested that iron levels reflect something of the smelting procedures used. The analytical results for each of these impurities and their significance is dealt with separately below. Arsenic, however, is seen as the most relevant impurity for this research project as it is regularly found in Iron Age alloys but is almost never found in Roman alloys. While the results for each impurity are shown separately below, a detailed discussion is reserved for pages 73-4 where they can all be considered together.

Impurities in Iron Age alloys: Arsenic

The most striking metal impurity in Iron Age copper alloys is arsenic (see figure 5:7). The relatively high arsenic levels found in Iron Age alloys from northern

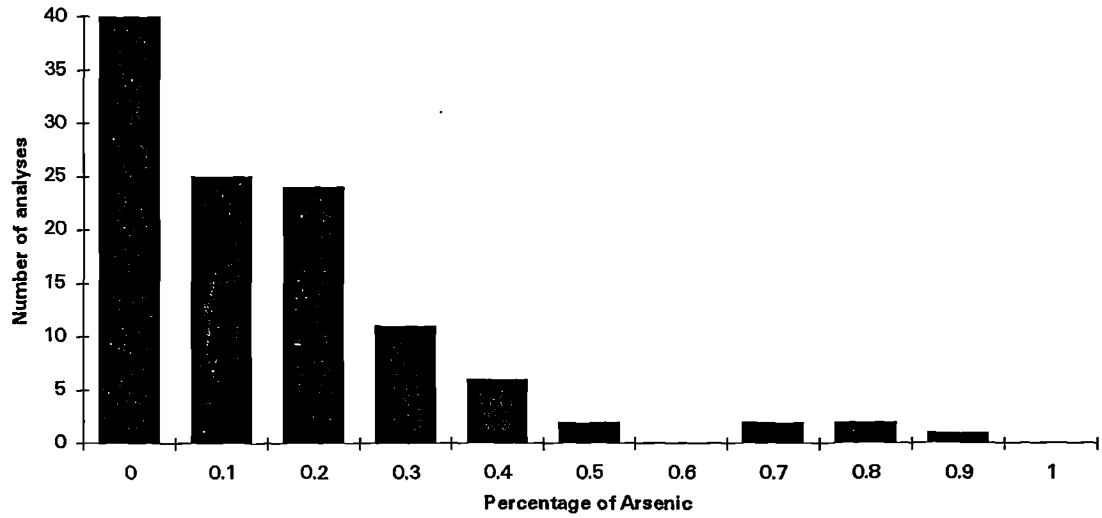

Figure 5:7. Arsenic content of Iron Age copper alloys (from northern Britain)

Britain can be paralleled with the analysis of Iron Age alloys from elsewhere in Britain (see figure 5:8), although arsenic levels in northern Britain are slightly lower. Arsenic as an impurity is therefore a regular feature of Iron Age alloys in Britain. This relatively high arsenic content of all the Iron Age alloys examined contrasts most strongly with those of Roman copper alloys from northern Britain (see figure 6.12) - 85% of all Roman copper alloys had less than 0.10% arsenic.

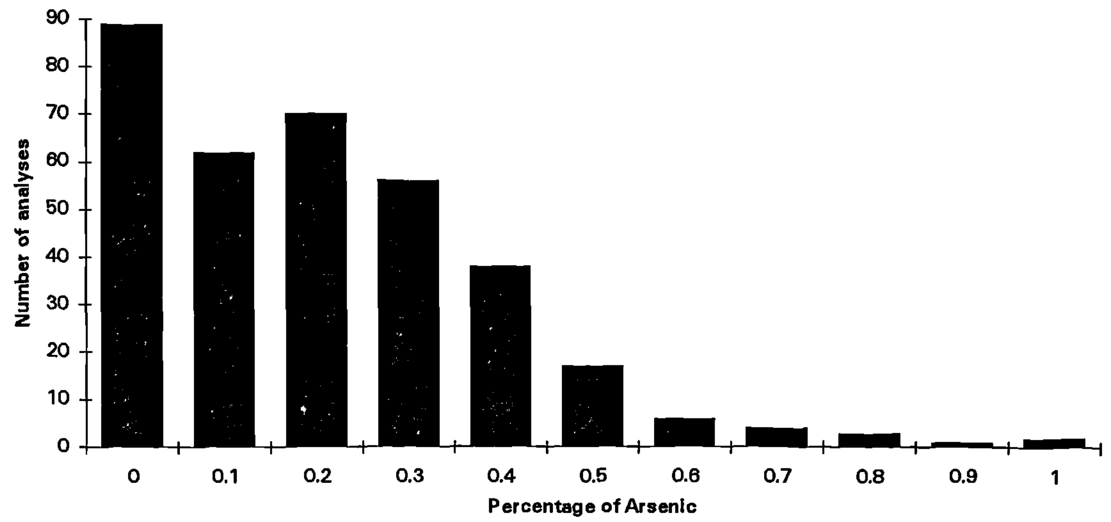

Figure 5:8. Arsenic content of Iron Age copper alloys
(previously published results. Sources as figure 5:2)

Impurities in Iron Age alloys: Iron

Most Iron Age samples analysed contained some iron (see figure 5:9). The

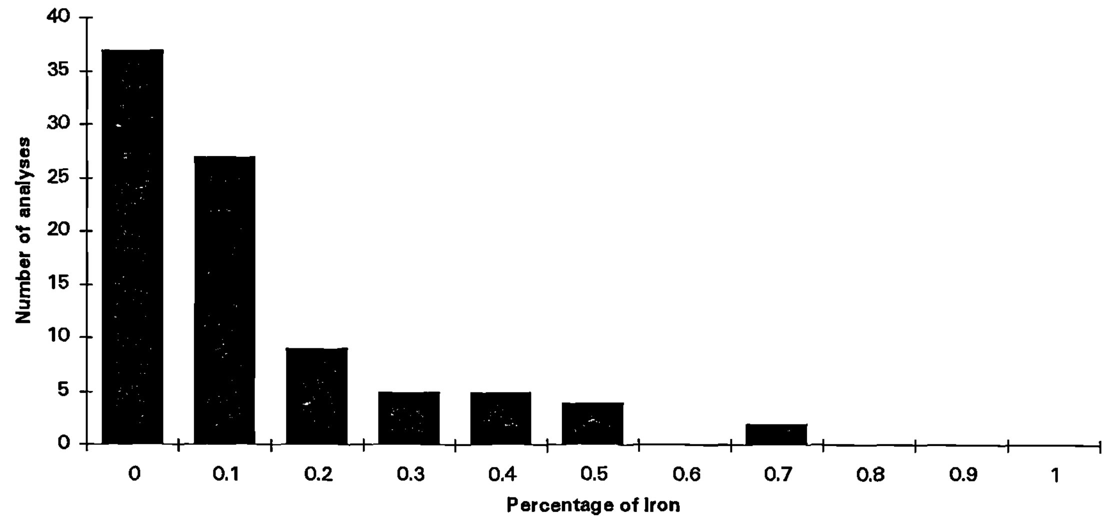

Figure 5:9. Iron content of Iron Age copper alloys (from northern Britain)

levels of iron in Iron Age alloys is generally higher than that found in the Scarborough/Staple Howe alloys (see above) or late Bronze Age alloys (Brown & Blin-Stoyle 1959; Northover 1982b). The mean iron content of the Scarborough/Staple Howe samples was 0.07% (and that largely due to a single high result), whereas the mean iron level in Iron Age samples was 0.20%. The iron content of Iron Age alloys shows more similarity with Roman alloys (figure 5:10).

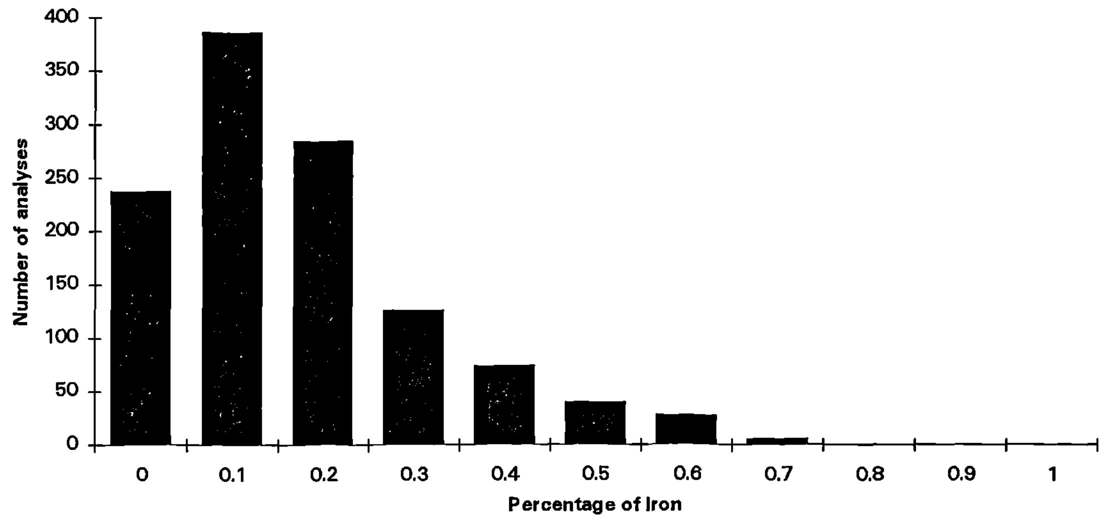

Figure 5:10. Iron content of Roman copper alloys (from northern Britain).

The mean iron content of Roman alloys is 0.24% (only slightly higher than that of the Iron Age ones). In terms of the iron content Iron Age alloys can be seen to bear more resemblance to Roman ones than to Bronze Age ones.

Impurities in Iron Age alloys: Cobalt

Cobalt was detected in a little over half of all the Iron Age samples analysed for

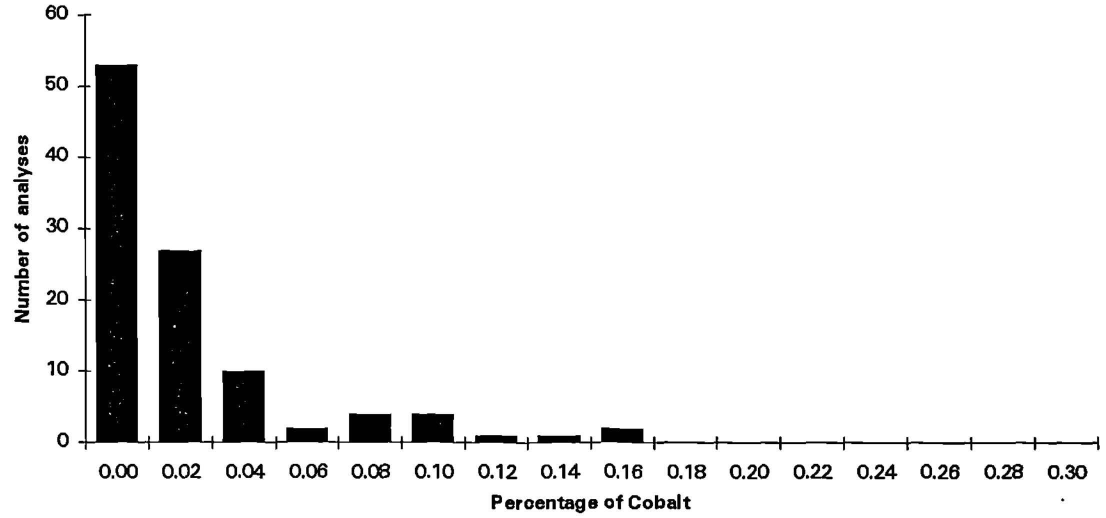

Figure 5:11. Cobalt content of Iron Age copper alloys (from northern Britain)

this thesis (figure 5:11). This is broadly similar to the range of cobalt levels found in a range of other Iron Age alloys (figure 5:12). Overall the cobalt levels in northern

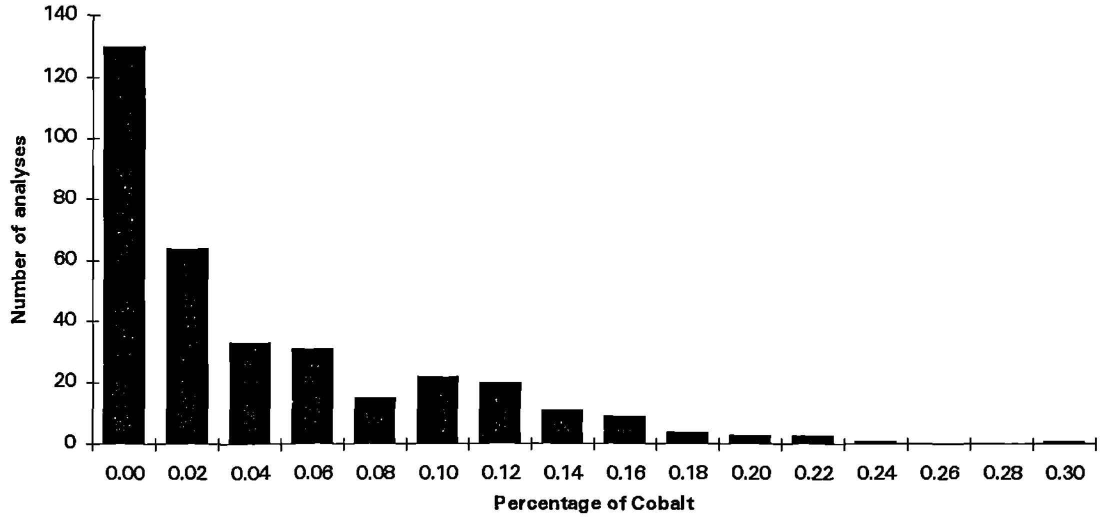

Figure 5:12. Cobalt content of Iron Age copper alloys (previously published results. Sources as figure 5:2)

Britain, however, are slightly lower than in southern England. While 46% of the samples from northern Britain contained no detectable cobalt, only 34% of the southern samples contained no cobalt.

It is not possible to compare Iron Age cobalt results with Roman ones as cobalt was not determined for Roman samples (see Appendix 1).

Impurities in Iron Age alloys: Nickel

Nickel was detected in approximately a third of all the Iron Age samples

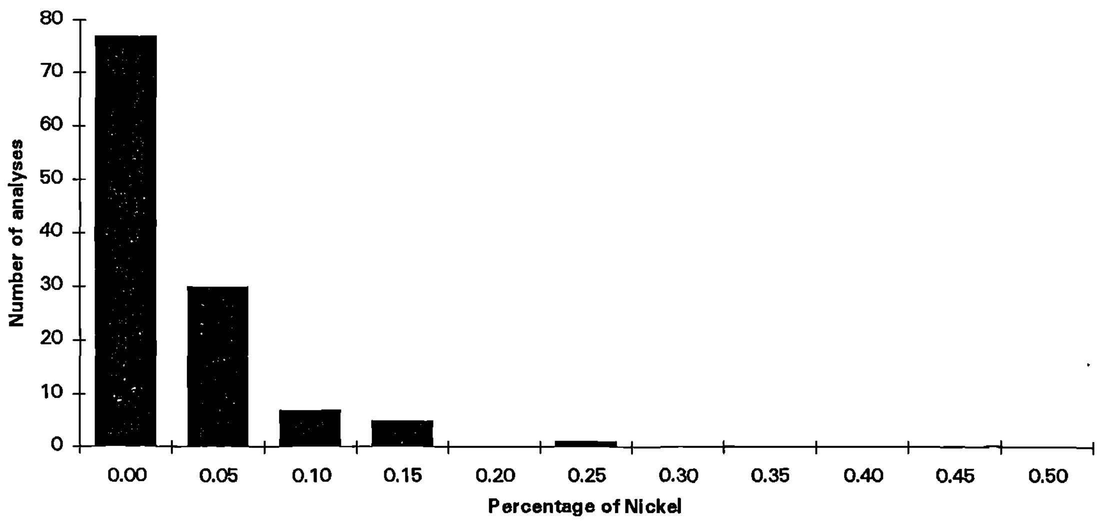

Figure 5:13. Nickel content of Iron Age copper alloys (from northern Britain)

analysed (figure 5:13). This is somewhat lower than the results from southern England (figure 5:14). While 40% of the samples from northern Britain have at least 0.05%

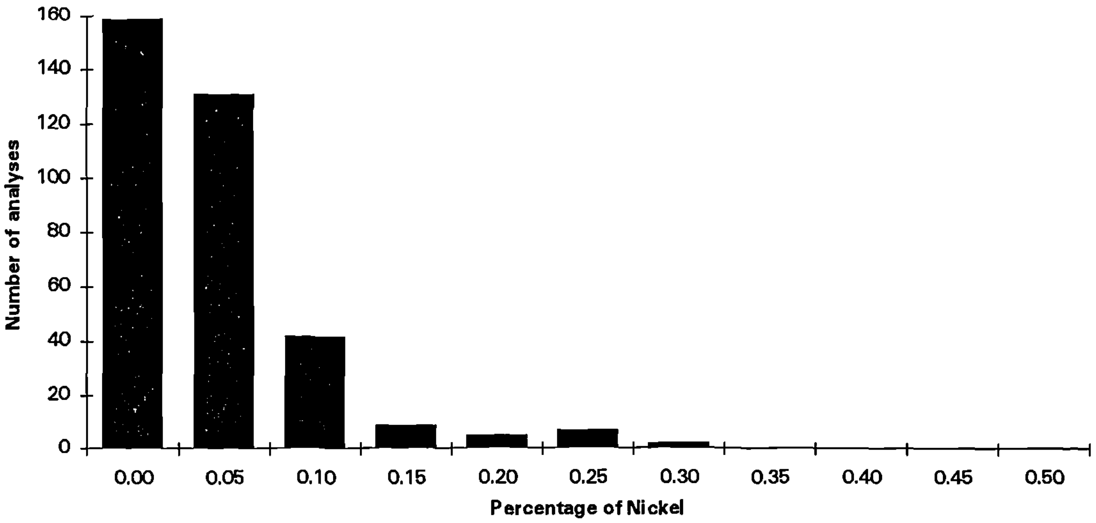

Figure 5:14. Nickel content of Iron Age copper alloys
(previously published results. Sources as figure 5:2)

nickel, 54% of the southern samples have at least 0.05% nickel. The nickel levels in Iron Age alloys is noticeably higher than that found in Roman alloys (see figure 6:11 - only 10% of Roman alloys have 0.05% or more nickel).

Impurities in Iron Age alloys: Conclusions

The above charts show the incidence of metal impurities in the Iron Age alloys of northern Britain analysed for this thesis. These have been be compared with similar results for the Roman alloys from northern Britain and with Iron Age results from southern Britain.

In general, impurity levels in Roman copper alloys are lower than those found in Iron Age alloys. The higher purity of Roman copper alloys might be seen as a reflection of the view that the Roman Empire was an improvement on the cultures it conquered. However, low levels of metal impurities are not detrimental to many of the properties of copper (except electrical properties which are irrelevant for the Roman period). In addition, the improved purity of Roman copper alloys could probably only be achieved at the cost of increased loss of copper into the slag. This would suggest that Roman copper production may have been less efficient than Iron Age production.

It might be tempting to see the difference in arsenic content between Iron Age and Roman copper alloys in terms of ore sources used. It might be thought that the Roman period saw the use of new ore sources and perhaps the abandoning of older sources. However, such an approach does not take into consideration the complexities of ore chemistry, smelting processes, and metal use and re-use strategies (as discussed above).

The metal impurities in Iron Age alloys have been used by Northover (1982b; 1984b) to determine the ore sources used for the production of copper (see the discussion of the problems of this approach above pages 5-6). Northover's early publications (e.g. 1984a) divided samples in to two classes: class I and II. Class I has higher cobalt and lower nickel, while class II has lower cobalt and higher nickel. The labels for these groups have changed in later publications (e.g. the use of a range of letter codes in Northover [1987]) and the groups have undergone some sub-division. The levels of cobalt and nickel have remained important: Northover sees a chronological trend from metal with cobalt as a principal impurity to metal with nickel as the main impurity (i.e. from class I to class II). This is difficult to reconcile with the results from northern Britain as both nickel and cobalt levels in northern Britain are lower than in southern England. If the northern samples were generally early then the nickel levels would be low *but* cobalt would be high, if the northern samples were generally later than the southern ones then the reverse would be true. The fact that nickel and cobalt are both lower in northern Britain suggests that the North had a different supply of copper. This copper may have come from another source or have been smelted differently.

The high cobalt and nickel content of some of the southern English bronzes has been interpreted by Northover as indicating the use of particular ore sources. While the results of analysis have been published piecemeal over almost a whole decade, the interpretation has changed considerably. When considering the higher cobalt metal Northover suggested in the first Danebury report (Northover 1984a) that the source was somewhere in south-west England. In the Hengistbury Head report (Northover 1987) the suggested source is 'Alpine'. In the Maiden Castle report (Northover 1991a) the source is again south-western England (and probably the Tamar valley). Finally in the second Danebury report (Northover 1991b) the suggested source is also south-western England, but it is noted that the same metal type is used for vessels from the site at La Tène. Given the problems of interpreting trace elements in terms of ore source (discussed above), such claims need to be carefully examined. Cobalt is chemically similar to iron and may be introduced to the metal from the flux or furnace lining rather than the ore source. Nickel is chemically similar to copper, and so it should be of more use in attempting to determine the ore sources used. very little nickel was found in objects from 'Arras culture' burials (84% of these objects had <0.05% nickel). Nickel was found in most of the objects from Weelsby Avenue (only 20% of these objects had <0.05% nickel). The copper alloys from northern Britain have lower levels of nickel than the alloys of southern Britain. This may indicate a variety of metal supply networks for the north and south.

Iron Age alloys - Summary

There is little variation in the composition of Iron Age copper alloys analysed for this thesis. Tin is the only alloy element regularly added and so Iron Age copper alloys can be safely referred to as bronze. The same cannot be said of Roman metalwork (see Chapter 6) which is made from a range of alloys; often containing tin, zinc *and* lead. Iron Age bronzes usually contain some arsenic (0.1-1.0%) and this pattern is repeated in bronzes from southern England. The northerly extent of this alloy type is uncertain as the North has produced fewer bronze objects. Nevertheless this alloy type (a tin bronze, with arsenic as an impurity but no zinc present) has been found at Broxmouth and Traprain Law. The alloy type may extend even further north - the analysis of two samples from Sculptor's Cave, Covesea on the Moray Firth (reported in Benton 1930-1) shows the use of zinc-free bronze (in one case with a substantial proportion of arsenic).

The uniformity of the tin bronze used in the Iron Age can be seen in a variety of sites (burials, settlements, and stray finds). There was insufficient contextual data to allow detailed intra-site contextual study of contexts and the alloy composition of artefacts associated with them (cf Hill 1994).

While tin bronze is the standard alloy of the pre-Roman Iron Age many of the stray 'Celtic' finds are made of alloys containing at least some zinc (see below). It is suggested here that there the presence of zinc in 'Celtic' alloys is of some chronological significance. This is discussed further below.

<u>'Celtic' metalwork</u>

The collection of metalwork catalogued by Macgregor (1976) has been regarded as 'Celtic' on stylistic grounds. The dating of this material is difficult, however, as it was mostly discovered in the 19th century and only limited data is available concerning the context or date of deposition. On stylistic grounds it has been assumed that many 'Celtic' metalwork objects were made in the Iron Age. Some of the finds actually come from Roman forts, and so have been dated to the first century AD. It will become clear from the results shown below that most 'Celtic' belongs to the late Iron Age. The two categories are discussed separately, however, as they are defined differently: late Iron Age by context date, 'Celtic' on stylistic criteria.

The analysis of 'Celtic' metalwork may help to shed light on the dating of these objects. A scatter plot showing the zinc and tin contents of 'Celtic' metalwork is shown in figure 5:15. This shows a range of different alloys being used - from bronze to brass. In order to compare these results with those from late Iron Age contexts (see the next

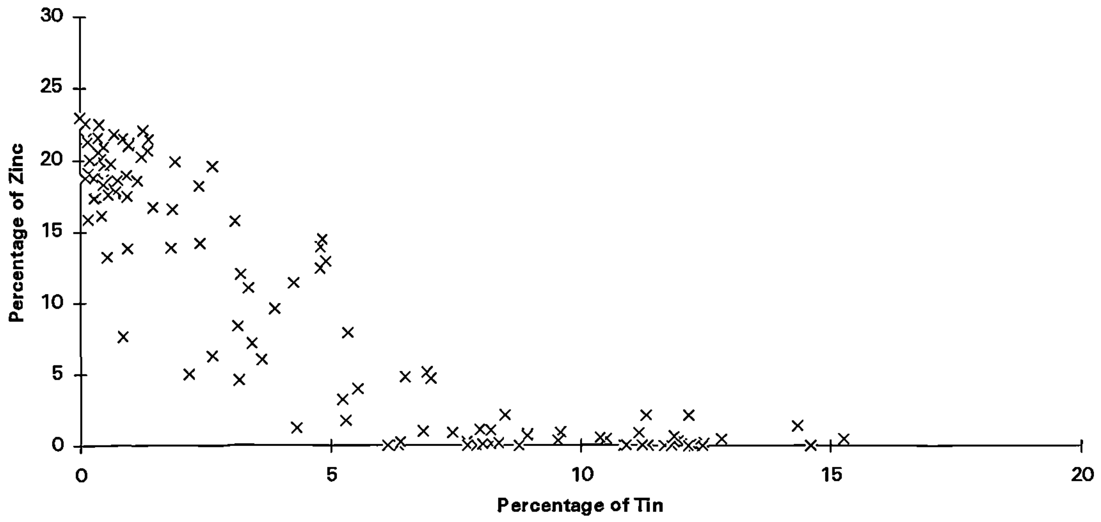

Figure 5:15. Plot of zinc and tin content of 'Celtic' metalwork (from northern Britain).

section below) and Roman alloys (see following Chapters) the results are shown in figure 5:16 as a bar chart using the classification system discussed in Chapter 2 (figure 2:9) and Chapter 6. While a substantial proportion of 'Celtic' metalwork is made of bronze, the majority contains some zinc and many items have zinc as the principal

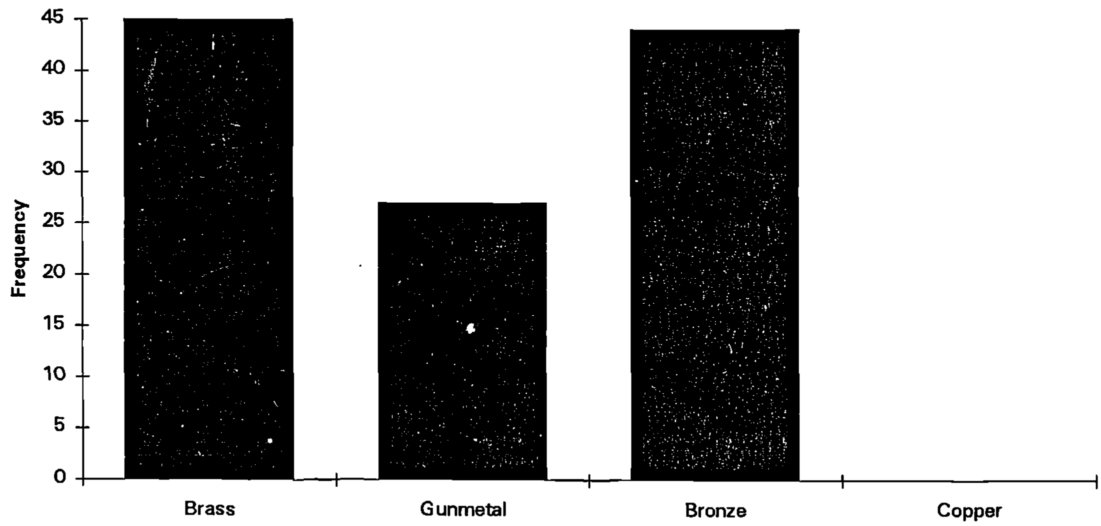

Figure 5:16. Barchart showing the different alloys used for 'Celtic' metalwork (from northern Britain).

alloying ingredient. This is in marked contrast to the Iron Age alloys discussed above which are largely zinc-free, but is broadly similar to the range of alloys used in Roman Britain (see figure 6:6). The relatively high incidence of brasses in 'Celtic' metalwork finds closest parallel with late Iron Age alloys (see next section) and with farmsteads of the Roman period (see figure 10:1). The high incidence of brass in such indigenous contexts is surprising as brass is conventionally regarded as a 'Roman' metal. This is discussed further below (page 82) and Chapter 10.

The contrast between the composition of Iron Age alloys and those of the late Iron Age and Roman period may be of chronological significance. This may perhaps be illustrated by reference to Piggott's 'Celtic' swords (Piggott 1950). Piggott suggested (on typological grounds) that the class III swords were produced in the Iron Age while the class IV were made somewhat later (roughly AD 50-150). The analyses of a series of fittings from these swords is shown in figure 5:17. All of the class III swords are

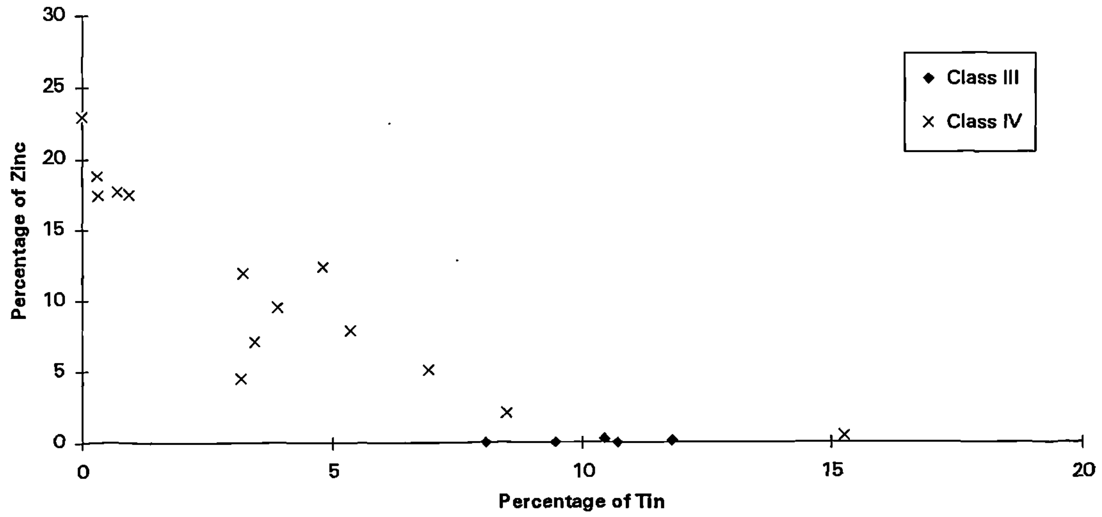

Figure 5:17. Plot of zinc and tin content of 'Celtic' Swords (from northern Britain).

made of tin bronze (with little or no zinc or lead, and arsenic as a common impurity), while the class IV swords are made of alloys containing zinc. Many of the class IV swords have zinc as the principal alloying element. Thus, the analysis of the metal composition tends to support Piggott's typology and dating (although the 'indigenous' alloy type of class III swords could continue to be manufactured after the Roman conquest). The exception to the rule is, however, Pilling Moss (Macgregor 1976: No. 155). This dagger scabbard is usually regarded as belonging to class IV but all of the components are made of tin bronze with little or no zinc present. The division between class III and IV is largely on the basis of the moulding at the tip of the scabbard. The Pilling Moss dagger scabbard has an unusual moulding and it may be argued that it belongs to class III.

The high incidence of brass in 'Celtic' metalwork is strikingly illustrated by the Melsonby (Stanwick) Hoard (Macgregor 1962; Haselgrove *et al.* 1990: 11-13). This large hoard consists of a number of fragmentary sets of horse harness and other items. Most of the items in the hoard are made of brass rather than bronze (figure 5:18), and even the bronzes usually contain at least some zinc. Dating the hoard is difficult as it was recovered in the 19th century and few of the finds can be closely dated on typological grounds. The conventional date of the hoard is the mid first century AD (Macgregor 1962: 36-7). The analysis of a large number of items from the Melsonby hoard has allowed a reappraisal of the grouping of objects into sets. On the whole the sets suggested by Macgregor (1962) and Leeds (1933) on stylistic grounds are strengthened by the analytical results. Figure 5:18 clearly shows that set D items are

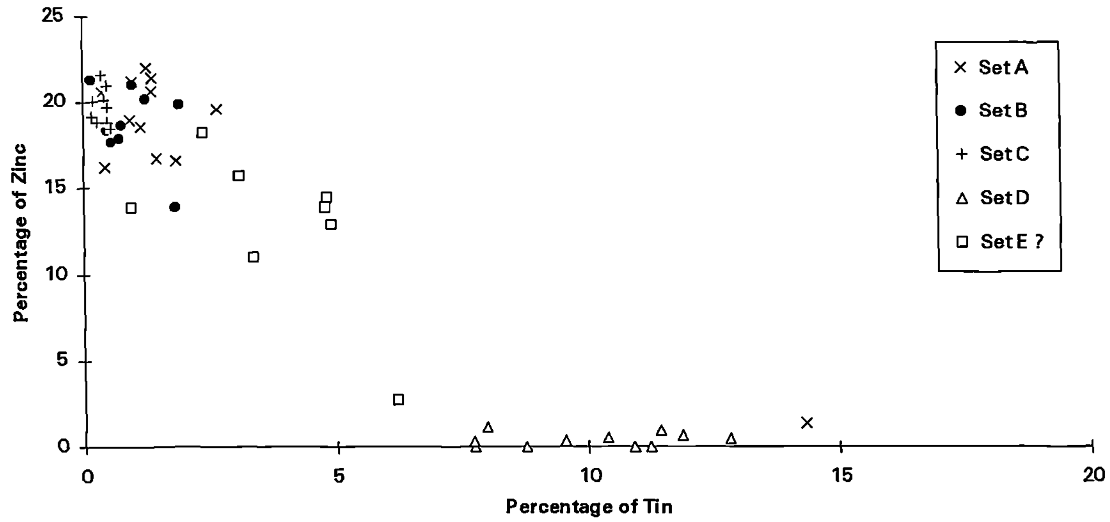

Figure 5:18. Melsonby Hoard: plot of zinc and tin content.

distinctive - all made of bronze (unlike the other sets). The differences between sets A,

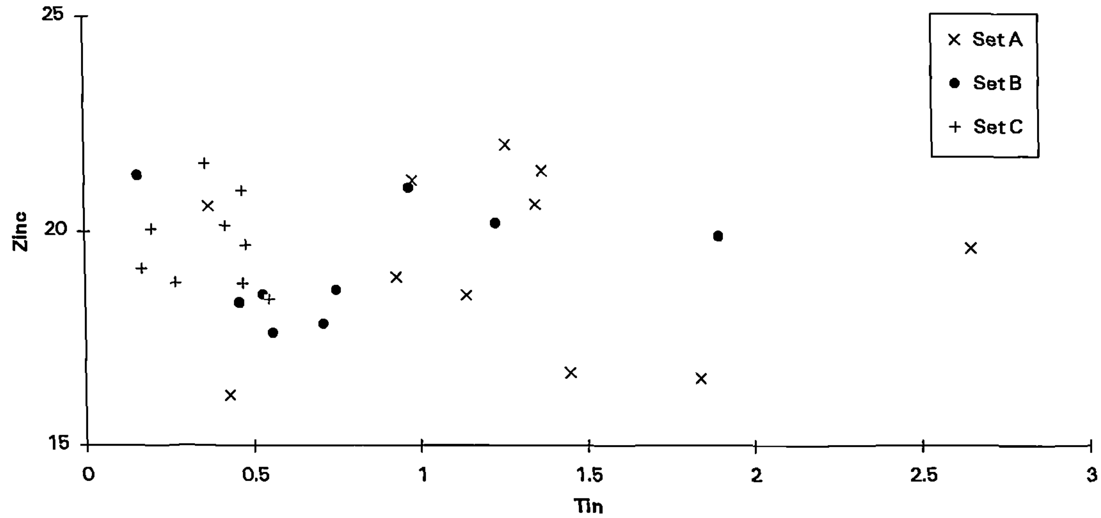

Figure 5:19. Melsonby Hoard: Enlarged plot of zinc and tin content.

B and C can be seen more clearly in figure 5:19 (an enlargement of part of figure 5:18). While all three sets have similar zinc levels (mostly 16-22%) there is more variation in the tin content. There is some overlap in the tin content between these three groups but Set A generally has the highest tin content (mean = 1.34% [excluding one outlier XRFID 2545b]), Set B the next highest (mean = 0.86%), and Set C the lowest (mean = 0.38%). Some of the items analysed did not fall into the compositional groups of Sets A to D. In particular some items all shared a gunmetal composition (mostly 10-15% zinc and 2-6% tin). These items (XRFID 2056, 2565, 2568, 2569, 2570, 2572, 2572, 2573) are all plain and so have not stood out as a group in their own right. They are shown on Figure 5:19 as a possible fifth set (E ?). This possible fifth set is not the same as that suggested by Spratling (1981), a sub-division of Set A into gilded and ungilded items. Spratling's fifth set is not convincing as there are gilded and ungilded items which are stylistically similar (if not identical). The presence or absence of gilding on the surviving items in the hoard should not be credited with too much significance. Most of the items in the hoard are broken, and some have been distorted by high temperature (e.g. Macgregor 1962: Nos 65 and 75). The illustrations in Macgregor (1962) are a little deceptive as the badly distorted items are not usually drawn. The distortion of some of the items by high temperatures has previously been mis-diagnosed as signs of miscasting (Macgregor 1962: 20; Spratling 1981: 14). Temperatures high enough to distort some but not all the items could be obtained in a funeral pyre. The Melsonby hoard may perhaps be the debris from a funeral pyre similar to Folly Lane, St. Albans (Selkirk 1993). It is perhaps no coincidence that one of the items from the Folly Lane burial is stylistically similar to Set C of the Melsonby Hoard.

It was possible to use the overall differences in metal composition between the different sets to confirm some doubtful items, and as a guide when considering those items which had not be assigned to a set (Table 5:5).

XRFID	Macgregor Number	Macgregor Group	Assigned Group
2563	44	B/D	B
2566	34	B?/C?	B
2552	32	A?/B?	B
2003	25	?	D
2004a & b	79	?	D
2562	43	B/D	D
2027	21	?	D
2020	80	?	D
2575	88	?	D

Table 5:4. Melsonby Hoard: assigning previously uncertain items to sets

The suggestion that zinc-free alloys are a regular feature of the pre-Roman Iron Age and that alloys containing zinc are largely a phenomenon of the Roman period is not a new one in the context of 'Celtic' metalwork. This issue was discussed by Savory (1964) and Spratling (1966) in relation to the Tal-y-Llyn hoard and by Megaw (1967; 1971; 1973) in relation to 'Wraxall' collars.

Savory's publication of the Tal-y-Llyn hoard (1964) suggested that the items dated to the 4th or 3rd centuries BC. It was noted that some of the objects were made of a zinc-copper alloy and suggested that such an alloy could be made by reducing local copper ores which occurred with zinc ores. In a response, Spratling (1966) noted that the hoard included a Roman-type lock plate. Spratling also argued (citing Tylecote [1962]) that copper alloys containing high levels of zinc could not be accidentally produced due to the volatility of zinc. The publication of the analyses of some of the Tal-y-Llyn objects in Savory (1971 Appendix 1) revealed that some had zinc contents in excess of 15%. Such high levels of zinc are unlikely to be the results of smelting a copper ore rich in zinc ore (the volatility of zinc is discussed further in Chapter 7). Analyses of other Welsh 'Celtic' objects (Cerrig-y-drudion, Llyn Cerrig Bach, and Tre'r Ceiri - reported in Savory [1971 Appendix 1]) suggest that tin bronze (rather than brass) was the standard copper alloy of the Welsh Iron Age. As high zinc alloys are unknown before the last quarter of the first century BC the Tal-y-Llyn hoard brasses are unlikely to have been made before the end of the first century BC.

In discussions of 'Wraxall' type collars Megaw (1967; 1971; 1973) used analytical data to support a first century AD date. Most of the collars analysed contained at least some zinc (see also Beswick *et al.* [1990]). The massive armlets found mainly in Scotland (Macgregor 1976: Nos 231-50) are another type of 'Celtic' metalwork which has been analysed (Tate *et al.* nd). Most contain at least some zinc and so should be dated to the first century AD or later (this is in agreement with the typological dating of the objects [Macgregor 1976]). Other Scottish material from the Roman Iron Age is also made of alloys often containing some zinc (Fraser Hunter personal communication).

The first wide spread production of brass in Europe occurred towards the end of the first century BC (see Chapter 8). The first Roman brass coins provide a *terminus post quem* for brass artefacts in northern Europe. It is suggested here that 'Celtic' copper alloys containing substantial proportions of zinc were produced from the beginning of the first century AD. It is assumed that the chief source of brass in northern Europe outside the Roman Empire was the Empire itself. Alloys with minor levels of zinc (a few percent ?) could, however, derive from the smelting of mixed copper-zinc ores and so could be dated much earlier. The presence of 'Celtic' items in the first century AD (and later) made of brass is less cause for surprise. Many 'Celtic' hoards also contain Roman military equipment (e.g. Camerton [Jackson 1990]; Fremington Hagg [Webster 1971]; Seven Sisters [Davies & Spratling 1976]; Santon [Smith 1908-09; Spratling 1975]). It is likely that 'Celtic' brass was obtained from the Roman world. The discussion of remelting alloys containing zinc in Chapters 8 and 9 points out that it is virtually impossible to remelt a brass and not suffer a loss of zinc. It is apparent that many 'Celtic' brasses have fairly low zinc levels (often 15% or less) while the theoretical maximum content for Roman brass made by the cementation process is around 28% zinc (Werner 1970; Craddock 1978). The maximum zinc content of 'Celtic' brass (analysed for this thesis) is 22.95% while the maximum zinc content of Roman brasses (again of those items analysed for this thesis) is 26.16% On the face of it then, 'Celtic' brass would seem to be melted down Roman scrap brass, however, the mean zinc content of 'Celtic' brass (19.4%) is not lower than that of Roman brass (mean = 18.8%) but higher. This apparent contradiction may be resolved by a reconsideration of the production and re-use of Roman brass. This is discussed in more detail in Chapter 8 where it is argued that the majority of both 'Celtic' and Roman brass objects in the archaeological record have probably been produced by recycling freshly produced brass. As such 'Celtic' brass should not be viewed as an inferior product compared to most Roman brass.

Late Iron Age copper alloys

The category late Iron Age is used to indicate the period of (perhaps intensive) contact between Britain and Rome before the Conquest (Haselgrove 1989). As discussed above it is discussed separately from 'Celtic' metalwork as the two categories are defined differently. The late Iron Age does not have exact chronological boundaries as the Roman Conquest was not instantaneous and many areas of Britain would have seen little or no evidence of Roman control. Under these circumstances many aspects of indigenous life (including copper metallurgy) may have continued after the conquest of Britain. For the purposes of this discussion the late Iron Age in northern Britain is assumed to start in the first century BC and end in the first or second century AD. For those areas outside the Roman empire (such as most of Scotland) there is no Roman period *per se* to separate the Iron Age and the early Christian era. It is usual to label the Roman period the Roman Iron Age.

Many of the indigenous rural sites examined have Iron Age and Roman phases, but do not have any significant stratigraphical or ceramic changes to indicate the 'moment' of transition. The exact dating of mid to late first century contexts at these sites is almost impossible. As a result some of the samples collected from late Iron Age sites may post date the Conquest.

Most of the objects from transitional phases on rural sites are classified as late Iron Age to distinguish them from the Iron Age (with little or no contact/influence from Rome) which was discussed above. Those finds from Iron Age contexts which contained high levels of zinc are clearly 'intrusive' (see above page 66-7) and so are dealt with in this section. The samples from late Iron Age sites are shown in Table 5:5. Most of the items are brooches and horse harness fittings are almost unknown. This is markedly different to the Iron Age burials (Table 5:2).

The late Iron Age artefacts considered here are those which can be so assigned on stratigraphical grounds. They are distinct from the 'Celtic' objects considered above

	Brooches	Toilet Implements	Horse Harness	Sheet	Droplet	Miscellaneous	Total
Dragonby	5	1					6
Redcliff	12	3		2		3	20
Thorpe Thewles				1	2	1	4
Dod Law	2					1	3
Others	1		1			2	4
Total	*20*	4	1	3	2	7	37

Table 5:5. Distribution of analysed late Iron Age finds in northern Britain

As with 'Celtic' metalwork, many of the late Iron Age alloys contain some zinc and the proportion of brasses (figure 5:20) is higher than that of Roman alloys. The similarity

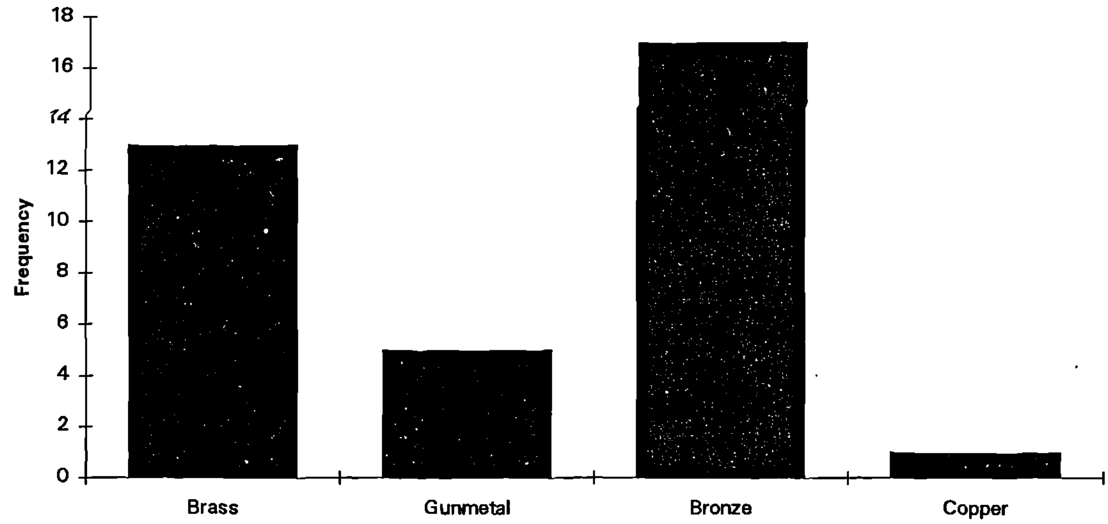

Figure 5:20. Late Iron Age Alloys in northern Britain.

between the late Iron Age and the 'Celtic' alloys strengthens the proposition that the two categories are linked in some way. Even though 'Celtic' metalwork is defined stylistically and late Iron Age metalwork on contextual associations, the similarities between the two indicate that they are of the same date.

There is a higher proportion of brass in indigenous contexts (late Iron Age, 'Celtic' and Roman period rural settlements) than in ordinary Roman metalwork. This is surprising given that brass is a often regarded as a 'Roman' metal. It was not invented by the Romans but they were certainly the first to produce brass in Europe on a large scale. This is all the more striking when it is realised that Roman brass production began in the first century BC just as the Iron Age in Europe was ending. The speed with which brass disseminated through Europe indicates the complexity of exchange networks at this time.

Summary

The analysis of a range of Iron Age alloys (from the earliest possible objects to those which are contemporary with the Roman occupation of most of Britain) has made it possible to describe and explain the copper metallurgy during this period. There are relatively few differences between the metals of the Bronze Age and the Iron Age and the change from Bronze Age to Iron Age should be seen as a transition. The only two substantial differences between late Bronze Age alloys and Iron Age ones are the higher iron content and lower lead content of Iron Age alloys. The higher iron content probably relates to the use of a new smelting procedure making more use of free-running slags. The lower lead contents are curious as there is no metallurgical reason why Iron Age alloys should have low lead contents (most are castings). The lower lead levels may reflect changes in the mining and supply of metals or wider social and economic changes in later prehistoric Britain.

The copper alloys of the Iron Age proper are all tin bronze (occasionally with a little lead). Zinc is almost never present in these alloys but arsenic is a frequent impurity. While previous analyses of Roman copper alloys have shown that they are actually a range of different alloys often containing zinc, tin and lead, Iron Age copper alloys can safely be referred to as bronze. The Iron Age alloys of northern Britain are similar to those previously published results for (mainly) southern England. The British Iron Age shows a great uniformity in its alloying tradition and implies wide exchange of materials or knowledge throughout Britain at this time.

The use of a single alloy type (bronze) ends some time towards the end of the Iron Age in Britain. Many items of 'Celtic' metalwork from the late Iron Age are made of alloys containing at least some zinc. This zinc will probably have come from imported Roman brass. Firm dating for the start of this change is not available and the change was almost certainly not instantaneous throughout the whole country. A succession of changes in the late Iron Age which begin in the second century AD and continue through to the Roman Conquest and after. 'Celtic' coinage appears in Britain in the last half of the second century BC, and later coins are produced in Britain. Amphorae are imported from *c.*100 BC onwards, and fine pottery, glassware and metalwork from the last half of the first century BC onwards. Roman (or Gallo-Roman) imports do not appear in northern Britain until the first century AD. There does not seem to be a single historical event which marks either the beginning or the end of the late Iron Age in Britain. The 'Celtic' metalwork made of brass would seem to belong to the late Iron Age. An even more precise date can be assigned in most cases as brass was not produced on any scale in Europe prior to the Augustan coin reforms of 23 BC. This provides a *terminus post quem* for the production of most brass in Europe. It is likely that there was a delay before brass appeared in northern Britain. It is suggested here that all brass in northern Britain was produced from the beginning of the first century AD onwards.

Brass is a relatively common alloy in 'Celtic' and late Iron Age metalwork - even more common than in many Roman contexts (the significance of this is discussed in Chapter 9). In addition the quality of 'Celtic' brass (as measured by the mean zinc content) is not inferior to Roman brass. 'Celtic' metalworkers probably obtained their brass from the Roman world but this brass was not always looted or stolen. They could obtain ingot quality brass, perhaps gifts as part of a treaty between the Roman empire and its northern neighbours (Braund 1984). It must also be considered that non-Roman metalworkers may have learned the cementation process and begun their own production of brass.

There are many changes in copper alloy metal composition through the course of the Iron Age. These changes are not always in step with the chronological horizons of conventional archaeology. The earliest Iron Age shows little change from the late Bronze Age, but considerable change does occur at the start of the middle Iron Age and the during the late Iron Age. This undermines a traditional notion of time, characterised by Collingwood as being neatly divided up into distinct eras

> each with peculiar characteristics of its own, and each marked off from the one before it by an event which in the technical language of this kind of historiography is called epoch-making.
> (Collingwood 1993: 50)

The mis-match between historical and archaeometallurgical evidence is not unique. A similar phenomenon can be seen in the production of Medieval pins (Caple 1991).

CHAPTER 6
ROMAN ALLOYS

Introduction

This chapter sets out the results for the Roman copper alloys from northern Britain. The results for the alloy elements (zinc, tin and lead) are initially dealt with individually, and then considered together (to examine the interrelationships between them). These results are then compared with previously published analyses of objects from other parts of the Roman Empire. The final section sets out the analytical results for some of the metal impurities (iron, nickel and arsenic). Subsequent chapters will examine certain themes (change over time, different alloy use on different sorts of sites, etc).

Sampling

Almost all previous studies of Roman copper alloys have studied a limited range of object types (e.g. statuary, brooches). In order to gain a more representative picture of Roman copper alloys in the study area (northern Britain), samples were collected from all parts of the study area, from all the periods of occupation (with dating primarily by context but supplemented with typological information), from all the types of sites present, and including all the sorts of objects found on these sites. The overall problems and biases of the sampling has already been discussed in Chapter 2. A breakdown of the types of sites investigated and the date of the samples from these sites is shown in Table 6:1.

	First	'Early'	Second	'Mid'	Third	'Late'	Fourth	'Roman'	Total
Fort	116	10	91	3	28	95	31	38	412
Milecastle			1	17					18
Turret			17						17
Town	4	1	11	2	16		17	7	58
Vicus	32	3	103		27	4		41	210
Larger rural settlement	33	17	4	2	3	11	9	47	126
Villa	1	8	20	3	13	52	17	24	138
Farmstead	1	5			2	1		15	24
Hillfort		27				6		8	41
Burial					57				57
Cave		26		4				46	76
Hoard	2	5	1		1		4	17	30
Stray Finds							4	1	5
Total	189	102	248	31	147	173	78	244	1212

Table 6:1. Provenance and date of all Roman objects analysed

While the overall chronology of the samples reflects the archaeology of northern Roman Britain (most of the samples come from first or second century contexts) there is some variation between different types of site. Most of the samples from forts come from the first and second centuries reflecting the intensive construction, and moving activities the army carried out in the early Empire. The extramural civil settlements have provided most evidence in the second century. The relative scarcity of first century samples suggests that there may have been a delay in the setting up of *vici*. There is little third century (and no fourth century) evidence from *vici*, but the evidence from towns is greatest in this late period. Villas are virtually absent before the second century.

While there are overall biases in the evidence and the evidence from different sorts of sites is not always strictly comparable (consisting of different sorts of objects from different sorts of contexts of different dates) this largely reflects the biases of the archaeological record.

Alloying in the Roman Period

The work of Craddock (1975; 1978; forthcoming), Picon *et al.* (1966; 1967; 1968), Beck *et al.* (1985), Bayley (1992), Riederer (1974a; 1974b) has shown that Roman copper alloys were made using the addition of zinc, tin and/or lead to copper. The results presented in this chapter support many of the findings of this earlier work. Zinc is characteristic of the Roman period as this is the first period in Europe when it is regularly used (Craddock 1978). It is of some chronological significance when examining late Iron Age artefacts (see Chapter 5) or determining the authenticity of certain finds. Nevertheless tin remains the prevalent alloying element. Many objects are made from alloys which can be loosely referred to as gunmetals (they contain appreciable levels of both zinc and tin). Modern gunmetals are deliberately made but ancient gunmetals may have arisen accidentally through the mixing of bronze and brass scrap metal. Lead is added in varying quantities (usually to cast objects). The presence of each alloying element (zinc, tin and lead) is dealt with separately below. The results are then brought together to examine the relationship between the different alloying elements.

Zinc

The distribution of zinc contents can be seen in figure 6:1. Forty percent of all Roman alloys had at least 5% zinc. The distribution of zinc in all Roman alloys is fairly flat between 5 and 25%. This apparently even spread of zinc contents is an over-

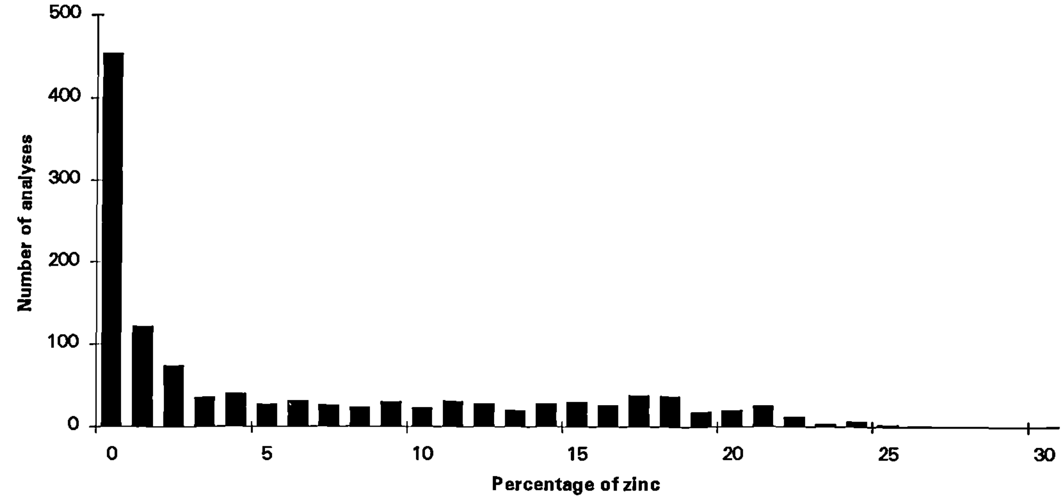

Figure 6:1. Distribution of Zinc contents in all Roman alloys from northern Britain

simplification. Zinc content varies with time (see chapter 8) with - high zinc alloys belonging to the early Roman period. In addition zinc is strongly correlated (inversely) with tin (see figure 6:4). The alloy type classification discussed below (see figure 6:5) defines brasses as those alloys with 15% or more zinc. The method of brass production at this time was the cementation method (Craddock 1978) which could yield brass with a maximum zinc content of *c.* 28%. The paucity of such alloys (those with more than 23% zinc) in all the samples analysed here is striking. The implications are discussed at greater length in Chapter 8.

Tin

The distribution of tin contents can be seen in figure 6:2. Tin is found more

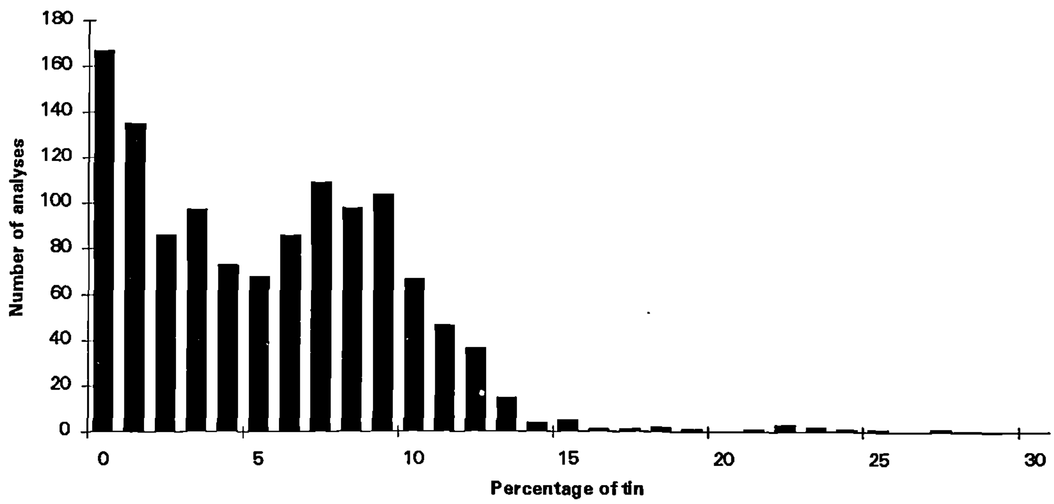

Figure 6:2. Distribution of Tin in all Roman alloys from northern Britain

frequently than zinc in Roman alloys (54% of all alloys have more than 5% tin). The distribution of tin contents is distinctly bi-modal, with one peak around zero (indicating the brasses and more-or-less pure coppers) and another peak *c.* 8-10%. There is a small number of alloys with relatively high tin contents (tin content over 16%). Many of these are mirrors made of speculum (Craddock 1975; see also figure 7:6). For the alloy type classification used here (see figure 6:5) bronzes are alloys with 5% or more tin (except those up to 10% tin where, tin + zinc > 10%). The remaining alloys, except for those with very high copper levels, are classified as gunmetals.

Lead

The distribution of lead contents is shown in figure 6:3. Lead is the least common of the alloying elements in Roman copper alloys (only twenty five percent of all Roman samples had more than 1% lead). In addition the distribution of lead

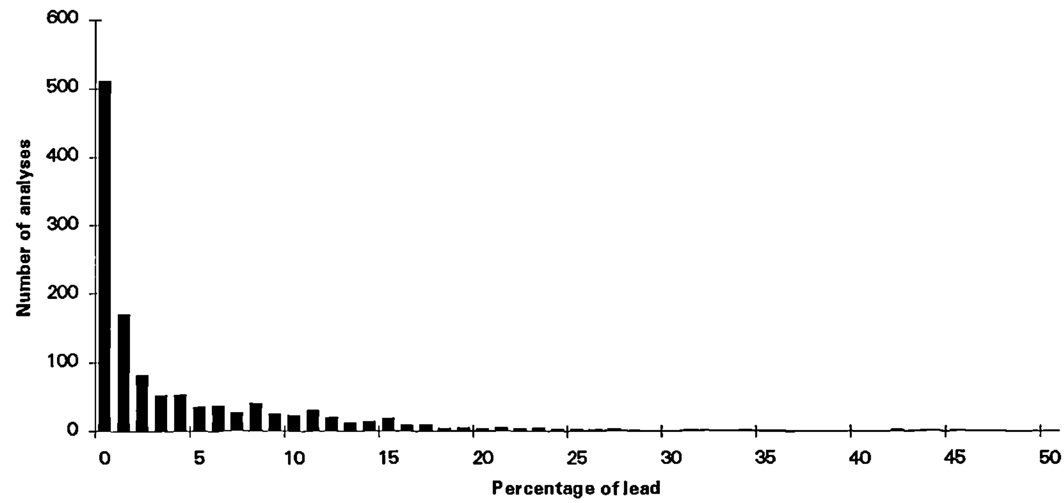

Figure 6:3. Distribution of Lead in all Roman alloys from northern Britain

contents decays logarithmically (only fifteen percent had over 9% lead). Most Roman alloys therefore had relatively low levels of lead, even though 63% of all Roman alloys (where the method of fabrication could be determined) were cast - see Table 6:2. Smythe (1938) noted that lead was found in greater quantities in cast objects than wrought ones. This is confirmed by the results of this project (summarised in table 6:3). A small number of the analysed samples had lead contents which were extremely high (20% or more). Such alloys are not now used because of their poor mechanical strength. They would only be suitable for casting decorative objects which would have to take no strain (including strain during finishing). There is also considerable doubt concerning the accuracy of the lead contents at these levels (in addition to increasing inaccuracy as the calibration equation is extrapolated beyond the lead content of the standards - see Appendix 2). Lead is always present as discrete globules, but at high levels the lead will tend to segregate into a core which may have more lead than

	Cast	Wrought	Unknown	Total
First Century	82	63	44	189
Early Roman	68	20	14	102
Second Century	106	88	54	248
Mid Roman	23	7	1	31
Third Century	74	24	49	147
Late Roman	76	66	31	173
Fourth Century	36	19	23	78
Roman	133	59	52	244
Total	**598**	**346**	268	1212

Table 6:2. Method fabrication (see pages 22-3 above) by date of object

copper. The accuracy of lead determinations for such alloys depends on the number of samples and the siting and depth of the samples. An accurate estimation of lead content can in this situation only be obtained through total wet chemistry analysis of the entire artefact.

	Zinc	Tin	Lead
Cast	5.4	6.6	6.7
Wrought	7.3	4.7	0.7

Table 6:3. Average alloy content (percentage) of cast and wrought alloys (see pages 22-3 above)

The relationships between different alloying elements

Smythe (1938) and Craddock (1975) noted that some of the alloying elements in Roman copper alloys were correlated with each other. In particular, tin and zinc levels were inversely proportional to each other. It is valuable, therefore, to examine the inter-relationships between tin, zinc and lead. Craddock (1975) and Caple (1986) achieved this through 2-D plots of zinc against tin (see figure 2:6). Caple has also used 2-D plots to indicate the gaps in the distribution of alloy type, e.g. alloys containing high levels of zinc *and* tin are almost unknown. In order to examine the relationship between alloy elements, and identify peaks and troughs in the distribution of alloy types a 3-D surface graph is used here (figure 6:4)[1]. The two horizontal axes show the

[1] Note this 3-D chart uses UNIRAS which involves a slight smoothing function. The 'raw' 3-D chart can be seen in figure 2:8.

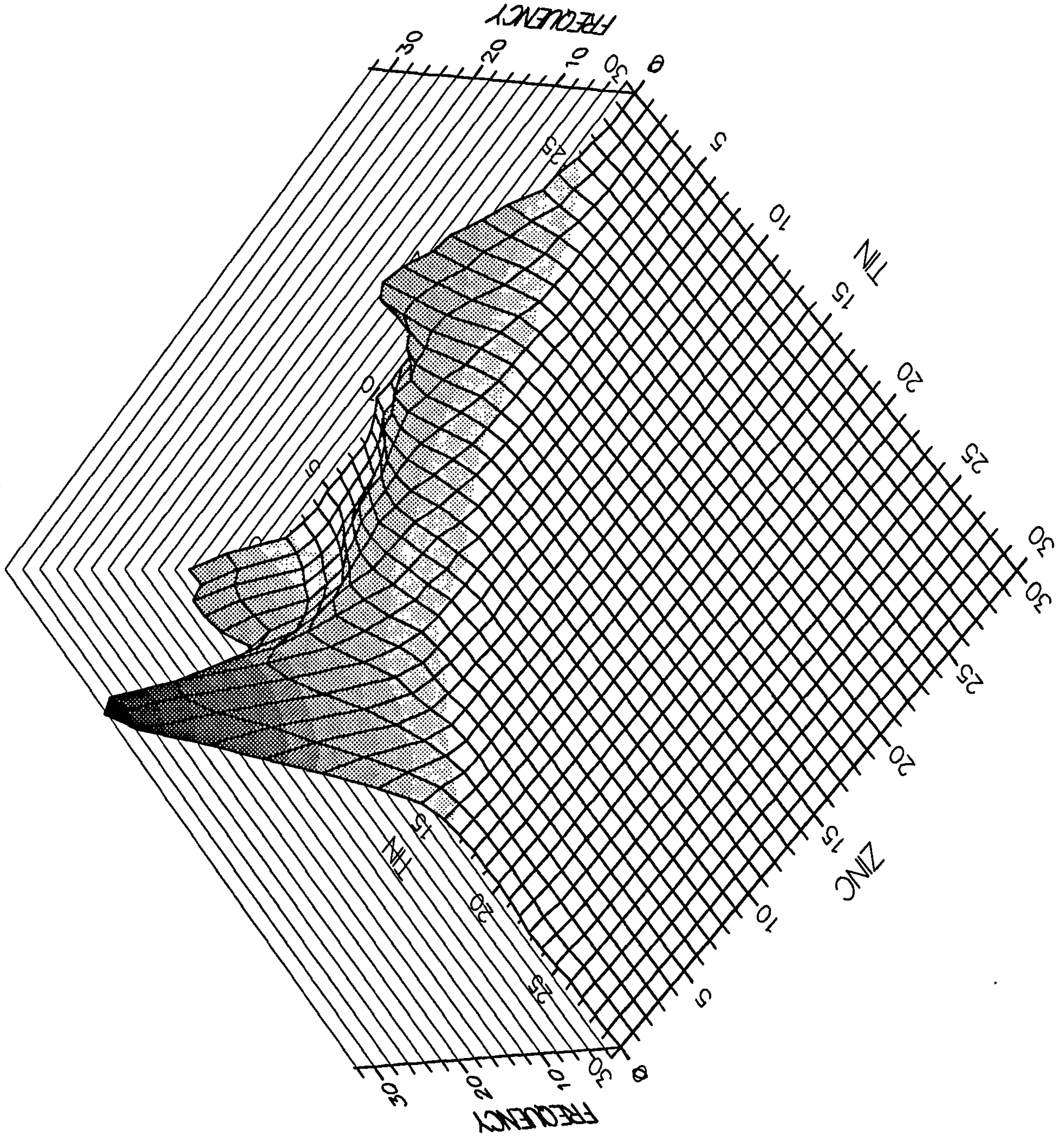

Figure 6:4. Smoothed 3-D surface chart (using UNIRAS) showing the zinc and tin contents of Roman copper alloys from northern Britain (compare with figure 2:8 which uses the raw data).

zinc and tin content while the vertical axis shows the frequency of any particular alloy type.

Figure 6:4 clearly shows two main peaks: one around *c.* 8% tin (with zinc approaching zero) and a second around *c.* 18% zinc (with tin approaching zero). These two peaks are bronze and brass, respectively. It can be seen from this figure that bronzes were commoner than brasses. This is somewhat surprising given the importance (among modern researchers) that is attached to the presence of zinc in alloys of the Roman period.

There is a spread of results between the two main peaks of brass and bronze. This range of alloys are the gunmetals which contain zinc and tin. The lack of any distinct peak in this region suggests that no one intermediary composition was particularly favoured over others. The mixing bronze and brass in varying proportions could have produce the observed pattern.

The almost complete absence of alloys containing moderate amounts of zinc (5-15%) and almost no tin is striking. This suggests that brasses were rarely recycled on their own (if they had then there should be more samples with 5-15% zinc (and no tin). If brasses were recycled they were almost always mixed with bronze.

A third (smaller) peak can also be seen around *c.* 2% tin (again, zinc approaching zero). This metal is technically a bronze (the only alloying element present is tin) but the tin content is very low. Many of the objects made of this alloy are sheet items (for which a low tin content would be appropriate as the metal would be more malleable). In addition, this alloy does not have the pinkish-brown colour of normal bronze but is more like the colour of pure copper. This alloy is referred to here as 'more-or-less pure copper' (or 'copper' for short).

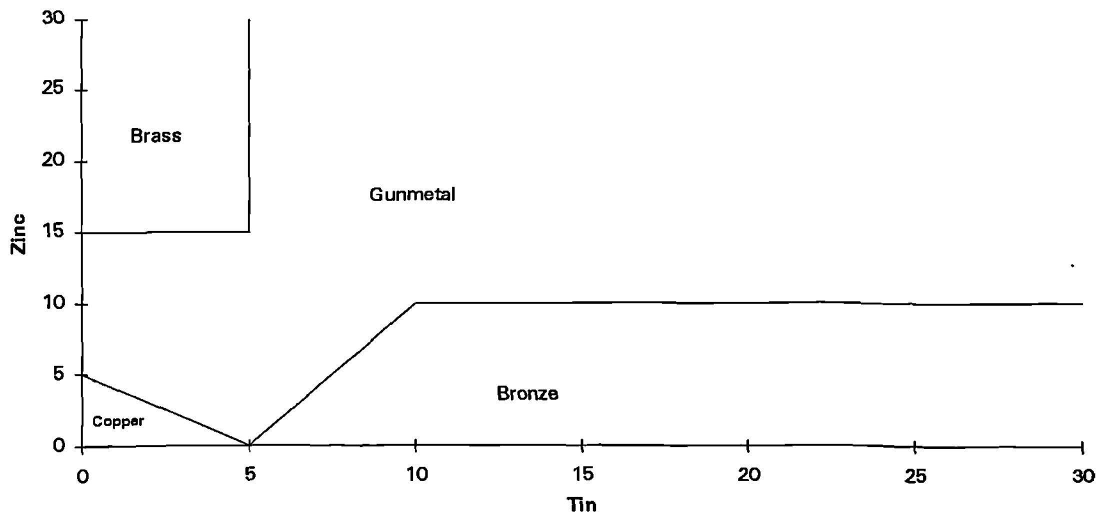

Figure 6:5. Boundaries for the alloy types defined from figure 6:4

The 3-D surface chart (figure 6:4) allows the identification of distinct and favoured alloy types (brass, bronze, gunmetal, and 'copper'). The drawing of boundaries between these four types is not that easy, however. Cluster analysis is of little help here in identifying the centres and boundaries of these types for a number of reasons. Most important is the fact that the centres of three of the alloy types rest against an axis. This makes the distribution of results around them hemi-spherical rather than spherical. Cluster analysis assumes that all its clusters are spherical (Baxter 1994: 155). Cluster analysis would not, for example, place the centre of a 'bronze' cluster near the tin axis (which is where a visual inspection of figure 6:4 would suggest it should go). Ultimately, the placing of the boundaries for the four alloy types has been subjective and based largely on a visual inspection of figure 6:4. The boundaries of the four alloys are shown on a 2-D plot of zinc and tin contents (figure 6:5). The proportions of these alloy types can be shown more clearly on a barchart (figure 6:6).

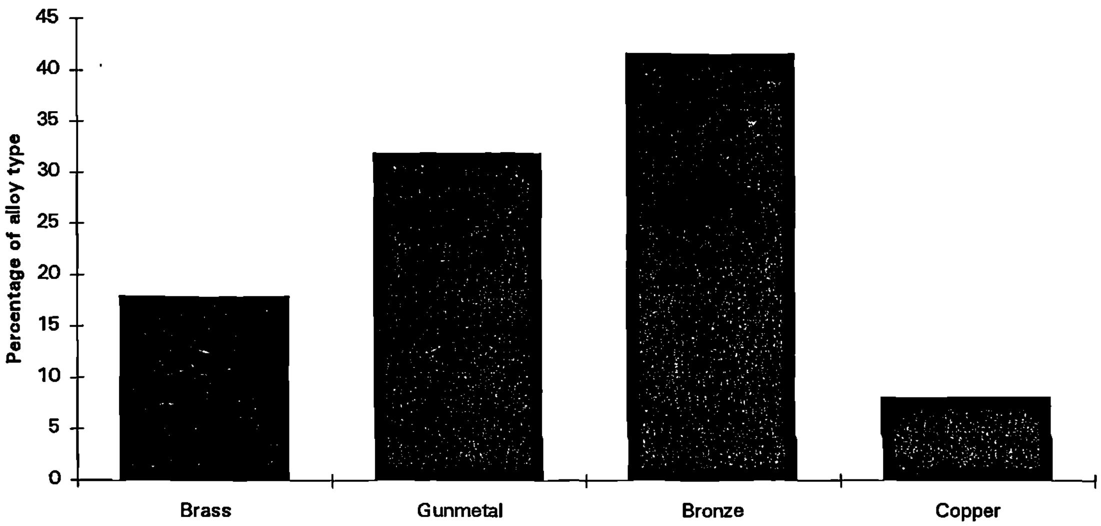

Figure 6:6. Barchart showing the proportions of Roman alloy types

Each of the four alloy types defined above can now be divided into two groups: leaded and unleaded. The amount of lead for this division is 1% (this reflects the difference between unleaded wrought alloys, and cast alloys [often leaded]).

The 3-D surface chart (figure 6:4) cannot, unfortunately, show the relationships between three alloy elements simultaneously. In order to examine the relationship between zinc, tin and lead figure 6:4 is repeated for unleaded alloys (figure 6:7) and for leaded alloys (figure 6:8). The unleaded alloys contain a higher proportion of brass and 'copper'. This is probably because these two alloys are often used for wrought sheet and wire work where a leaded alloy would be inappropriate. The leaded alloys, however, have almost no brass or 'copper'. Bronze and gunmetal are the commonest alloy types for leaded alloys. The proportion of gunmetals is much lower for unleaded alloys than it is for leaded ones. If gunmetals are usually formed as a

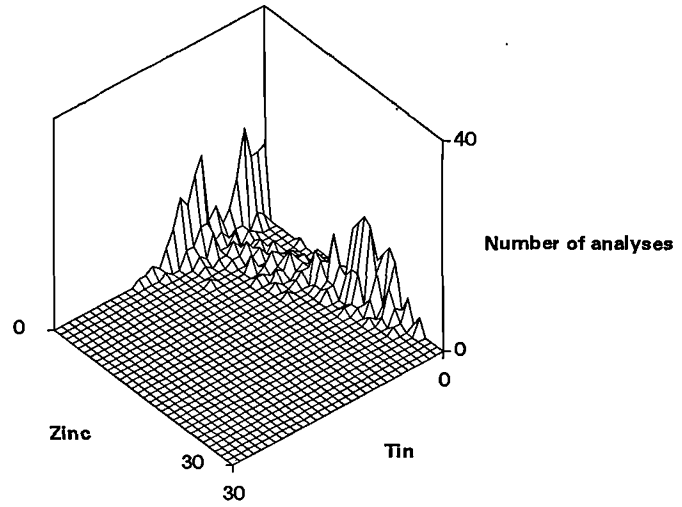

Figure 6:7. Zinc and tin contents for unleaded Roman alloys

result of recycling of scrap metal (as discussed above), then lead would often have been added during recycling. The speculum used for mirrors appears in figure 6:8 but not 6:7 - speculum always contains some lead.

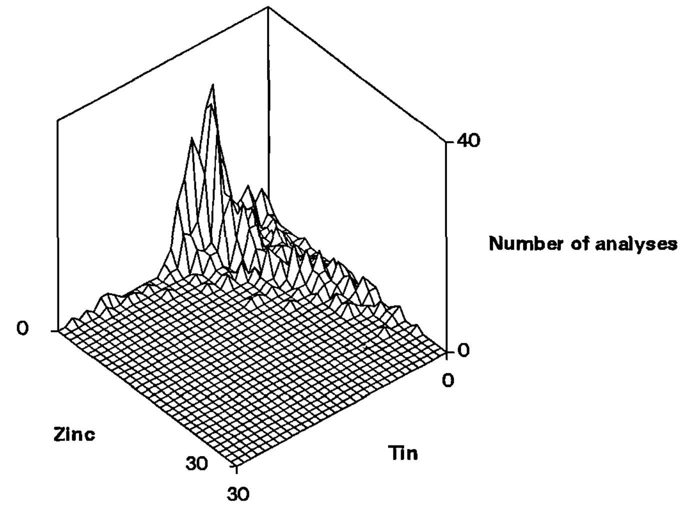

Figure 6:8. Zinc and tin contents for leaded Roman alloys

The 3-D charts showing the distribution of alloy types for leaded and unleaded alloys can be simplified into barcharts (figure 6:9). Barcharts of this type also allow the alloys from different sites, or of different dates to be compared with each other. This is explored further in Chapters 9 and 10.

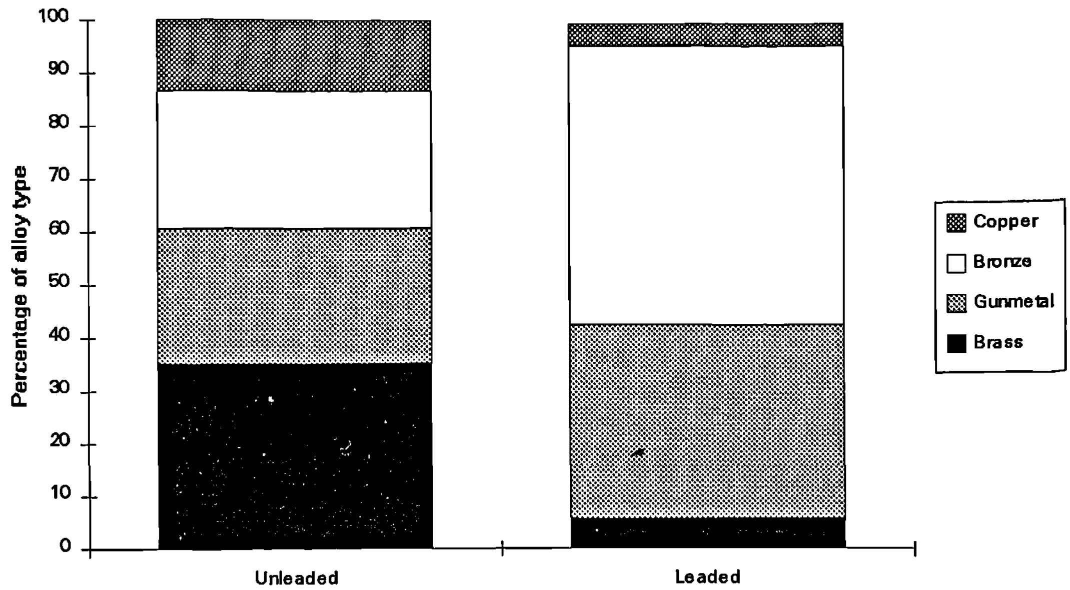

Figure 6:9. Barcharts showing leaded and unleaded alloy compositions (compare with Table 6:2)

Comparisons with Previous Analyses

A large number of analyses of Roman copper alloys have been carried out but the collection of samples has usually constrained in some way. Craddock's work (1975; forthcoming) has largely been restricted to those objects available from museum collections and concentrated on cast objects such as statuary, musical instruments, military equipment, etc. Picon *et al.* (1966; 1967; 1968) and Beck *et al.* (1985) have examined a very large number of statues and statuettes from across France (the latter also examining a limited number of other objects (mostly casting waste and *ex votos*). Riederer has presented the results of the analysis of drop handles, needles, and other objects found in the Tiber during the late 19th century (Riederer 1974a; 1974b; Riederer and Briese 1974; Laurenze & Riederer 1980). Few of these objects could be closely dated and the associated coins range from the 1st through to the 4th century AD. Bayley (1992; Bayley and Butcher forthcoming) has analysed a large number of brooches (mostly from southern England).

The results presented here are based on a wider survey of Roman artefacts and should give a more representative picture of copper metallurgy as a whole. Detailed comparisons with other programmes will tend to highlight differences related to typology and method of construction, rather than differences due to social and economic factors in different Roman provinces. Riederer's results, for instance, show very little use of leaded alloys (only 11% had more than 5% lead, compared to 28% of the samples analysed for this project). This could be interpreted as showing that Britain had greater access to lead than Italy. The lower lead levels in Riederer's objects are, however, a reflection of their method of construction - most needles and drop handles were wrought rather than cast. The work on Gallic statuary suggests relatively little use of brass in Gaul, but Craddock's work has shown the statuary tends to be made from leaded bronze rather than brass. While Bayley's analysis of brooches has used concentrated on a single artefact type (Bayley 1992), the semi-quantitative analysis of a large number of everyday objects from Gorhambury has produced results (Bayley 1990; see also Bayley 1992 for a range of other sites) comparable with those presented here (i.e. roughly 20% of all objects are brasses).

As most previous analyses have been carried out in a typological framework the considerable body of comparative data is of more use in understanding the relationship between alloy composition and object typology. This will be explored further in chapter 7.

Trace elements in Roman Alloys

The Roman alloys are relatively 'clean' compared to Iron Age alloys - generally the levels of impurities in the metal are lower in Roman alloys. This might be taken as indicative of the differences between the Iron Age and Roman societies as a whole. This would, however, impose modern expectations onto ancient metallurgy. Modern alloys are usually very 'clean' (especially if they are to be used for electrical work) and modern metallurgists have come to expect relatively pure metal. Even quite high levels of trace elements, however, are not detrimental to copper alloys when used for the manufacture of decorative castings. Moderate levels of trace elements (0.5% or more ?) such as arsenic and antimony could lead to the formation of a range of highly attractive surface finishes (perhaps in conjunction with inverse segregation) including alloy and patena colours. The lower levels of trace elements in Roman alloys could only be achieved through the use of hotter or more oxidising smelting conditions, repeated smelting, or more rigorous fire-refining purification of the finished metal. All of these processes would tend to reduce the overall yield of copper as more copper would be lost to the slag at each step. Thus Roman copper smelting may have been in this sense less efficient than that in the Iron Age. The Iron Age smelting may have used a more 'appropriate technology' and the Roman period should not necessarily be seen as a technological advance on the Iron Age.

Cobalt levels were not determined for any Roman alloys (see Appendix 1) and so no comparison can be made with the Iron Age alloys in this respect.

Iron

Figure 6:10 shows the distribution of iron contents for all Roman alloys.

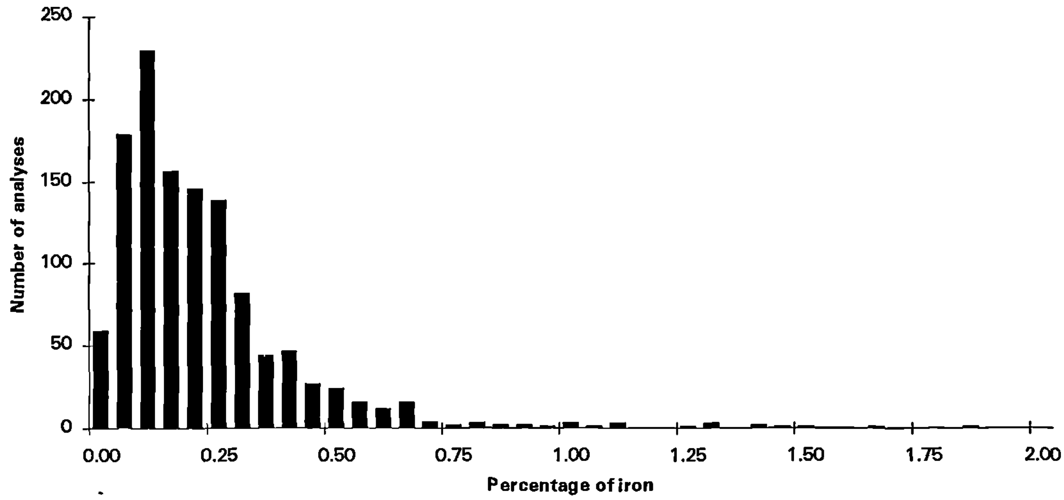

Figure 6:10. Distribution of Iron in all Roman alloys from northern Britain

Iron was the only impurity which was regularly detected in all Roman alloys. Unfortunately iron is possibly the least useful of the elements for use in provenancing copper alloys. Iron would be present in the ore, the flux and the furnace lining, and so it is not possible to relate iron levels in objects directly with ore sources. The level of iron may, however, tell us something about the smelting process used. Craddock & Meeks (1987) argue that the low levels of iron in early prehistoric copper alloys suggests the use of a smelting procedure which did not use a free-running slag (this would explain the lack of copper smelting slags in the Bronze Age). The iron levels in Roman alloys are considerably higher than in Bronze Age alloys and suggests that Roman copper smelting used a free-running tap slag method.

The production of brass by the cementation process occurs under reducing conditions and the brass will tend to absorb any iron present. If the source of zinc is ZnS then this will be roasted prior to smelting and most iron will be removed. If the source of zinc is $ZnCO_3$ then pre-roasting will not occur and the iron levels in the resulting brass should be higher. Figure 6:11 shows that there is no correlation between zinc and iron contents. It is likely that the major source of zinc ore for Roman brass was the sulphide rather that the carbonate ore.

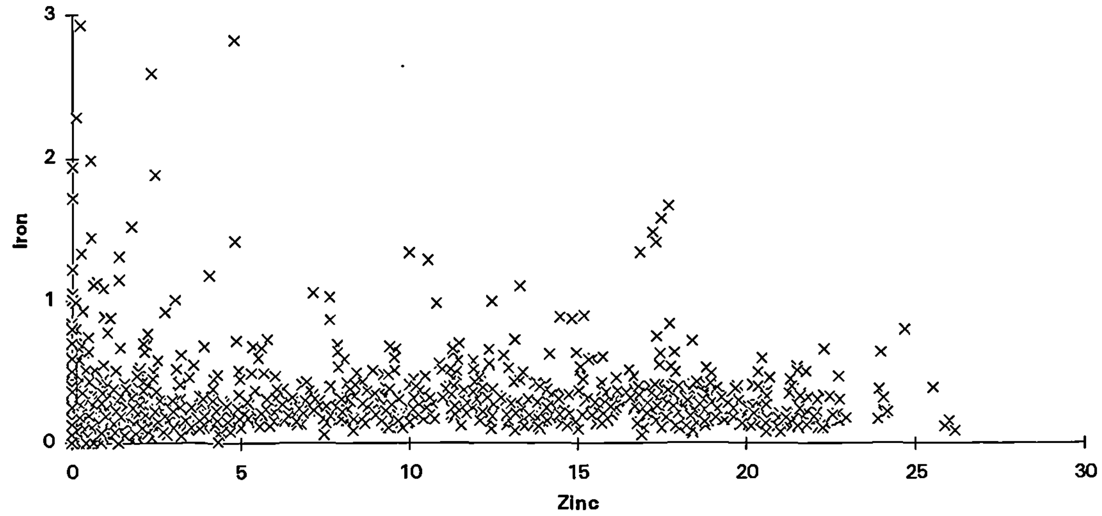

Figure 6:11. Scatter chart showing zinc and iron contents of Roman alloys.

Nickel

The nickel content of all Roman alloys is shown in figure 6:12. Nickel is chemically similar to copper and may be a more useful indicator of the ore source used. However, the nickel levels in Roman alloys are so low as to make it of little use. The nickel content of Roman alloys is lower than that for Iron Age alloys (cf figures

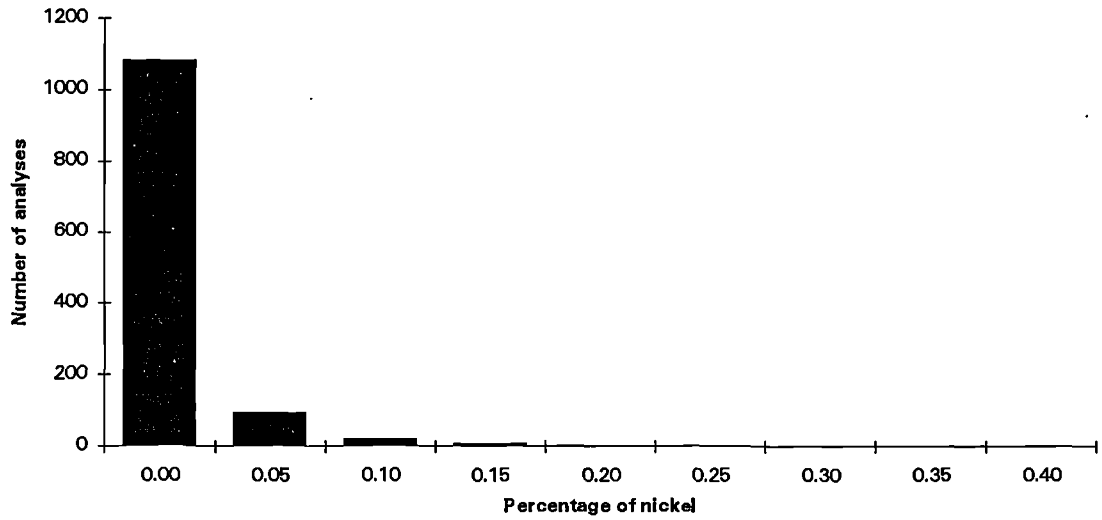

Figure 6:12. Distribution of Nickel in all Roman alloys from northern Britain

5:13 and 5:14). While nickel was detected in a quarter of Iron Age alloys it was detected in only 10% of Roman samples.

Arsenic

The distribution of arsenic contents for all Roman alloys is shown in figure 6:13. Arsenic was detected in only 15% of all Roman alloys. This contrasts strongly

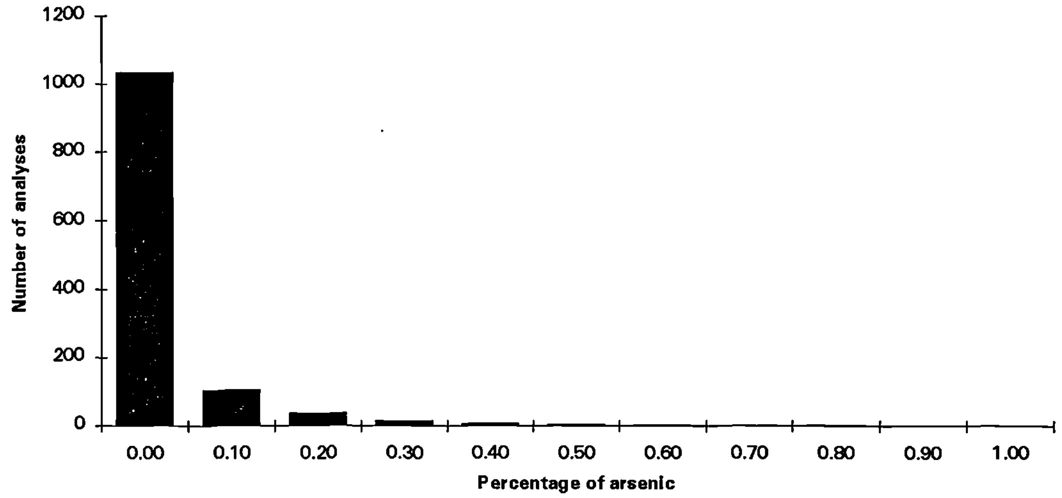

Figure 6:13. Distribution of Arsenic in all Roman alloys from northern Britain

with the results for the Iron Age (chapter 5) where arsenic levels are much higher (arsenic was detected in 62% of all Iron Age alloys).

Summary

Roman copper alloys were manufactured through the addition of zinc, tin and/or lead to copper. The presence of zinc is often seen as important because it first appears in copper alloys on a routine basis in the Roman period. The results presented above, however, suggest that it was not the most important of the three alloying elements. Tin bronze (with varying amounts of zinc and/or lead) still constituted the most important alloy type.

The distribution of zinc and tin contents (figure 6:4) show three distinct peaks: brass, bronze and copper. These three alloy types were probably those which would have been available to smiths. The inverse relationship between zinc and tin suggests that scrap bronze and brass were often mixed together before remelting. Most gunmetals may have been formed in this way. The absence of low zinc brasses shows that brass was rarely recycled on its own (see chapter 8).

Trace element levels in Roman copper alloys are very low and it is unlikely that they will be of much use in provenancing the ore sources used. They do illustrate, however, some of the differences between prehistoric and Roman smelting and alloying. Most striking is the higher arsenic levels in Iron Age alloys compared to Roman ones.

CHAPTER 7
COPPER ALLOYS AND TYPOLOGY

Introduction

Early work on archaeological copper alloys has concentrated almost entirely on the alloys themselves (and this was the approach used in the previous chapter). More recently (i.e. since the early 1970s) the compositions of copper alloys have been related to the typology of the objects concerned (see Chapter 2). One of the primary aims of the present research has been to obtain a representative sample of all copper alloys used in Iron Age and Roman northern Britain, and so there is relatively little scope for an in depth examination of alloy composition in terms of typology. More importantly, a large proportion of the objects analysed for this project are not typologically distinctive (e.g. wire, sheet, droplets). Nevertheless where a substantial proportion of typologically distinct objects has been analysed the results are considered (especially in the light of previous research).

As part of the sampling procedure artefacts were assigned to functional categories: Personal, Household, Military, Transport, Metalworking Waste, and Uncertain. These categories were useful in monitoring the selection of samples and ensuring representativeness. The wider usefulness of the categories is questionable, however, as many items occupy intermediary or uncertain positions within such a classification system. In addition, a classification based solely on function must rely on modern rather than ancient perceptions of function and fails to take into account possible symbolic meanings. The proportions of alloys used for the categories are shown in figure 7:1. There is some variation in the proportions of the alloys used for different categories of artefact.

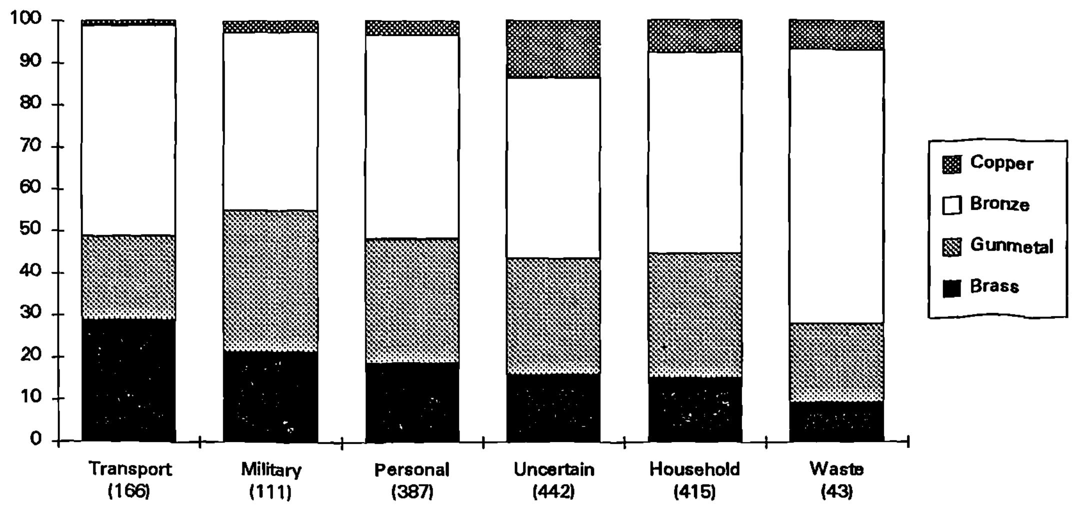

Figure 7:1. Alloys used for different categories of artefact
(Actual number of analyses given in brackets)

The proportion of brass is highest for Transport and Military items and lowest for Metalworking Waste. The variation, however, is relatively slight, especially when this is compared to the variation seen in alloys over time (Chapter 9) and on different sorts of sites (Chapter 10).

Brooches

A variety of different types of Iron Age and Roman bow brooches are known. Two detailed typological examinations of these brooches have been carried out by Don Mackreth and by Mark Hull, but neither has been fully published (Hull's typology and catalogue of Iron Age brooches has been published - Hull & Hawkes 1987). General typological divisions are well-known (based mostly on Collingwood 1930b) but a knowledge of the detailed sub-division of types is largely restricted to a small group of specialists.

Iron Age brooches are plainly different from Roman ones: they are rarer than Roman ones, there are fewer types and most Iron Age brooches are actually made of iron rather than copper alloy. Straight-forward comparisons should, therefore, be avoided. There is no chronological overlap in types between the *early* Iron Age and the Roman period. Late Iron Age types do overlap, however. One-piece brooches derived from La Tène III types (e.g. Colchester A and Nauheim derivative) and early hinged brooches (e.g. Rosette) span the 20 or 30 years around the Roman conquest. The Roman period sees an expansion in the number of different types of brooches produced (Colchester B, Polden Hill, Dolphin, Trumpet, Headstud, etc — see figure 7.2). These brooches are common on Roman sites occupied in the first two centuries AD. The later Roman period sees a dramatic decline in the deposition of bow brooches which may or may not reflect a decline in the use of such brooches. Knee brooches belong to the second and third centuries while Crossbow brooches are dated to the third and fourth centuries.

The range of alloy compositions of Iron Age and Roman brooches has been dealt with in detail by Bayley (1992). The alloys used were often specific to the types of brooches, and distinct alloy compositions also pointed out flaws in the typology used (Hull's). A re-assessment of Hull's typology in the light of Bayley's analyses is forthcoming (Bayley & Butcher forthcoming). All the results of the brooch analyses carried out for this research agree with those carried out by Bayley (1992) except where noted. Lists and details of the brooches can be found in Appendices 4 and 5. In this section most attention will be devoted to those brooch types which are found predominantly in northern Britain (Trumpet, Headstud, and Dragonesque brooches).

The numbers of these analysed by Bayley were small as they are rare in southern Britain.

All of the Early Iron Age brooches were made of tin bronze. This alloy was typical of the period (Chapter 5). There are no differences between different types of Iron Age bow brooches, except perhaps in the case of Birdlip brooches which have a relatively high tin content (12-14%) compared to other brooches (8-11%).

La Tène III brooches have their origins in the pre-Roman period but similar types (e.g. Nauheim derivative — see figure 7.2. No. 1) continue in production after the Roman conquest of Gaul (and possibly after the Roman conquest of Britain). These brooches can be split into two groups on the basis of their composition: some are made of tin bronze with no zinc present, while others are made of brass with 20% or more zinc. The use of either brass or bronze (but not gunmetal and always with low lead) for these brooches is also found in Bayley's (1992) results. The first group of brooches has an alloy composition similar to most Iron Age objects (tin bronzes with little or no zinc). A simple chronological separation of such brooches into pre-Roman bronze, and Roman brass, is unlikely, however as the bronze used to make these brooches does not have the same impurity pattern (regular presence of arsenic) that is found in almost all Iron Age alloys.

Many of the Hod Hill and other early hinged brooches analysed for this research have compositions comparable to those found in Bayley (1992). Most of these brooches have a relatively high zinc content (15-25%) which is often accompanied by a moderate level of tin (0-5%). The remaining early hinged brooches are made of tin bronze with little or no zinc. In all cases lead is absent (or present at only very low levels). The lack of consistency in the choice of alloy (brass or bronze) for early hinged brooches is also found in Bayley (1992). It is also reflected in the wide typological variation of these brooches (Hull's typology includes 31 different variants of the Hod Hill brooch), and exact parallels for a particular Hod Hill brooch are rare. This lack of exact typological standardisation can also be seen in the military fittings catalogued by Oldenstein (1977). This catalogue is indispensable for finding parallels for newly excavated finds, but exact parallels are extremely rare. This suggests that each object was unique and that production was on a relatively small scale (Allason-Jones 1994).

Only two Langton Down brooches were analysed during this project but these have compositions which are similar to those found in Bayley (1992). They are made of brass (moderately high zinc - rarely over 20%) with low (0-3%) levels of tin *and* lead present. Only one possible Rosette brooch was analysed. This was made of brass (as are those analysed by Bayley) but has very low tin content and no lead present

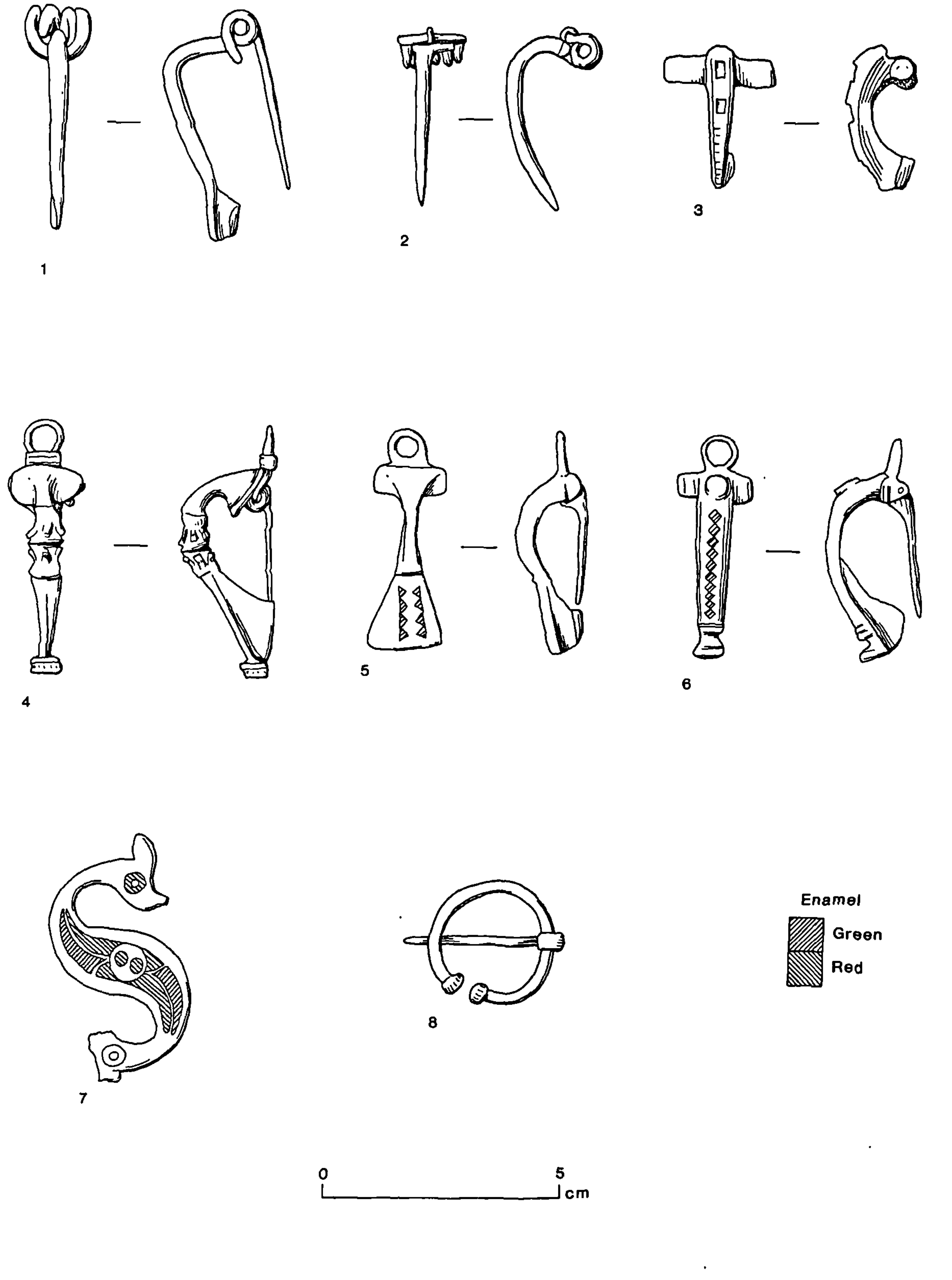

Figure 7:2. Principal Brooch types

(**1** Nauheim derivative (XRFID 1230); **2** Colchester A (XRFID 1010); **3** Dolphin (XRFID 1605); **4** Trumpet, loose headloop (XRFID 1234); **5** Fantail, fixed headloop (XRFID 1635); **6** Headstud, fixed headloop (XRFID 1766); **7** Dragonesque (XRFID 1392); **8** Penannular, type A2 (XRFID 1505)).

unlike those analysed by Bayley.

Eight Colchester A brooches were analysed during this research project (figure 7.2. No. 2). (It was only realised that no Colchester B's had been selected after all analysis had been completed. This may reflect the fact that Colchester B's are relatively rare in northern Britain). All but one of the Colchester A's had a typical composition (brass with little or no tin or lead). The Colchester A from Elginhaugh (XRFID 1201) was the only one with an atypical composition — it had a relatively high lead content for a one-piece brooch. (It is hardly surprising that the brooch had broken — possibly during manufacture. One other incomplete Colchester brooch was found on the site).

The Polden Hill and Dolphin brooches (figure 7.2. No. 3) are all of bronze or gunmetal (the zinc content is fairly low and never exceeds 10%, while the tin content never falls below 3%) with variable lead content.

The work of Bayley & Butcher (forthcoming) has considerable impact on the typology of Trumpet brooches (figure 7.2. No. 4). These were sub-divided into various types on the basis of variations in the nature of the moulding in the middle of the bow (first by Collingwood 1930b, and later by Hull). Analysis of Trumpet brooch composition by Bayley (1992: 154-6) has shown that the nature of the headloop is a more useful criterion for sub-division. The re-categorisation of Trumpet brooches briefly reported in Bayley (1992: 154) argues for five types:-

A 'A standard undecorated Trumpet brooch . . . with sprung pin, loose headloop and fully-rounded waist moulding . . . most of these are brasses or gunmetals' (Bayley 1992: 154).

B 'devolved plain ones with fixed headloops and half-round waist mouldings . . . which are leaded bronzes' (Bayley 1992: 154).

C 'A further group of devolved imitations . . . are all leaded bronzes whether they have loose or fixed headloops. They have lower tin and higher lead contents on average than the Trumpet B leaded bronzes' (Bayley 1992: 154-156).

D 'decorated Trumpets . . . which display a high degree of craftsmanship with a number of distinctive patterns of enamelling . . . Most are unleaded alloys with brass predominating.' (Bayley 1992: 156).

E 'assorted Trumpet-headed brooches . . . mainly have low lead contents with zinc-rich alloys predominating . . . this is not a tight compositional grouping' (Bayley 1992: 156).

This new typology is as yet a little difficult to use as there is no discussion of the criteria required, for example for a brooch to be regarded as 'devolved'. The new Trumpet brooch typology still draws on fairly subjective appreciations of the style of moulding derived from Hull's typology. Nevertheless some agreement with the principles of the new typology can be found in the analyses of Trumpet brooches analysed for this thesis (figure 7.3).

All of the Trumpet brooches with fixed (cast) headloops are of leaded bronze or leaded gunmetal (the lead content is at least 2% in every case, and the average is 6.6%). There are no obvious sub-divisions in the alloy composition that can be related to the nature of the moulding (whether acanthus or not, and whether all-round or front only). Those with loose (wire) headloops are made of varied alloys (brasses and

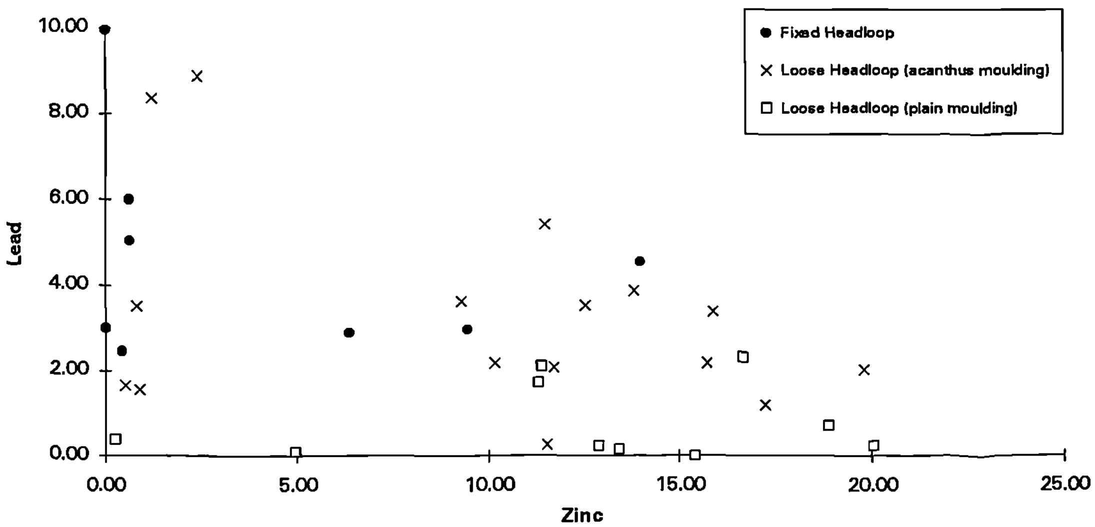

Figure 7:3. Lead and zinc content of Trumpet brooches

bronzes, with and without lead). They can, however, be sub-divided into two groups based on the style of the moulding. Those with acanthus mouldings (all-round and front only) are mostly brasses (zinc 10-20%) with low lead contents (average = 1.4%). Those with plain mouldings (all-round and front only) all have higher lead contents (average = 3.7%). There is no obvious sub-division based on whether the moulding is all-round or front only.

Only one possible Aesica brooch (XRFID 1447) was analysed during this research. Only half of the brooch survives and so the identification is uncertain. This brooch is made of brass (13.5% zinc) with a small amount of tin and lead. This is unlike the two Aesica brooches analysed by Bayley which were made of bronze with high lead levels. This difference in alloy composition does not necessarily rule out the identification of XRFID 1447 as an Aesica brooch however, as the Aesica type is not typologically homogenous and only three brooches of this type have ever been analysed.

The fantail brooches analysed (figure 7.2. No. 5) can be divided into two groups on the basis of their composition. The first group consists of two brooches with discs on the bows. These are both made of brass (zinc 10-15%) with low levels of tin and lead also present. The second group consists of small fantails often with curvilinear enamel decoration on the tail. These are all made of leaded bronze but the tin and lead levels are relatively modest (always less than 10%).

Just as Trumpet brooches can be split into those with fixed and those with loose headloops, the same can be done with Headstud brooches (figure 7.2. No. 6). Most of the Headstud brooches with fixed headloops are made of leaded bronze (figure 7.4). There are three exceptions (XRFID 1425, 1791 & 1905) which are made

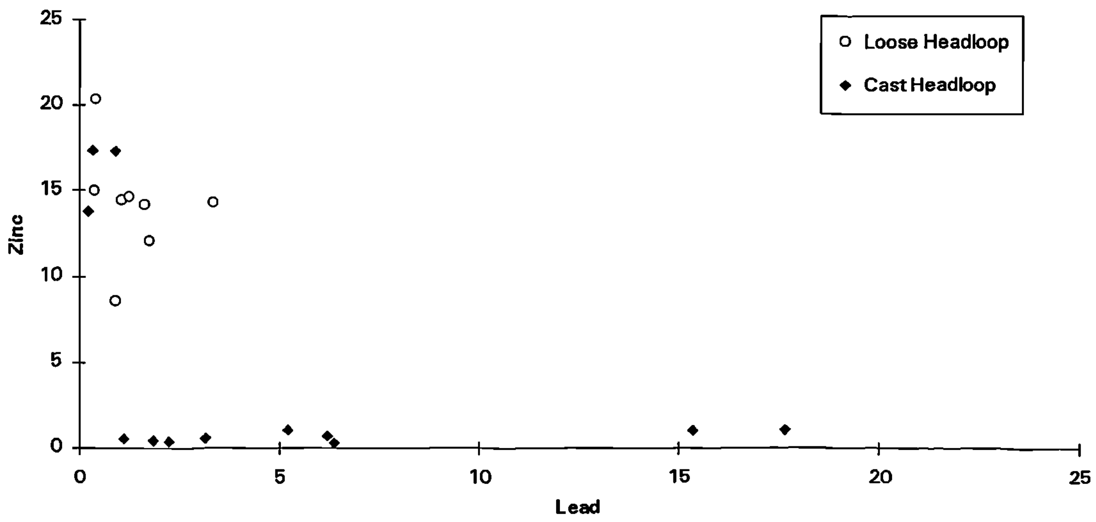

Figure 7:4. Zinc and lead content of Headstud brooches

of brass (with little or no tin) but there is no obvious typological basis for separating these brooches from others with fixed headloops. The majority of Headstud brooches with loose headloops are made of brass with low levels of lead.

Knee brooches and Crossbow brooches are almost always made of leaded bronze with little or no zinc. Insufficient numbers of either type of brooch were analysed to be sure if compositional variation could be related to typological variation

A limited number of plate brooches have been analysed during this research project. Relatively few attempts have been made to devise typological frameworks for plate brooches as there is considerable variation (Hull lists 81 different types of plate brooch - not including variants). Most plate brooches seem to have been used throughout the Roman period and few can be more precisely dated. Dragonesque brooches are one of the few sorts of brooches that are found almost exclusively in the north of Britain and so were especially selected for analysis. They are discussed more fully below.

Bayley suggests that some early plate brooches were made of brass while most other plate brooches were made of leaded bronze (Bayley & Butcher 1989; Bayley

1992). The results of the present research supports this as the few high zinc plate brooches are of early types (e.g. Cruciform, XRFID 1595, 1876) or from early contexts (e.g. Stanwick, XRFID 1850; Redcliff, XRFID 1014). The remaining plate brooches are of mixed alloys with leaded bronze predominating.

Dragonesque brooches (figure 7.2. No. 7) have been studied in a series of short articles by Bulmer (1938) and Feachem (1951; 1968). The Bulmer/Feachem typology divides brooches according to the nature of the enamel decoration:

i circular motif
ii lozenge motif
iii panel of squares
iv row of squares

(Feachem 1968: 100). Bulmer envisaged a chronological sequence from unenamelled Dragonesque brooches to type iv which gave rise to both type iii and type i. Finally type ii developed out of type iii (see Bulmer 1938: figures 3 and 4). Dating for Dragonesque brooches suggests that they appear roughly at the same time as the Roman conquest and they continue in use until the mid/later second century AD.

Analysis of 16 Dragonesque brooches during this research supplements the single analyses carried out by Bayley (1992) and Craddock (1975). Unfortunately there is no obvious correlation between typology and composition. The only group

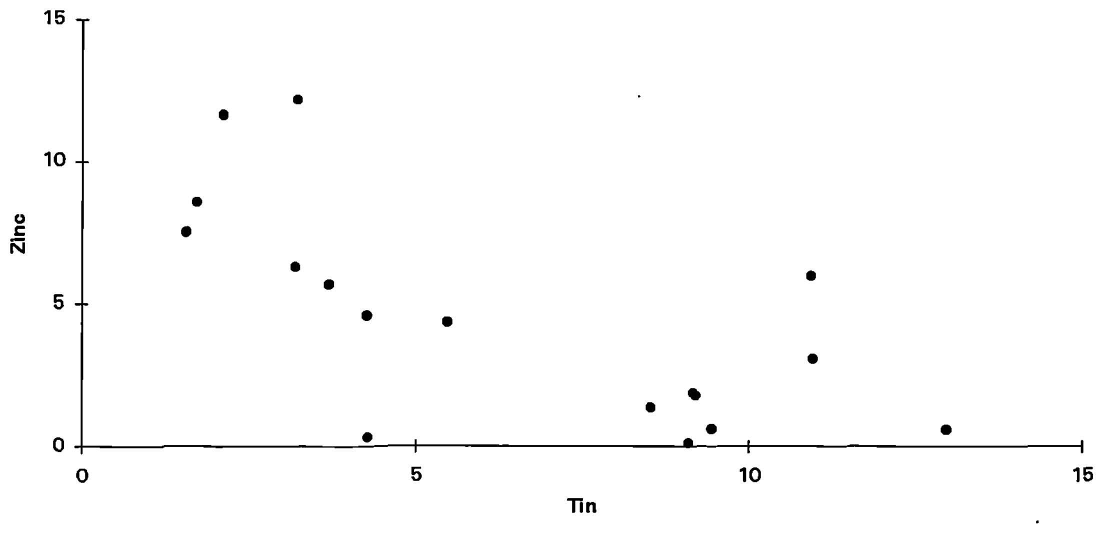

Figure 7:5. Zinc and tin content of Dragonesque brooches

which shows any consistency (Zn 5-7%; Sn 1-4%; Pb 2-6%) is type iii of which only three have been analysed. The other examples all showed considerable variation in their compositions. Like other plate brooches the Dragonesque brooches were usually made of mixed alloys with tin being the most consistently added alloy element. The use of Bulmer's typology as a chronological tool may be weakened by the analysis of the

Milking Gap brooch (XRFID 1392). This brooch has a composition that is typical of the early Iron Age (tin bronze with little or no zinc or tin; and the presence of arsenic as an impurity) and yet it is not placed early in the sequence of types.

The standard work on penannular brooches (figure 7.2. No. 8) is still Fowler (1960). This divides brooches into types according to the nature of the terminals (moulded, bent, etc). Type A consists of those with slight thickening of the terminals and no other decoration. Fowler places these at the start of her typology and this is supported by the metal composition. The type A brooches analysed for this project were all made of bronze with little or no zinc or lead. This alloy is relatively rare in the Roman period but is typical of the early Iron Age. Two type A brooches are from mid (XRFID 2100) or late Roman (XRFID 2110) contexts at Rudston villa but they may be residual (especially as there was pre-Roman occupation at Rudston).

Type A2 and A4 both have terminals with oblique incisions in the terminal moulding (referred to as 'milled terminal' by Fowler). These brooches usually made of bronze with only low levels of zinc. The common presence of lead in these brooches would seem to be sensible as they would have been cast rather than wrought.

A3 penannulars consist of those with plain but repeated mouldings on the terminals. Some of the brooches are made of leaded bronze (with low levels of zinc) while others are made of brass (15-20% zinc). There are no obvious typological correlations between the alloy used and either the size of the brooch or the complexity of the mouldings.

Type D penannulars have terminals formed by bending the terminals back on themselves (these are often shaped and are decorated with incised lines, etc) and type C have terminals formed by bending the terminals back on themselves into spirals. Both C and D penannulars are made from a range of alloys (brass, gunmetal and bronze) but both C and D are wrought and so they usually have lower lead levels than most A3 brooches which have cast terminals. There are no other correlations between typology and metal composition.

During the selection of artefacts for analysis a type of penannular brooch was identified which does not seem to have been described before. This is a very simple brooch with terminals formed by wrapping sheet metal around the ends of the loop. In all four cases the brooch was incomplete and in fragments and so it is possible that the 'sheet terminal' is actually the remains of the pin wrapped around the body of the penannular loop. In at least one case (XRFID 1646), however, both terminals have survived. All of these brooches are made of tin bronze, occasionally with low levels of zinc or lead.

Other items of personal adornment

A considerable proportion of the copper alloy artefacts from Roman Britain are objects of personal adornment. This includes the bow, plate and penannular brooches discussed above, and bracelets, rings and other items discussed below. Discussion of the possible relationships between metal composition and typology is inhibited by the lack of explicit typological discussion of these items. Where no explicit typology exists Crummy's (1983) catalogue of Roman artefacts from Colchester provides a framework. This volume is of limited use however as it only deals with recently excavated material from Colchester.

Bracelets have been subjected to more study than many other personal items (Wheeler & Wheeler 1932; Allason-Jones & Miket 1984; Crummy 1983). Bracelets are probably of most interest as some types are restricted to the late Roman period and so are useful as dating material. The Wheelers' (1932) study was restricted to late Roman decorated strip bracelets and so concentrated on the 'grammar' of the decoration (zig-zag, ring-and-dot, etc). The catalogues by Allason-Jones & Miket (1984) and Crummy (1983) both cover a wider chronological range of material. The former suffers from a concentration on the method of fastening with little attention paid to the types and organisation of decoration. For the present research a simplified typology, using Allason-Jones and Miket (1984) for overall form, with late Roman decorated strip bracelets divided into four groups: 'crenellated', 'ring-and-dot', 'notch-decorated' (or 'running wave'), and miscellaneous.

Attempts to relate the composition of late Roman decorated strip bracelets has not met with success. A range of tertiary alloys (copper with zinc and tin) were used with no obvious correlation between alloy type and the 'grammar of decoration'. All of these decorated strip bracelets, however, have a consistent (if relatively small) addition of lead (mean 2.85%; s.d. = 1.25%). The presence of at least a small amount of lead would suggest that most of these bracelets were cast rather than wrought.

Solid bracelets all have thick, circular or oval sections (3-7 mm). Most are made of leaded bronze and few can be closely dated. Various wire bracelets (plain, twisted wire, spiral wire, etc) have been analysed. These are all united by having a low lead content, this is unsurprising as all wire bracelets were wrought, and wrought alloys generally have low lead contents. The wire bracelets were usually made of brass, copper or bronze, with relatively little use of tertiary or quaternary alloys. Three examples of one bracelet type, with all-round incised groove decoration (cf Allason-Jones & Miket 1984: catalogue 245), were analysed and all were composed of 'impure copper' (the only alloy element present was tin in the range 1-3%).

Typologies for finger rings have been proposed by Henig (1978) and Crummy (1983), however, the former includes only those rings which could have held a gem, while the latter lumps all of these different rings into one single group (bezelled). The largest group of rings analysed here, however, consisted of plain rings with no decoration or bezel. While some of these are the right size to be finger rings this is no guarantee that they are in fact finger rings. Some of these plain rings had large sectional diameters (6-8 mm) and are almost certainly not finger rings. They may have been items of horse harness or belt fittings. Others with smaller sectional diameters may have served similar utilitarian functions. Plain rings were made from a range of alloys with mixed (zinc and tin) being the most common, and almost all are leaded. Some of these leaded alloys have extremely high lead contents (20% or more). These highly leaded rings form a substantial proportion of all highly leaded alloys. 33 out of 1212 Roman alloys have more than 20% lead, and 8 out of these 33 are rings.

Spiral finger rings are all made of brass with only low levels or tin or lead. The lack of lead is sensible from a metal working stand point but the choice of brass over bronze seems strange when the three ear-rings analysed were all made of tin bronze (again with little or no lead). This may show that there were 'social rules' governing the wearing of jewellery which included the composition of the metal. It is difficult to know whether the composition of the metal in this case reflects rules governing the colour of the metal (brass being golden, and bronze a more pinkish colour), or a more passive reflection of workshop practice or metal supply.

Henig's (1978) typology for bezelled finger rings is a little difficult to use as the rings are only defined by simple illustrations. Three of the rings analysed here (nine were analysed in total) belong to a type which seems to be transitional between types II and III. There is no apparent correlation between Henig types and composition but leaded bronzes are the most numerous.

Button and loop fasteners have been studied in detail by Wild (1970) who divided them into types based on the shape and decoration of the button. Most of the button-and-loop fasteners analysed here were made of quaternary alloys with moderate levels of zinc, tin and lead. In few cases did the level of any alloy element rise above 10%. The only fastener with a relatively high zinc content was of class IX which seem to be related to *lorica segmentata* tie loops (Robinson 1975: fig 184).

'Household objects'

This section deals with the range of (mainly Roman) artefacts which are believed to have been used primarily in domestic settings, but were not used as items of personal adornment. However, the term needs to be used flexibly as the exact use to which objects were put is unknown (similarities with modern objects is no proof of utilitarian function, let alone symbolic meaning). Toilet items (e.g. probes, spoons, tweezers, etc) can easily be envisaged as being used in a domestic setting for personal grooming. This does not, however, rule out the use of such items as symbolic markers (badges of Romanisation ?) especially when used in social contexts far removed from the Mediterranean world.

The term toilet implements is used here to cover a range of items which are assumed to relate to personal grooming: tweezers, probes, nail cleaners, and scoops. Many of these objects were wrought rather than cast and so a low lead content is not unsurprising. A low lead content is also found, however, in those toilet implements which were cast.

There has been little systematic study of these items and the only typological distinctions made here are for the toilet scoops (*ligulae*). These are divided into three groups: those with small round bowls and long handles, those with small round bowls and short handles (made of sheet metal), and those with elongated bowls (figure 7.6).

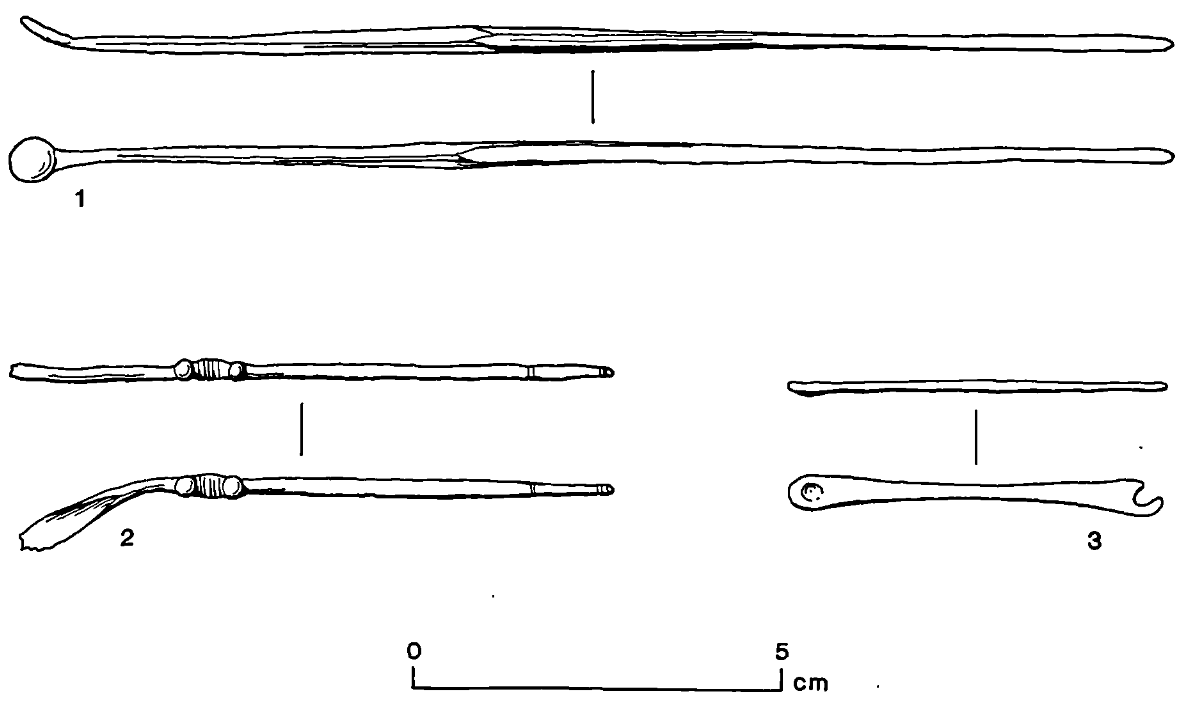

Figure 7:6. Three categories of *ligulae* analysed in this thesis.
(1 Long Handle, Small Bowl; 2 Elongated Bowl; 3 Short Handle, Small Bowl).

The first group is usually made of brass, the second group of bronze, and the last group of gunmetal.

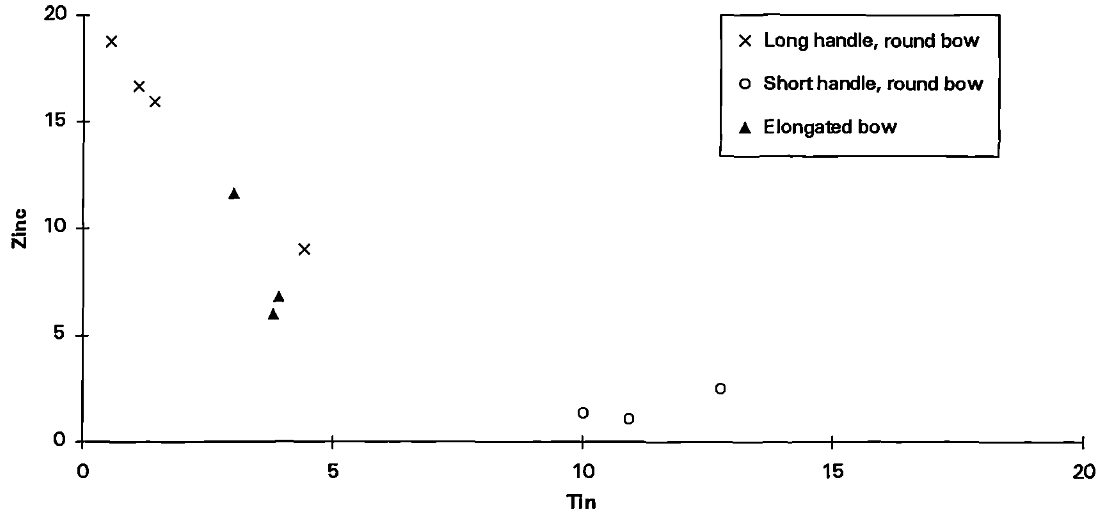

Figure 7:7. Alloys used for *ligulae*

Tweezers are usually made from a single strip of sheet metal which is bent back on itself, so it is not surprising that they are rarely made of alloys containing lead. Tweezers are made from both brass and bronze.

Of the numerous types of Roman spoons studied by Riha & Stern (1982) only the plain round bowled type has been analysed during this research. The 7 spoons analysed here are made of a range of alloys but zinc is rarely a major component. Some spoons are wrought and have virtually no lead present (and often low tin content). Others are cast and have high lead content. The cast spoons can be distinguished typologically from the wrought ones by the presence of a rib, extending from the handle, part way along the bowl. Stern's results (Riha & Stern 1982) seem to show the use of very highly leaded bronzes (almost pewter). However, Stern's analyses were all made of the surface of the spoons which could be misleading as many spoons were corroded and some had surface tinning (nevertheless Stern treated the results quantitatively).

All of the Roman mirrors analysed during this research have been found to be made of speculum (a high tin bronze). A tin content of *c.*15% or higher can give a silvery-white alloy which can be polished to give a reflective surface. Craddock found that the Roman mirrors that he analysed had tin contents of 18.6% to 22.8% (with one exception of 8.5% (Craddock 1975: 152). All of the mirrors analysed during this project have tin contents of 18% or more. In addition all of the mirrors had relatively high lead contents (8-26%) and only trace levels of zinc. There is very little overlap between the tin contents of Roman mirrors and other artefacts with high tin contents

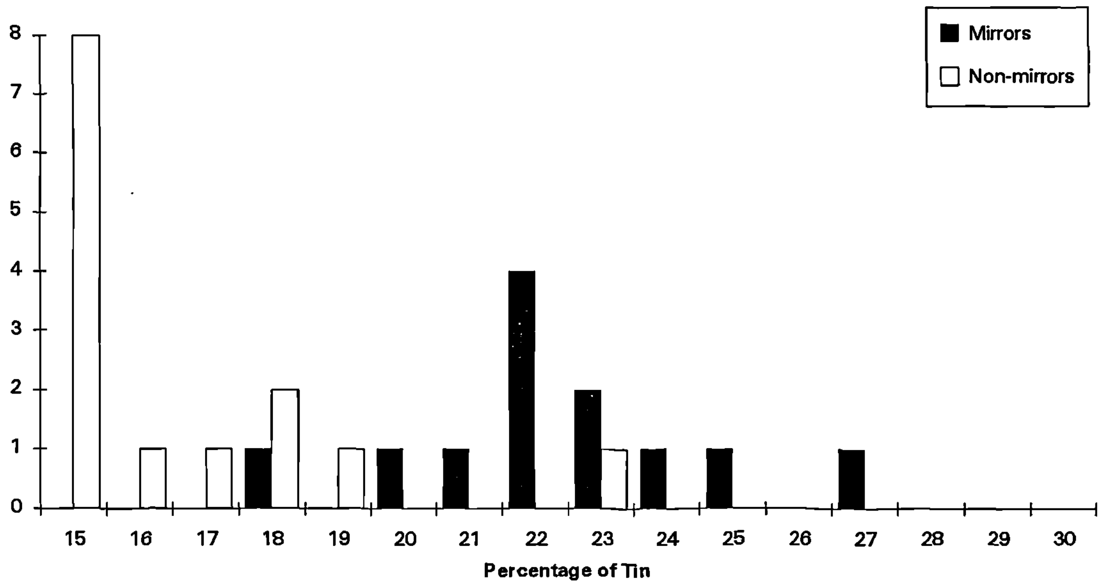

Figure 7:8. Tin content of Roman mirrors and other objects (with tin 15% and over)

(see figure 7:8). Of the 14 artefacts with 15-20% tin only one was a mirror, and only one of the 12 artefacts with more than 20% tin was *not* a mirror. (This sample was a piece of casting waste from Rudston villa, and may indicate the production of speculum mirrors in Britain. Limitations of the composition of casting waste are discussed in Chapter 8).

The large sheet metal vessels of prehistory known as cauldrons have been studied by Hawkes (1951). Cauldrons first appear in late Bronze Age hoards (e.g. Heathery Burn) and these early vessels are characterised by having suspension rings attached to the body by staples. Simpler vessels with no suspension loops are also known and these are conventionally dated to the Iron Age. These are divided into two types: Santon and Globular. The former (also known as 'projecting-belly') are often made of least two pieces of metal, while the latter are hemispherical and are made of a single piece of metal. Many cauldrons are only roughly provenanced and are without any archaeological context. This makes their dating difficult. Some cauldrons have been found in hoards which also contain Roman items (Piggott 1952-3; Hawkes 1951: 181) and may have been made during the Roman occupation.

The Santon vessels analysed were all made of tin bronze with no zinc or lead - typical of Iron Age alloys (see Chapter 5). These vessels, however, are made from a tin bronze which has little or no arsenic present as an impurity (unlike most Iron Age bronzes). It is not possible (from the analysis of the metal) to be certain of the dating of this type of cauldron. They may be Iron Age *or* Roman in date.

The Globular cauldrons analysed were mostly made of tin bronze but one (Lochmaben XRFID 1950) also contained 1.2% zinc. The presence of some zinc is typical of many Roman alloys, and uncharacteristic of the Iron Age. Nevertheless the presence of small amounts of zinc in pre-Roman alloys (from the use of mixed copper and zinc ores, or the use of some scrap brass imported from the Mediterranean world) cannot be dismissed (see discussion in Chapter 5). A vessel from Welton Wold (XRFID 1492) which came from a fourth century context was made from sheet bronze in a similar way to many cauldrons.

Both Santon and Globular cauldrons occasionally have repairs made to slight tears by the addition of a small patch. Some of these patches are not riveted on but consist of a piece of sheet metal bent back on itself so that two 'wings' can be pushed through the tear. The patch is then smoothed down. These artefacts can be seen *in situ* in some Scottish cauldrons (Abercairney, Elvanfoot, Kyleakin, and Carlingwark Loch Macgregor 1976: catalogue nos. 300, 303, 306, and 309). Macgregor (1976) refers to these as 'paper-clip repairs', and Cool (1990) refers to them as 'diamond clips'. All of those analysed here were made of copper or bronze. Zinc and lead are virtually absent. The composition of the 'diamond clips' closely matches that of many cauldrons. It is curious that while the cauldrons are mostly found in Scotland (with a few in southern England, see Macgegor 1976: 170-171; map 21), the 'diamond clips' have been found at a number of sites throughout Britain: Vindolanda (Birley forthcoming), Piercebridge (Fitzpatrick in preparation), Dalton Parlours (Cool 1990: 89; fig 72: 51-7), Brough-on-Humber (Wacher 1969: 89; fig 38: 26), Gadebridge Park (Neal 1974: 137; fig 59: 104-6), and Whitton (Jarrett & Wrathmell 1981: 187-8; fig 74: 99, 100).

While most pre-Roman vessels are made from beaten sheet metal, Roman vessels are usually cast (although some may be spun). The large-scale production of *paterae* and other vessels is assumed to have taken place in Campania in Italy in the late Republican period (Fredericksen 1959). Production seems to have shifted north (ultimately into Gaul) during the Principate (Willers 1907). The study of vessels has been greatly helped by the publication of two Dutch monographs on the subject: a catalogue and typological discussion of the vessels in Nijmegen Museum (den Boesterd 1956), and the spectrographic analyses of these vessels (den Boesterd & Hoekstra 1965). Most of these vessels date to the earlier part of the Empire. A discussion of the typology and metal composition of some later continental vessels can be found in Lindberg (1973).

The present research has included the analysis of 45 vessels or vessel fittings. All of the *paterae* are dated to the first or second centuries and confirm the earlier *finds of den Boesterd & Hoekstra (1966) that all* of these vessels are made of leaded bronze with little or no zinc. This composition is also found in miscellaneous vessels from the early Empire and many of those which were not closely dated.

A substantial number of third century vessels were made available due to the analysis of finds from the cemetery at Brougham (Wilson 1968: 179). Vessels formed a significant proportion of the grave goods and 17 vessels were analysed. Unfortunately the burial rite at Brougham was cremation and all of the vessels are fragmentary. Four of these vessels had wedge shaped rims which were decorated (usually with lines). This decoration closely resembles the Hemmoor vessel illustrated in Lindberg (1973: fig 17). The four wedge-rimmed vessels are all brasses which is the same as most Hemmoor vessels analysed by den Boesterd & Hoekstra (1965) and Lindberg (1973). The use of brass for a specifically mid to late Roman artefact type confirms Craddock's (1975: 221-4) suggestion that brass production continued into the late Roman period (see Chapter 9).

The other third century vessels have rims similar to early Roman vessels (straight or turned over). Like first century vessels, many of these may have been formed or finished on a lathe. These later Roman vessels, however, are usually made of bronze with little or no lead, in contrast to those from the early Empire which are usually leaded. The single fourth century vessel analysed was a large sheet bowl from Welton Wold (XRFID 1492). The method of manufacture is similar to that of the cauldrons discussed above, and the vessel may have been made some time before the fourth century. The alloy used in this case was a slightly leaded bronze with no zinc (or arsenic) present.

Military fittings

Roman military equipment is one of the most intensively studied areas of Roman material culture (reflecting traditional interests in the period - see Bishop & Coulston 1993, for a recent review of the subject). Military equipment from archaeological sites has often been used to date the period of occupation at a site, and identify the units stationed there (i.e. legionary or auxiliary). The highly distinctive fittings of the *lorica segmentata* (the segmented cuirass, Bishop & Coulston 1993: 85-90) have attracted considerable attention as they are identified as items used by Roman legionaries during the first two centuries AD (see also Maxfield 1986, for discussions of the use of military equipment in this way). Many other military items are used over much greater periods of time and cannot be associated with just one particular type of unit. Despite the considerable attention paid to *lorica segmentata* fittings it is only recently (Bayley 1985b; Bishop 1989b) that they have been shown to be made of brass (rather than bronze). Bishop & Coulston (1993: 191) suggest that two different sorts of brass were used in the manufacture of *lorica segmentata*: one containing *c*.20% zinc used for the sheet fittings (hinges, buckle plate, hinges, etc), and one containing 10-15% zinc used for rivets.

Eight samples of *lorica segmentata* were analysed during this research, all but one of these was made of brass. The average zinc content was *c*. 20%, in line with Bishop & Coulston (1993: 191). One *lorica segmentata* fitting (XRFID 1082) was, however, made of a bronze with 5.7% tin. This item may have been an *ad hoc* repair or replacement. Overall the uniformity of the composition of *lorica segmentata* fittings suggests that they most were made to a strict recipe. This may indicate that they were produced centrally by the state. Alternatively they may have been produced on a more local scale but to recipe known and adhered to on a much larger scale (Welbourn 1985). This scale can only be known when fittings from other parts of the Empire are analysed, but typological uniformity hints at metallurgical uniformity.

The rivets and other fittings associated with *lorica segmentata* fittings have a more varied composition. Some are made of a brass with zinc content similar to the actual sheet fittings while others have much lower zinc contents (in some cases approaching 0% zinc). Nevertheless, other alloy elements (tin or lead) rarely seem to be deliberate additions. Some rivets, etc do seem to conform to the lower zinc alloy suggested by Bishop & Coulston (1993: 191). The lower zinc content of rivets can be explained as it would have made the rivets softer and so easier to work. Alternatively (or additionally), the lower zinc content would have made the rivets more coppery and so redder. This colour contrast may have been selected on aesthetic grounds. This colour contrast has been suggested on theoretical grounds. The colour difference that the difference in composition ought to produce was confirmed visually during the sampling of one *lorica* fitting and its rivet (XRFID 1805a & b). The corroded metal appeared uniformly green over the sheet metal and the rivets but the removal of corrosion products by air abrasion showed a dramatic colour contrast between the sheet metal and the rivets. Nevertheless in two out of three cases where a *lorica segmentata* fitting and its rivet could be analysed, the rivet contained the same level of zinc as the fitting.

Some other military fittings of the early Roman Empire ('armour tin pins' and some scale armour) are consistently *not* made of brass (*contra* Bishop & Coulston 1993: 191). Other alloys used include bronze and impure copper (usually with a small amount (1-3%) of tin, but very little else). This does not affect whether or not the army's brass was produced under an official monopoly but it does show that a range of alloys were used to manufacture military equipment.

Scale armour (*lorica squamata*) has been found in contexts from the first century to the fourth century, however, the eight samples analysed here are mostly from early Roman contexts. All the armour scales are made of alloys which do not contain lead. This is logical as the scales are wrought from sheet metal. The levels of tin and zinc in scale armour varies: some are made of brass, one of bronze, and two are made of impure copper. The one armour scale made of bronze is also the only one from a late Roman context (XRFID 2169). This change over time from brass (or copper) to bronze fits the wider compositional changes in Roman metalwork (see Chapter 9).

Bishop & Coulston (1993: 191) suggest that Roman cavalry fittings of the early Empire were usually made from leaded brass (primarily on the basis of analyses by Craddock and Lambert in Jenkins 1985). Many of the cavalry fittings (especially junction rings and loops) analysed here are made of brass which also contains small amounts of tin and/or lead, but there does not seem to be the same consistent addition of lead to brass as seen in the Xanten fittings (Jenkins 1985). XRFID 1277 is a bifid pendant of a type typical of the first century AD but it comes from a third century context. There are typological parallels with pendants from the Xanten hoard but the composition is most unlike those from Xanten. The Catterick pendant (XRFID 1277) is a leaded bronze with only 2.2% zinc (not untypical of alloys in the third century), whereas most bifid pendants from Xanten are leaded brass. The Catterick pendant may show the late manufacture of bifid types (in contemporary alloys) *or* the use of a variety of alloys for cavalry fittings in the first century. Production of cavalry fittings at Alesia has recently been discussed by Rabeisen (1990). The production of these items within a Roman town suggests that they were produced privately rather than by the state.

The study of mid-Roman military fittings is largely based on the work of Oldenstein (1977) who catalogued all of the second and third century (supposedly) auxiliary equipment from forts in Upper Germany. The catalogue contains a large number of cast belt fittings (often in openwork), of which few are identical. Allason-Jones (1994) has suggested that searches for detailed typological parallels amongst this equipment may always fail because each object was unique. The uniqueness of these fittings is in stark contrast with the limited number of forms of *lorica segmentata.* Production of late second and third century fittings was probably at the scale of the individual artefact and so each was different. The casting of most mid-Roman military fittings contrasts with the early Roman equipment which is often wrought. The analysis of mid-Roman fittings shows most of them were made of quaternary alloys. These have only moderate levels of zinc (rarely over 10%) but few are zinc-free. Tin is the most consistently added alloy element. In addition, almost all of these fittings contain considerable quantities of lead (usually over 5%). This composition is in marked contrast to that used for most first century military fittings where lead was rarely used. The mixed nature of mid-Roman military alloys could be the result of recycling scrap of varied composition but the overall increase in the lead content must result from the use of metal (whether scrap or fresh) not previously used for most military fittings. The fact that the mixed alloy is ideally suited to the method of manufacture (casting) suggests that such alloys may have been deliberately aimed for, rather than the passive result of recycling.

Fourth century Roman military fittings are relatively rare. This may reflect the fact that the army was smaller (James 1984) and may have been less well supplied (and so much less equipment would be abandoned). Some of the most useful finds of Roman military equipment in the early Empire are the result of expansion and military conquest. As units were moving to new locations on a regular basis they may have abandoned some of their scrap metal at each old fort (Bishop 1989a; Allason-Jones & Bishop 1988). The relative paucity of identified fourth century military fittings may also reflect the ways in which the late Roman army was becoming less different from the civilian world (Esmonde Cleary 1989). The standard work on these late Roman military fittings is still Hawkes & Dunning (1961), which catalogues chip-carved belt plates (cast from bone or wooden originals), zoomorphic buckles, sheet metal strap ends, and other miscellaneous finds. Chip carved belt plates are almost unknown in northern Britain so samples for this study were taken from zoomorphic buckles and sheet strap ends. In addition, one belt plate (from Catterick, XRFID 2025) with simple ring-and-dot decoration was analysed. The zoomorphic buckles are made of leaded bronze with little zinc. The strap ends are made of bronze with only low levels of zinc or lead (but rarely absent). The Catterick belt plate is made of a quaternary alloy with moderate zinc content, but the tongue for the buckle is made of leaded brass (with 20% zinc). The tongue is very simple and may be a replacement (and so does not necessarily relate to 'official' military production). The overall low zinc content of late Roman military equipment reflects a general decline in zinc content of copper alloys by the fourth century.

Conclusions

The above discussion of the relationships between copper alloy compositions and typology illustrates that many items were made to more-or-less strict recipes. The use of recipes is not, however, universal as many objects were made of a range of different alloys. Many of those objects which lack distinctive typologies are also made from a range of different alloys. This suggests that in some cases production was on an *ad hoc* basis.

This chapter and previous work (e.g. Craddock 1975; Bayley 1992) have identified the use of distinct alloy types for the production of some items. The use of recipes may reflect a number of different metallurgical, economic or social constraints. Roman mirrors are made of speculum (tin over 20%) as this is the alloy which produces a silvery-white surface. Complex cast objects are usually made of leaded alloys as these produce a more fluid molten alloy at a lower temperature and so aid the casting process. Many distinctive alloys may reflect traditions where it is difficult to separate economic and social constraints. The use of lead for some recipes may reflect the abundance of this metal rather than the metallurgical need for it. A leaded alloy may then continue to be used because it is traditional to do so, even if lead becomes more scarce.

CHAPTER 8
METAL SUPPLY AND RECYCLING

Introduction

The preceding chapters have set out the results of a detailed programme of analysis of Iron Age and Roman copper alloy. It is not sufficient, however, merely to describe these alloys. In order to make further sense of the data it is necessary to understand how the compositions arose. This can be achieved in part through a detailed knowledge of the scientific constraints, such as the raw materials, the techniques and practices, and the thermodynamics of a series of complex processes of production and use (ore chemistry and geology, smelting methods, alloying techniques, etc). Further explanation of alloy composition requires an appreciation of archaeological factors such as context, date, symbolic meanings, etc. By relating alloy composition to the known physical constraints of metal production, however, it is possible to provide a framework for further explanation. This approach is used to examine the metal systems method proposed by Caple (1986). The implications of some of the physical constraints of metallurgy (especially the volatility of zinc) have already been discussed for 'Celtic' metalwork (Chapter 5). A detailed re-examination of Caley's so-called 'zinc decline' (Caley (1964) and chronological changes in alloy use is given in Chapter 9. Discussions of cultural factors influencing alloy composition can be found in Chapters 5 and 10. For the most part this chapter is restricted to a study of the Roman period (as there is little alloy variation in the Iron Age).

The Production of Alloys

Alloys can be produced in a number of different ways: by mixing pure metals together in measured quantities, by 'co-smelting' two or more metal ores, or by the mixing of scrap metal (with or without the pure or co-smelted metals). Most Roman alloys could be formed in a number of different ways and analysis alone can rarely provide conclusive proof of which method was used. This section will discuss the archaeometallurgical evidence for the existence of different raw materials and production process. Analysis also shows that some artefacts were clearly made to recipes. Some of the recipes in Pliny's *Natural History* have been discussed by a number of scholars (e.g. Craddock 1975; forthcoming).

The existence of pure copper is attested by the survival of a number of Roman copper ingots which are usually very pure (total impurities <0.5% - see Tylecote [1962:

33, Table 10]). Other ingots are known with larger proportions of alloy elements, e.g. the highly leaded bronze ingots from Lullingstone villa (Craddock in Meates [1987]). Pure copper is very rare in finished objects, such as those analysed for this thesis. Much more common is a very low tin bronze (tin = 0-5%, see figure 6:4). Bronzes with varying levels of tin and lead could be made by adding metallic tin and/or lead to the molten copper. Both lead and tin ingots are known (Tylecote 1992: 71) but there are many more Roman lead ingots than tin ones in Britain. The large numbers of lead ingots may reflect the fact that lead was a by-product of the extraction of silver from lead by the cupellation process (Bayley 1988: 194-5). Not all lead may simply have been a by-product, however, as there was a demand for lead in its own right for plumbing, etc in towns and forts. The tin contents of Iron Age and Roman bronzes are normally distributed around a mean of *c.*9%. This alloy may have been made to a commonly known recipe. Roman mirrors were made of speculum, a bronze with *c.* 20-30% tin (usually accompanied by a similar quantity of lead). While a leaded bronze could be made by adding pewter (an alloy of tin and lead) to copper, the lead content of most Roman copper alloys varies considerably and lead was probably added independently as a more-or-less pure element (Craddock 1975: 160). In addition the composition of Roman pewter varies considerably (Beagrie 1989), and most pewter dates to the third or fourth century but leaded bronze and leaded gunmetal are common in the late first century and second century.

While bronzes could be produced from separate elements, brass could only be produced by the cementation process (Werner 1970; Craddock 1978) as elemental zinc was not isolated in Europe until the eighteenth century (Tylecote 1992: 151). Copper ores are usually smelted at *c.* 1200°C but zinc metal boils at 907°C and so simple co-smelting of zinc and copper ores will not produce brass. Northover (in Musson *et al.* 1992) discusses the possibility that trace/minor levels of zinc might be introduced to smelted copper in this way. The loss of gaseous zinc during smelting can be avoided if the zinc ore is reduced in a sealed container. Thus, Craddock (1978) argues that ancient brass was produced by roasting copper, zinc ore and charcoal in a sealed vessel (see also Bayley 1984). The use of the cementation process is supported by reference to ancient and early Post-Medieval accounts of brass production (e.g. Agricola's *De Re Metallica*). Werner's (1970) experiments have also been influential in our understanding of ancient brass production. He showed that the maximum zinc content achievable by the cementation process was *c.* 28%. He even melted a modern brass (containing 42% zinc) under cementation conditions and the zinc content dropped to *c.* 28%. This empirical maximum was reinforced by reference to phase diagrams, and the analysis of Roman brass ingots from Sheepen (Musty 1975). This maximum zinc content has proved useful in testing the authenticity of European objects - those with a zinc content in excess of *c*.28% must have been produced in the post-Medieval period.

Brass was first produced in Europe in the 7th century BC but remained a rare and possibly precious metal until the first century BC (Craddock 1978) when it was used for the production of large numbers of Roman coins. Brass was also used for the production of some military equipment and some brooches of this period (i.e. from the later first century BC onwards).

Despite the importance attached to brass it is a relatively rare alloy in the Roman period. Even more striking is the rarity of brasses with the theoretical maximum (*c*. 28% zinc) suggested by Werner and Craddock. The peak in the zinc distribution of the results presented in this thesis (figure 6:1) is in the region 17-20%. Less than 1% of the Roman alloys analysed for this thesis had more than 23% zinc. This can also be seen in Craddock's (1975) and Bayley's (1992) results. There are a number of possible reasons for the apparent lack of 'fresh brass': mixing of brass with other alloys, using impure copper in the cementation process, melting loss of zinc during casting, or deposition practices.

Craddock (1975: 222) noticed that tin and zinc in gunmetals were negatively correlated with each other and suggested that these alloys were formed by mixing various amounts of bronze and brass. The lack of high zinc brasses could indicate the high degree of remelting and recycling of Roman alloys.

The use of impure copper in the cementation process would result in the production of a brass with a maximum zinc content less than the maximum achievable with pure copper. Werner and Craddock argued that the reduced zinc vapour diffused into solid (but finely divided) copper much faster than molten copper (due to the high surface area). The cementation vessel would be heated up until the zinc boiled, the zinc would then diffuse into the solid copper. As the temperature was further increased the new alloy (brass) would melt and zinc uptake would decline. If the copper contained tin and/or lead then its melting point would be lowered, the copper would melt sooner and so there would be less zinc in the resulting brass.

If cementation brass was produced using pure copper and a zinc content of *c*.28% was achieved this would still only be the composition of the brass as produced in the cementation vessel. In order to produce any artefacts the brass would probably have to be remelted. This remelting could involve the loss of some zinc due to oxidation or volatilisation (see below).

The apparent lack of 'fresh brass' in the archaeological record may not reflect a lack of 'fresh brass' in the past. It is possible that the range of alloys that survive in the archaeological record are not representative of those used in the past. J.D. Hill's (1994) study of deposition practices on Iron Age sites has shown that material is often deposited according to rules. Artefacts were often deliberately placed in the ground and were selected for this purpose. 'Fresh brass' may have been particularly valuable (socially or economically) and so not deposited.

'Fresh brass' may have been a significant raw material available for producing copper alloys but it is rarely found in the archaeological record. The 17-20% zinc brasses may have been directly produced from 'fresh brass' by mixing with bronze, or may be the 'fresh brass' produced using impure copper.

The use of brass for the production for coins and military equipment of the early Empire has already been mentioned. Some (e.g. Grant 1946) have suggested that brass production was officially controlled but as Bayley (1992) has shown brass was also used to make some brooches. Some of the early brass brooches (e.g. Nauheim derivative) are contemporary with the earliest brass coins. In some cases all examples of a particular type of brooch were made of brass while in other cases (e.g. Nauheim derivative) brass or bronze were used. In other cases the alloy is still basically a brass but there is a significant proportion of tin and/or lead (e.g. Hod Hill). In some cases the composition was tightly controlled (by a recipe?), in other cases a range of different alloys were acceptable.

The use of recipes can be seen in a range of other artefacts (not made of brass). Early Roman copper alloy vessels (*paterae*, etc) are almost always made of leaded bronze (den Boesterd & Hoekstra 1965). This alloy was also used to produce lamps, statues and musical instruments (Craddock 1975; forthcoming). In some cases the alloy may have been produced to meet metallurgical demands. The presence of lead in large complex castings such as statues and lamps is usually explained in terms of the physical properties of the alloy. It is argued that lead produces a more fluid melt which would aid the production of complex castings (Craddock 1975: 249; Tylecote 1992: 35).

The composition of an alloy used may have been influenced by social or economic factors. Alloys could only be made from those raw materials which were available. Some correlations between artefact type and alloy used may in fact be correlations between composition and a regionally based industry. The recipes used may have been passed on from worker to worker and so remained relatively constant over time. The increasing use of brass in mid and later Roman vessels (Lindberg 1973) matches the movement of this industry northward nearer the postulated zinc mines of the lower Meuse valley. In some cases there may have been social rules concerning the uses of alloys. Some alloys may have been seen as inappropriate for the production of certain types of artefacts.

Craddock (1975; forthcoming) also discusses the use of recipes for the production of copper alloys as described by Pliny in his *Natural History* (Book XXXIV, lines 94-8;

159-60). Pliny gives names to three different coppers depending on their purity (*aes coronarium*, *regulare* and *caldarium*). The Latin term *aes* could mean copper *or* bronze (although Craddock argues that Pliny usually uses the term to mean bronze). Brass is given its own name: *orichalcum*. The term *plumbum* could mean lead or tin (the former is sometimes called *plumbum nigrum*, and the latter *plumbum album*). Pliny makes use of the term *plumbum argentarium hispaniensie*, which Craddock argues meant lead from the Spanish silver mines (i.e. a by-product of silver extraction from silver-bearing lead ores). Pliny also explicitly mentions the use of scrap metal as an ingredient in many recipes. Craddock has shown that many of Pliny's recipes correspond to the analytical results.

The above discussion has shown that the composition of some alloys was strictly controlled (for a variety of possible reasons). In other cases where a range of raw materials were available and the composition was not of great (technical or social) importance objects could be of varied composition. Attempts to reconstruct the method of production of a particular copper alloy must take into account all of the raw materials discussed above. Stock metals available for mixing:-

Copper (total impurities <0.5%)
Copper (1-5% tin)
Bronze (*c*. 10% tin)
Speculum (*c*. 25% tin)
'Fresh Brass' (*c*. 25% zinc)
'Re-used Brass' (15-20% zinc)
Tin (pure)
Lead (pure)
Pewter (variable composition)
and mixtures of any of the above.

Recycling Models

Pliny's comments (*Natural History* Book XXXIV, 95-8) on alloys mention the use of scrap metal (*aes collectanium*) as an ingredient in the manufacture of some alloys shows that recycling of scrap metal took place in the Roman period. It is often assumed that most metal was recycled in the Roman period, and it has been assumed that this is an insurmountable problem as recycling would tend to blur typological, regional and chronological variations. Caple, however, has suggested a 'metals system' approach which sees recycling as a solution rather than a problem (Caple 1986; forthcoming). Caple assumes that recycled metal was the major source for most metal production, and that chronological variations can be related to the addition of fresh metal to the stock of recycled metal. Thus, the change from Roman to early post-Roman alloys is accommodated by suggesting that fresh leaded bronze was added to the 'metal system'.

This model is important as it explicitly admits that copper alloys may have been continually recycled and looks for ways of explaining changes in metal composition. However, the chemical analyses themselves cannot prove that the metal of a particular object was 'fresh' or recycled. The early post-Roman alloys may have all been made up fresh to recipes that were consistently different to those used in the Roman period. The degree of recycling is difficult to prove on the basis of analysis alone.

Caple's assumption that the usual source of copper alloy was recycled scrap metal seems attractive as recycling makes common sense, however, the projection of modern Western concepts of common sense on to the archaeological past may be dangerous. Pliny (*Natural History*, Book XXXIV, 95-8) mentions the use of scrap metal but this rarely forms more than a third of the alloy in any recipe. We do not know whether scrap metal was mixed together before being remelted, or if it was carefully sorted. Caple assumes that four random objects were remelted together at any one time (Caple 1986). The number of objects remelted, the degree of sorting and the proportion of scrap metal could have varied considerably. The discussion of chronological variations in alloy composition (see Chapter 9) shows that the proportion of ternary and quaternary alloys (gunmetals and leaded gunmetals) increases over time. This may arise through progressive mixing of scrap metal. Alternatively, mixed alloys such as these may have been actively chosen.

A further problem is the representativeness of the samples available for analysis. Some artefacts which have been sampled were probably accidentally lost but others may have been deliberately deposited (Hill 1994). Those selected for deposition may have been of different compositions from those selected for recycling. It may have been seen as propitious to recycle some alloys but inauspicious to recycle others. We can only ever be dimly aware of the details of such codes of behaviour.

Remelting Thermodynamics: Theory

The shift in composition of the early post-Roman copper alloys compared to Roman ones (discussed in Caple 1986) may be explained as the result of another process. Caple explained this shift as the result of adding 'fresh' leaded bronze to the recycled scrap. This shift could also have been achieved through the decline in zinc content of the alloys. Zinc (the most volatile element present) may have been lost during the remelting necessary to recycle metals. The post-Roman alloys may be composed entirely of Roman scrap, with the zinc decline explained by zinc volatilisation or oxidation during remelting. The theoretical basis for oxidation and volatilisation are discussed in this section, while the next presents the results of small-scale experiments.

The energy required to effect a chemical transformation is called the Gibb's Free Energy. This varies with temperature and is conventionally displayed in an Ellingham diagram (figure 8:1, which shows the Gibb's Free Energies for the formation of metal oxides from the four principal metals in copper alloys: copper, zinc, tin and lead). This

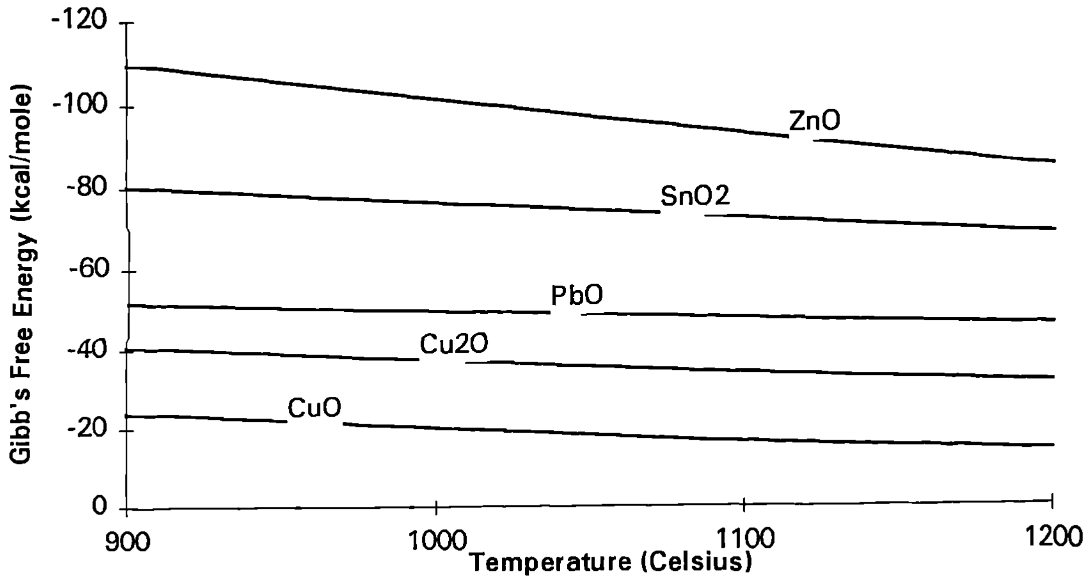

Figure 8:1. Ellingham Diagram: Gibb's Free Energy for the formation of metal oxides from the metals (From data in Reed 1971 and Kubaschewski & Alcock 1979)

Ellingham diagram is not directly representative of conditions encountered in crucible remelting of alloys, however, as the Gibb's Energy values are based on oxidation from pure elements. Further complicating factors arise as published thermodynamic data are based on measurements at equilibrium conditions. Such conditions may not be present in practice. In addition the oxidation of metals will be influenced by CO_2 and O_2 pressures.

Nevertheless, figure 8:1 shows that all alloy elements are more easily oxidised than copper and that zinc is the most easily oxidised of all the alloy elements.

The volatilisation of elements can be represented by a similar diagram which shows the variation in Vapour Pressure above the molten metal against temperature. Such a diagram for the four main components of copper alloys is shown in figure 8:2. As with the Ellingham diagram this is only an indication as the vapour pressures are for pure elements. The behaviour of different gases above a complex alloy are imperfectly understood. The vapour pressure of zinc above its boiling point (907°C) can only ever be a notional value, although zinc will be present in alloys above its boiling point. Despite these limitations,

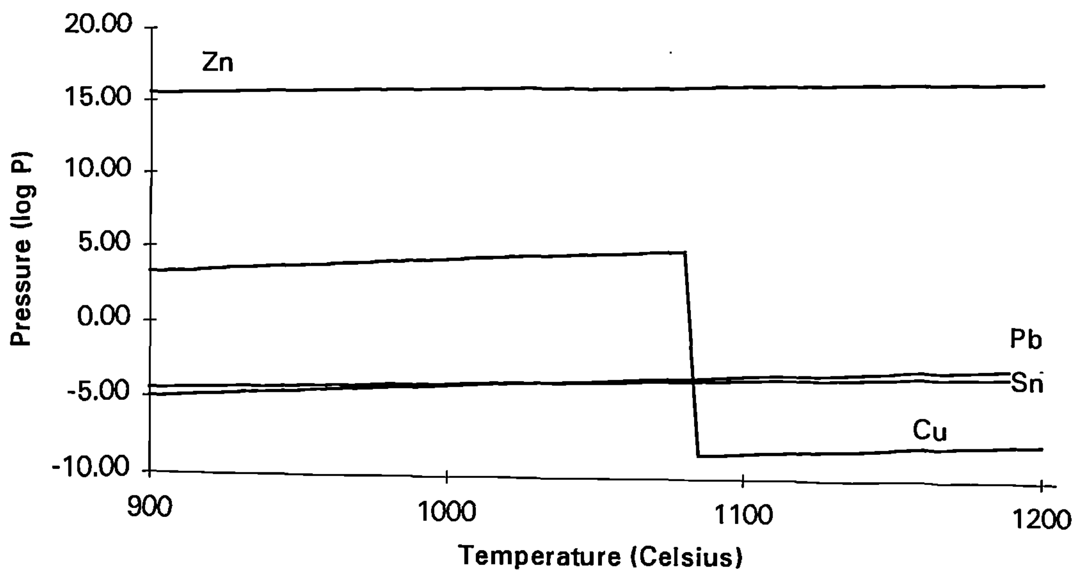

Figure 8:2. Vapour Pressure Diagram (From data in Kubaschewski & Alcock 1979)

figure 8:2 does show that the three alloy elements are more volatile than copper at most pouring temperatures. Again zinc is the most volatile.

The volatility of zinc is well-known in modern copper foundries: 'zinc is the most susceptible to volatilisation, with losses ranging from less than 0.5% to 12%' (presumably absolute rather than relative percentages, American Society of Metals 1970: 422), and 'typically, 4 to 5% extra zinc must be added to compensate for melting losses' (American Society of Metals 1970: 419).

It would seem from the above discussion of oxidation and volatilisation that remelting of copper alloys would tend to cause the loss of some of the alloying elements (most especially zinc). The change in alloy composition due to remelting adds another variable into Caple's (1986) 'metal melting system'. The loss of zinc from remelted brasses has a considerable impact in our understanding of the use and re-use of Roman brass.

Remelting Thermodynamics: Experiments

The above discussion of oxidation and volatilisation suggests that some loss of alloy elements (especially zinc) is to be expected during the melting of copper alloys. In order to examine the practical implications of this a series of remelting experiments were carried out. Samples (roughly 50 grammes) of brass (zinc content varied from 10% to 30%) were melted in a modern clay graphite crucible (100ml capacity) using an electrically powered muffle furnace. In most cases the crucibles were not provided with lids, or charcoal or flux covers. No attempts were made to monitor or control the atmosphere in the furnace (as there were no facilities for this). The samples were kept in the furnace for variable lengths of time to investigate the influence of time on zinc loss. The results are illustrated in figure 8:3 and show that substantial losses of zinc can be expected when

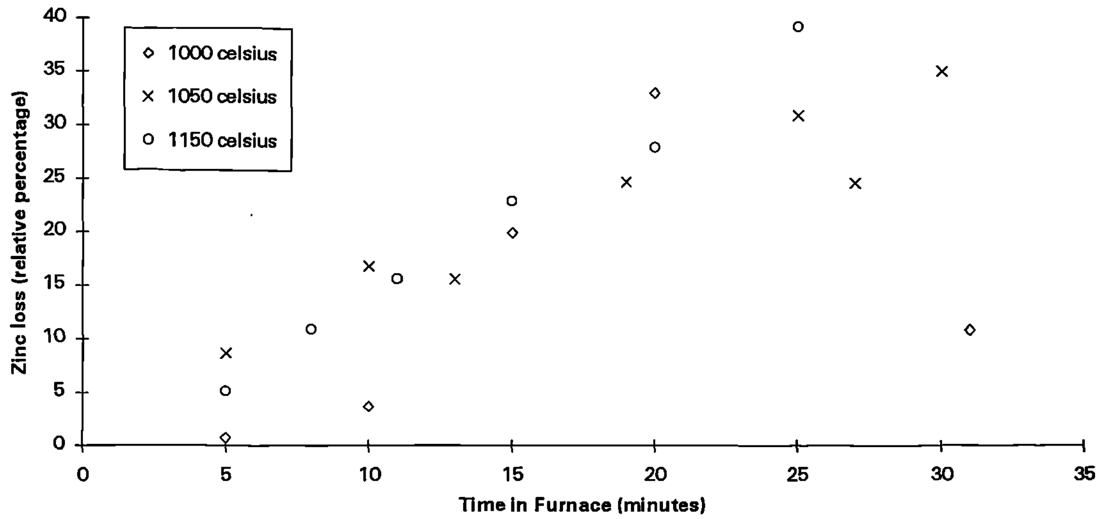

Figure 8:3. Relative zinc loss during remelting

brasses are recycled, but the loss is variable. For the production of complex castings the melt would have to be heated considerably above its melting point in order to ensure that the alloy properly filled the mould before it solidified. Recommended pouring temperatures for copper alloys are in the range 1000-1200°C, depending on the composition of the alloy and the complexity of the shape to be cast (American Society for Metals 1970: 424).

The volatility of zinc is also attested by the levels of zinc frequently found in copper alloy working crucibles (Bayley 1988; Barnes n.d.). Even crucibles which were used for casting copper alloys with minor levels of zinc, had high zinc levels in the crucible fabric. Moulds are in contact with metal for even shorter periods but zinc is still found in mould fabric even where the zinc content of the alloy is as low as 1% (Barnes n.d.). The potential for further zinc mobility was experimentally investigated by melting a zinc-free bronze in the crucibles used for the brass melting experiments described above. The results are shown in Table 8:1. Thus trace levels of zinc in some copper alloys could result from the use of crucibles previously used to melt brasses. Table 8:1 also shows that minor or

	Before melting	1st melting	2nd melting
Sample 1	0.00%	0.47%	0.57%
Sample 2	0.00%	0.49%	0.59%

Table 8:1. Zinc levels in a bronze melted in a crucible previously used for brass casting

trace levels of even a relatively volatile element like zinc may be difficult to remove. Yazawa & Azakami (1969) suggest that impurities such as this can be divided into three groups. The first includes Au, Ag and Hg, elements which are less likely to be oxidised than copper. These will tend to be enriched during melting. The second group (e.g. Pb, Ni, Sb, As, Co, Sn) consists of elements which are slightly more easily oxidised than copper, and the third group (e.g. Fe, Zn, Mn, Si, Ca) consists of those elements which are much more easily oxidised than copper. The third group of elements are easily removed from copper by fire-refining but the second group will be much harder. Yazawa & Azakami's (1969) conclusions are perhaps of limited use when considering archaeological copper alloys as they were concerned with oxidation and do not consider volatilisation. In addition their research is specifically aimed at modern large-scale commercial production of copper. Small-scale crucible melting typical of the Iron Age and Roman periods will involve a greater surface area to mass ratio for the melt and so oxidation will be probably be easier. Experimental purification of an alloy in a muffle furnace (using charcoal and prolonged heating) produced pure copper quite easily. Similar results were obtained by Merkel (1991) who carried out experimental purification of copper.

The proportions of CO_2 and O_2 are important in considering the loss of some elements during remelting. Oxidation will tend to decrease as the proportion of CO_2 increases. The American Society for Metals (1970: 419) recommends that, 'melting under oxidising conditions is the best approach to keeping zinc volatilisation at a minimum'. This is because zinc is a gas at most pouring temperatures, but ZnO is a solid. Thus, allowing the zinc to oxidise prevents it being lost by volatilisation (although some will be lost to crucible slag).

Fluxes can be added to molten metal to remove impurities and different fluxes will react differently with a range of impurities and alloy elements (Bailey 1960).

The American Metals Society *Metals Handbook* suggests that, 'Lead and tin losses are small (less than 1%)' (American Metals Society 1970: 422). The brasses remelted in the above experiments also contained minor levels of tin and lead (1-5%). These two elements actually show an increase in their percentages after remelting. This is, however, a relative increase due to the considerable decline in zinc content. The tin and lead contents as percentage of just the copper content do not show any systematic increase or decrease after remelting.

The change in alloy composition due to remelting can also be seen in the alloys from Brougham, Cumbria (figure 8:4). All of the samples came from a third century cemetery where cremation was the principal burial rite, and so many of the samples consisted of droplets of metal. Figure 8:4 compares the alloy composition of artefacts from Brougham with droplets of metal (i.e. remelted objects). The lack of brass among the

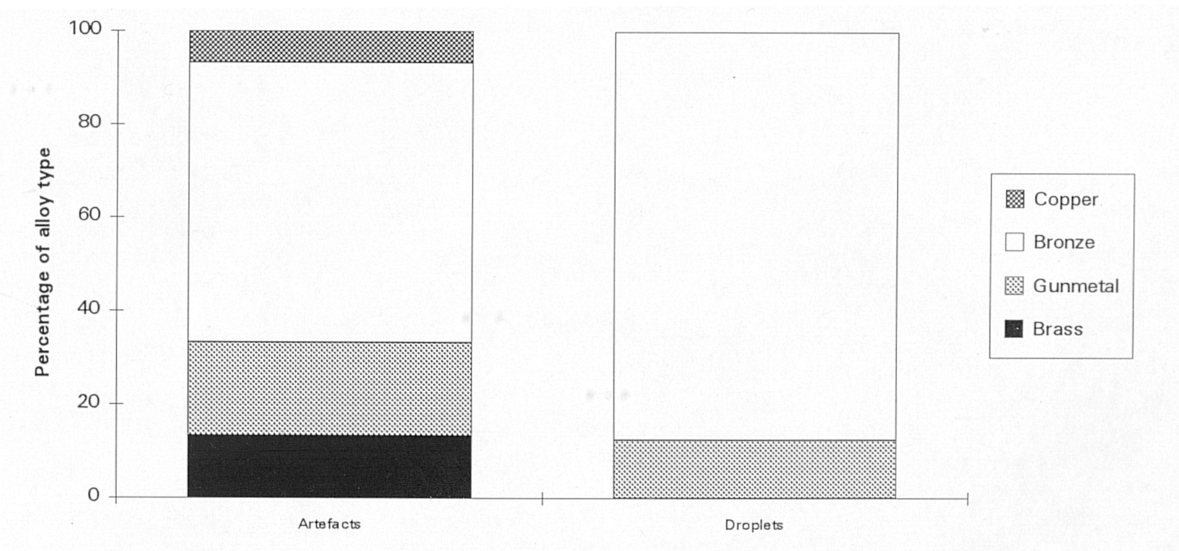

Figure 8:4. Alloys used at Brougham

melted samples could easily be explained due to the oxidation and volatilisation of zinc. An alternative explanation could be sought, however, in terms of the structure of the archaeological record. Those items which were melted were those which were placed with the corpse for cremation whilst those which were not were those which were added after cremation. Particular artefacts, classes of artefacts, and types of metal may have been selected for these two distinct stages in the cremation rite.

Thermodynamics: Conclusions

The theory of metallurgical thermochemistry (Kubaschewski & Alcock 1979), industry practice (American Society for Metals 1970) and the above small-scale experiments all show that alloy composition varies as a result of remelting. This conclusion and Caple's (1986; forthcoming) 'metal systems' theory have wider implications in understanding Roman copper metallurgy. Caple suggests that the composition of remelted scrap metal is simply the average of the initial scrap. Recycling, however, will inevitably produce some changes in the composition of the metal as whole. In some cases this might be slight but in other cases the scrap metal could easily be purified to copper and alloyed anew. Caple interpreted the slight changes in alloy composition from the Roman period to the early Anglo-Saxon period as reflecting the addition of new supplies of leaded bronze to Roman scrap metal. This post-Roman shift in alloy composition could also arise through the loss of zinc during remelting (with no new metal involved).

The loss of zinc during remelting also influences an interpretation of the results seen in figure 6:4. The peak in zinc contents for brasses was not in the 23-28% range as suggested by Werner's (1970) experiments, but centred around 17-20%. Brasses were produced by the cementation process, as discussed above, with zinc contents 23-28%. The alloy could only be used, however, once the vessel had been broken open. In order to produce a cast object the fresh cementation brass would have to be broken up, melted and cast. This melting would inevitable result in a drop in the zinc content. Brasses in the 23-28% range which suffered a relative zinc loss of 25% would produce brasses in the range 17-21%. This 're-used brass' is precisely that which is observed in the analysed objects.

The loss of zinc from Roman brasses has been discussed above in terms of 'Celtic' metalwork (Chapter 5) and will be discussed below (Chapter 9) in terms of chronological variations.

The analysis of large numbers of copper alloy samples allows the comparison of a number of different archaeological variables (typology, time, culture) in terms of the alloys used. The relevance of these variations must, however, be assessed in the light of the metallurgical constraints discussed above.

CHAPTER 9
CHRONOLOGICAL VARIATIONS IN ROMAN ALLOYS

Introduction

This chapter will examine the chronological changes in the proportions of Roman alloys. Most of the analysed Roman samples have been assigned to a century based on stratigraphical/contextual grounds. Occasionally context information could not be this precise in which case the terms early Roman (first two centuries AD), mid Roman (second and third centuries AD), late Roman (third and fourth centuries AD), or simply Roman were used. Where the contextual information could be improved or corrected on typological grounds, the typological dating was used.

Little previous research has looked at chronological variations in Roman copper alloys. Caley's (1964) analysis of *orichalcum* coins has provided the only detailed examination of progressive changes in alloy composition. The interpretation of these results is reconsidered below.

Caley's 'zinc decline'

Caley (1964) carried out the analysis of 24 Roman brass coins (*sestertii* and *dupondii*). He noticed that the zinc content was highest in the early coins and lowest in the latest coins - there was a progressive 'zinc decline' from the late 1st century BC to the early third AD (when production of brass coins ceased). This led Caley (1964) to suggest that brass production started in the late 1st century BC but stopped shortly after. He argued that the brass coins of late 1st century AD date onwards were made from recycled brass. The volatility of zinc meant that the zinc content of the brass declined after each remelting (Caley 1964: 83). Caley's explanation seemed to assume that after *c.* AD 50 the method of manufacturing brass was 'lost' but the reasons for this were not explored.

Since Caley's initial work, the number of analysed Roman brass coins has increased dramatically (see figure 9:1). Riederer (1974) analysed another 20 or so coins, carefully selected to cover reigns which would complement Caley's research. In addition, Riederer reviewed the results of analyses from the 19th century (some of which seem to be unreliable - probably due to the analysis of corrosion products and

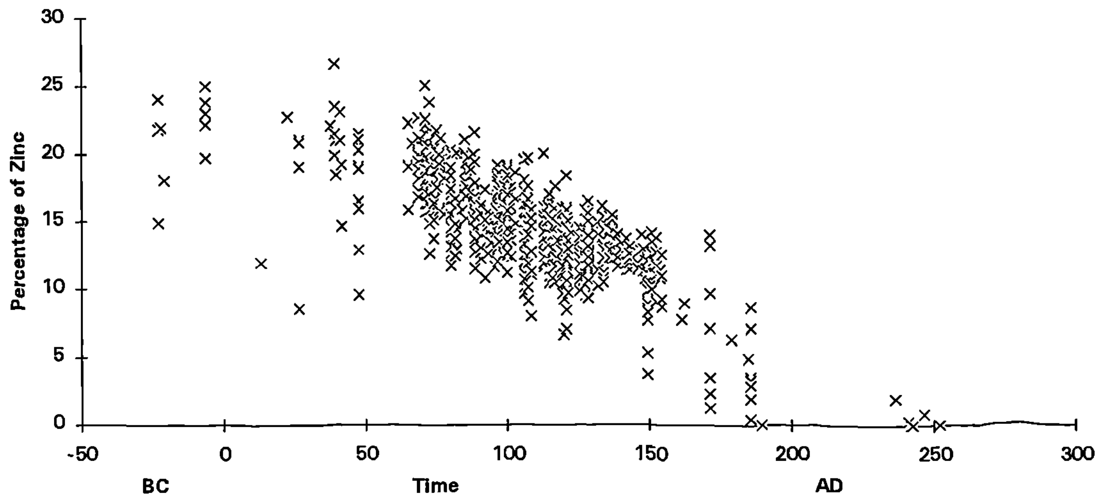

Figure 9:1. Zinc content of Roman Brass coins (Sources: Caley 1964; Carter 1966; 1971; Cope 1974; Etienne & Rachet 1984; Riederer 1974; Carter & Buttrey 1977; Carradice & Cowell 1987).

metal). A small number of analyses of Roman brass coins can also be found in Cope (1974), Carradice & Cowell (1987), Carter (1966), and Carter & Buttrey (1977). The total number of Roman brass coins analysed has been greatly increased by the analysis of over a thousand coins from the River Garonne hoard (Etienne & Rachet 1984). The vast majority of the coins which have been analysed, however, were minted in the early 2nd century AD (the Garonne Hoard [Etienne & Rachet 1984] deposited in the mid second century AD). The types of alloys used for the earliest and latest brass coins are still imperfectly understood. The lack of third century analyses is particularly acute and so seven late 2nd/ early 3rd century coins have been analysed for this research project

XRFID	Reign	Ref	Date	Cu	Zn	Sn	Pb
7032	Commodus	BMC 1665	177	81.42	7.25	6.11	2.23
7033	Commodus	RIC 659	181+	78.84	3.63	4.41	12.86
7034	Gordian III	as RIC 316(a)	240-4	81.78	nd	8.35	9.80
7035	Gordian III	RIC 297(a)	241-4	85.25	nd	8.59	6.06
7030	Philip I	RIC 148(a)	244-7	88.28	0.85	8.59	2.06
7031	Volusian	RIC 249(a)	251-3	71.76	nd	6.16	21.98

Table 9:1. Alloy content of some late *sestertii* and *dupondii* analysed for this thesis

(Table 9:1). The zinc contents of all of the analysed Roman brass coins are plotted against time in figure 9:1. There are, however, some problems with this approach -

many of the coins are shown as single points when in fact they could only be assigned to a date range. In these cases an average value was used. An alternative view of the same data can be gained by plotting the mean values of zinc content for each reign (figure 9:2). This is not entirely satisfactory either as there was some change

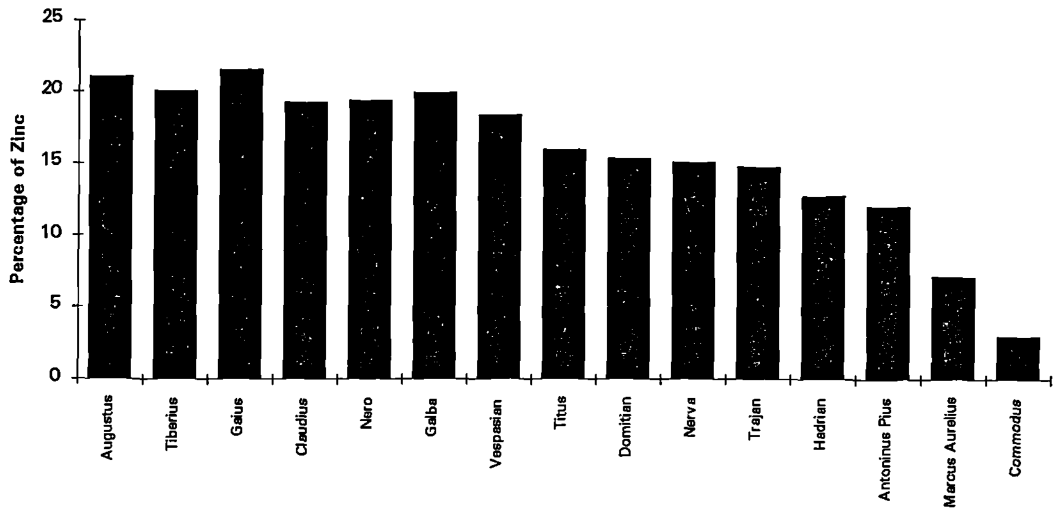

Figure 9:2. Zinc content of Roman Brass coins (mean values for each reign)

in zinc content within individual reigns (Etienne & Rachet 1984). Figures 9:1 and 9:2 do, however, show that the zinc content of Roman brass coins did decline over the first and second centuries AD. As discussed above, this 'zinc decline' was interpreted by Caley as resulting from the exclusive use of scrap brass for the production of later coins and the subsequent loss of a proportion of zinc on each remelting (Caley 1964:83, suggested the loss of 1/10th of the remaining zinc on each remelting).

The 'zinc decline' re-examined

A close look at the large number of analyses of Roman brass coins now available (figure 9:1) casts doubt on Caley's explanation. The actual loss of zinc is slight in the late 1st century and early 2nd second century. In the late 2nd century and the early 3rd century the gradient increases considerably. The observed relationship between zinc content and time is approximately described by the function,

$$Zinc_T = Zinc_{START} - a^{(\frac{T}{b})}$$

Where	$Zinc_T$	is the zinc content after T years have elapsed,
	$Zinc_{START}$	is the starting zinc content,
	T	is the number of years which have elapsed,
	a and b	are constants.

An illustration of this function (fitted to the data in figure 9:1) can be seen in figure 9:3. This curve is not, however, what would be expected if the brass was suffering the

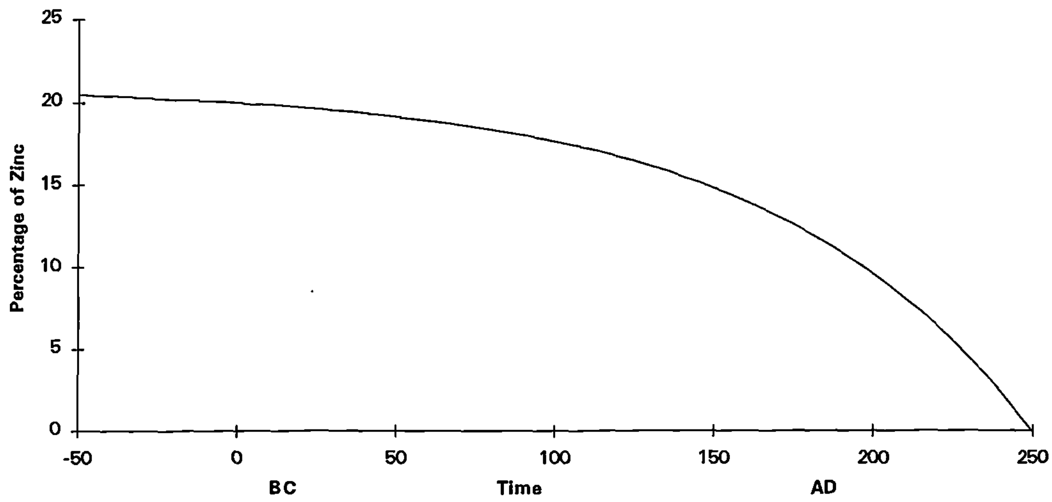

Figure 9:3. Function matched to observed zinc decline

loss of 1/10th of the remaining zinc on each remelting (remelting occurring once every 10 years). In this case we would expect the greatest absolute loss of zinc to be greatest in the early years. Over time the zinc content would decline - it would begin to approach zero but, it would never reach it (see figure 9:4). This expected decline is described by the function,

$$Zinc_T = 20 \times a^{(-\frac{T}{b})}$$

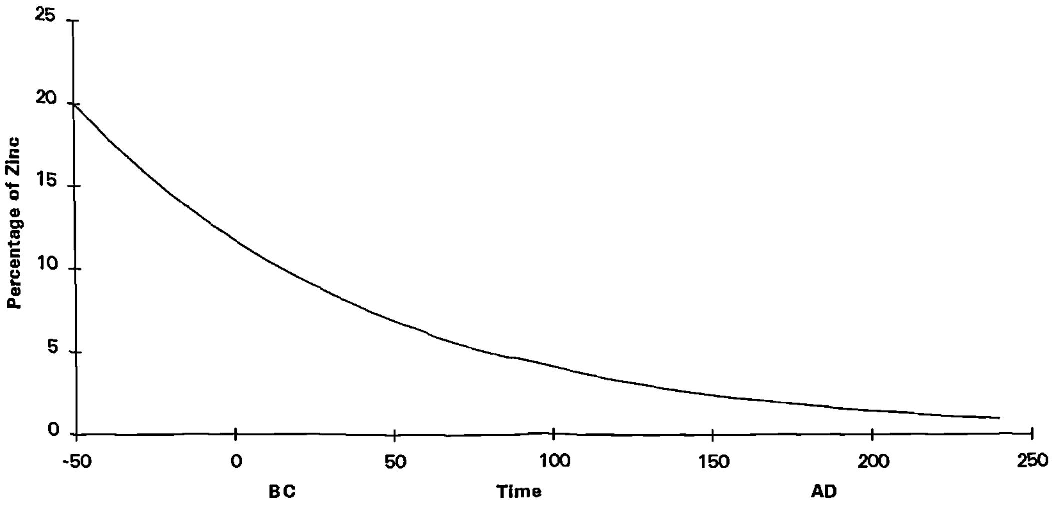

Figure 9:4. Theoretical zinc decline in recycled brasses

The observed and expected zinc declines do not match each other, and so the suggestion that the zinc decline is due to the recycling of brass seems most unlikely. Further evidence for the non-recycling of Roman brass coins is provided by an examination of the tin and lead contents. The proportion of both of these elements increase as zinc decreases. One possible source of the tin and lead is leaded bronze (such as that used for *paterae*, etc). It is possible that after the mid first century AD Roman 'brass' coins were made by mixing a fresh brass and a fresh leaded bronze. Over time the proportions of these two fresh metals changed - less and less brass was used until in the third century almost no brass was added to the metal used for minting coins (Bastien 1967). The careful manipulation of the metal content of Roman 'brass' coins should come as no surprise as the silver content of *denarii* is progressively altered (Casey 1980: 8-11, figure 2). While the decline in silver content has been seen as deliberate, the changes in base coinage have been seen as less important and more likely to be accidental. The 'zinc decline' cannot be due to the recycling of scrap brass coins, instead it was a deliberate alloying policy.

Chronological changes in alloying

Caley's (1964: 83) argument that the knowledge or means of production of brass was 'lost' sometime in the 1st century AD has already been challenged by Craddock (1975; 1978) who found that some late Roman objects (other than coins) were made of brass. Craddock's work (1975) was hampered by the nature of the samples available, however, as most were from museum collections were without archaeological context dating. The existence of some brass artefacts which could be dated typologically to the late Roman period proved that brass production did not cease in the first century AD.

The present work has involved the analysis of 1212 Roman artefacts and allows the close examination of the change in alloy composition over time. Most samples analysed for this thesis could not be as closely dated as coins and so are mostly assigned to a single century. The results, using the alloy types defined in Chapters 2 and 6 (see figure 2:9), are shown in figure 9:5.

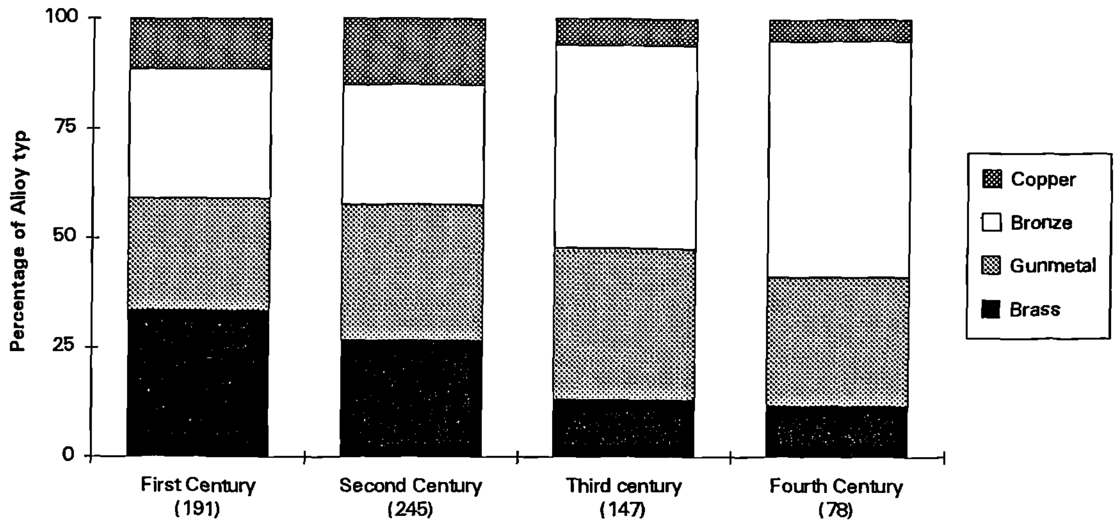

Figure 9:5. Chronological changes in the proportions of Roman alloys (Actual numbers of dated samples in brackets)

Approximately a third of 1st century Roman alloys were brasses but this proportion drops to about a sixth by the fourth century. Thus, there would seem to be a 'zinc decline' of some sort. The 'zinc decline' in Roman alloys is not as dramatic, however, as originally proposed by Caley (1964). The proportion of alloys containing high levels of zinc does decline and the average zinc content also declines. The late Roman Empire still saw the use of some brasses comparable to those in use in the early empire (e.g. the Mansell Street chip-carved belt fittings, see Bishop & Coulston 1993: 191), however, they were substantially less common. The chronological decline in the proportions of brass used in Roman alloys is matched by an increase in the proportion of bronze used (figure 9:5). There, is however, little change in the proportion of gunmetal used. The apparent changes in the proportions of brass and bronze used through the Roman period seen in the results presented here may in part arise through changes in the samples selected (discussed below).

A considerably more dramatic chronological change in alloy use can be seen in the use of leaded alloys (figure 9:6). While less than half of 1st century alloys were leaded (i.e. more than 1% lead), almost three-quarters of 4th century alloys were leaded. The increase in the lead content of alloys is curious as most evidence for the production of lead in Roman Britain (in the form of stamped ingots) comes from the first century AD. The larger proportion of leaded late Roman alloys may reflect the changing emphasis in the methods of production of objects. While 56% of 1st and 2nd century alloys were cast, 75% of 3rd century and 65% of 4th century alloys were cast (see Table 6:2). As the proportion of cast alloys increased, the proportion of leaded alloys could also be expected to increase.

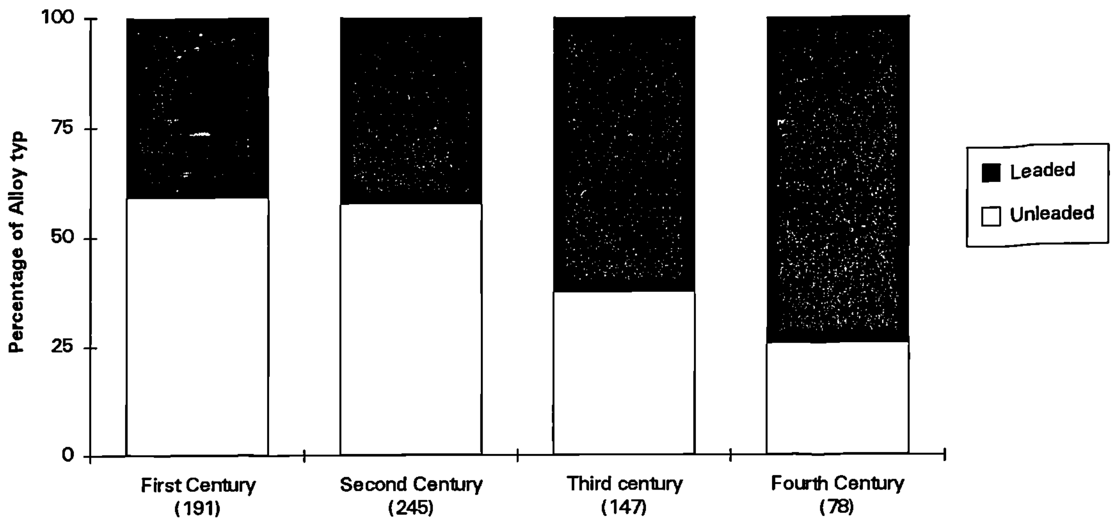

Figure 9:6. Chronological changes in the proportions of Roman leaded alloys (Actual numbers given in brackets).

The changes in the proportions of leaded and unleaded alloys may not directly reflect social or economic changes but simply metallurgical practice (i.e. an increasing proportion of cast as opposed to wrought alloys). The reasons for such a change in manufacturing should still be addressed. Generally, casting is a more straight-forward method of manufacture than working with sheet and wire. Wrought alloy working requires considerably more skill. The increasing proportion of cast alloys could be interpreted as resulting from a decline in the number of skilled smiths working with copper alloys. Such a change could occur due to an increased volume of production. Most explanations of the production of Roman military equipment in the late Empire suggest that production process were simplified (James 1988). The 'rationalisation' of production in order to meet an increased demand is, however, difficult to reconcile with the archaeological record. Most Roman finds can be dated to the early rather than the later Empire (see figure 2:2).

Any interpretation of the changing proportions of bronze and brass seen in Roman alloys has to be qualified by a consideration of the provenance of the samples. Strictly speaking the samples from each century are not comparable with each other (see figure 9: 7). First century evidence is dominated by that from forts and larger rural settlements. The second century evidence is provided mostly from forts and *vici*. The third century is the only period to have provided evidence from burials. The fourth century evidence comes primarily from forts, towns and villas. Some of these differences are problems arising out of modern archaeological activities (e.g. the only large excavated cemetery available for study was Brougham which is exclusively third century). Other differences reflect changes which occurred during the Roman period

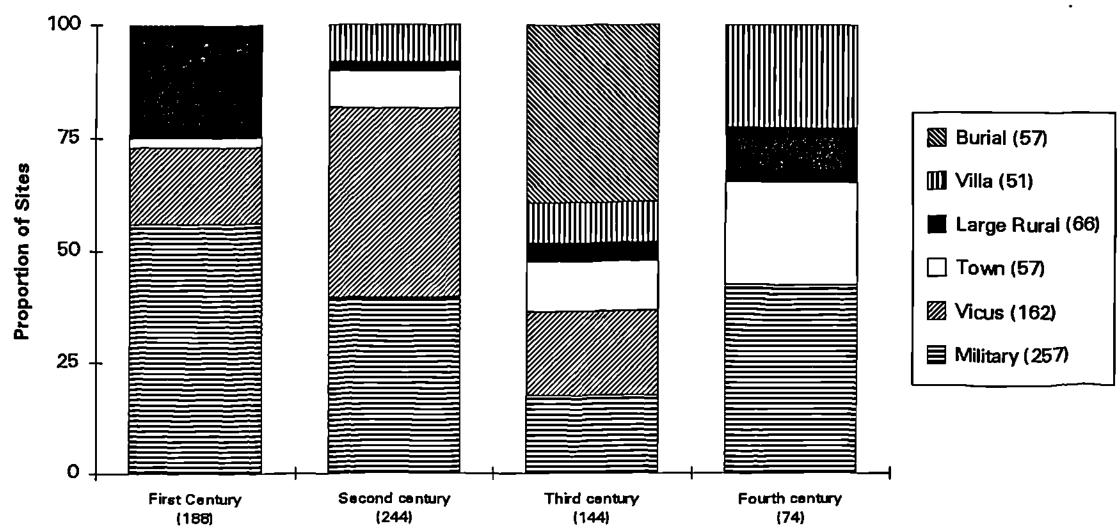

Figure 9:7. Chronological changes in the provenance of samples
(Actual numbers of samples given in brackets)

(e.g. towns and villas were genuinely rare in the earlier Roman period). These differences make chronological comparisons difficult. If there are differences in the sorts of alloys used and deposited on different sites, then the observed chronological changes may simply reflect the socio-economic differences between the sites, rather than the general chronological changes in alloy production.. This problem is addressed further in the next Chapter.

Summary

The role of brasses in the Roman period has long been seen as important. Brasses first become widely used in the early Roman Empire. Caley, using the evidence from coin analyses (Caley 1964), suggested that brasses were only produced in the early Empire. The only source of brass in the later centuries was recycled brass. The decline in zinc content (figures 9:1 and 9:2) apparently reflected the decline of the Roman Empire. Craddock (1975) suggested that at least some late Roman artefacts were made of brass and suggested that brass production may not have gone into such a decline. The re-examination of the analyses of *orichalcum* coinage (figure 9:3 and 9:4) suggests that such coinage was not regularly recycled.

Analyses presented in this chapter show that brasses were used through each of the centuries of Roman control in northern Britain. The use of brasses did, however, decline over time. Many of the late Roman brasses contain only moderate levels of zinc and could have been produced by remelting old brass scrap rather than being freshly produced by the cementation process (see Chapter 8). Remelting of scrap metal may have been important throughout the Roman period.

Chronological changes in alloys used can be identified but it is difficult to be certain of their meaning. Changes may reflect general chronological changes in alloy production and use, or they may arise due to socio-economic differences between different sorts of sites and the changing nature of the available data set.

CHAPTER 10
CULTURAL VARIATIONS IN ALLOYS USED

Introduction

This chapter will set out some of the analytical results obtained from copper alloys in terms of the types of sites where they were found. This will allow inter-site comparisons to be made. Of particular interest is the incidence of brass on a range of Roman sites. The first large scale use of brass in Europe was at the beginning of the Roman Empire. Brass was used for the production of certain classes of objects (such as coins and military equipment) and it has often been assumed that the state held a monopoly of production. It might be hoped therefore that the incidence of brasses on a variety of sites in northern Britain might indicate the degrees of Romanisation. This chapter examines this approach. The results are presented to show inter-site differences and similarities and these are discussed in terms of Romanisation and settlement hierarchies. In addition the results are considered in terms of possible deposition practices (and especially differences between different sites). This chapter ends with a more critical examination of the sources of the samples analysed and the problems inherent in the kinds of inter-site comparisons made here. It is unfortunate that a large proportion of the samples were collected from excavations where detailed contextual data was not available (either because the excavation was very recent and the post-excavation analysis had not proceeded far enough, or because the excavation was completed some decades ago and the level of on-site recording inappropriate for this kind of analysis). For these reasons no attempt is made at intra-site examinations of alloy composition related to types of contexts (ditch fills, pits, etc - cf Hill 1994).

The Early Use of Brass in Europe

Brass is an alloy of copper and zinc which is relatively hard to produce as zinc is a volatile metal and was not isolated in Europe until the 18th century AD (Tylecote 1992: 152). Prior to this brass was produced by the cementation process (Craddock 1978; Bayley 1984). The best yield obtainable with the cementation process is *c*.28% zinc. The cementation method was first used on a large-scale during the early Roman Empire. Before this brass was a rare (and perhaps a precious) metal. The monetary reforms at the end of the Republic and the beginning of the reign of Augustus, however, saw the intensive production of brass coinage (Caley 1964). At approximately the same time large quantities of military equipment began to be produced in brass (Bishop and Coulston 1993, 191).

This sudden increase in the production of brass and the relative obscurity of the manufacturing process has suggested to some that the early Roman Empire acquired the knowledge and resources to manufacture brass and maintained a monopoly (Caley 1964, 92; Grant 1946, 88; Bishop & Coulston 1993, 191).

If the early Empire maintained a monopoly of brass production (primarily for its own use) then the incidence of brass in other (non-official) objects and away from centres of Roman control, might indicate degrees of Romanisation.

Brass as an 'index of Romanisation'

The last decade or so has seen increasing interest in 'Romanisation' (e.g. Millett 1990; Freeman 1993). The term was originally coined by Haverfield (1912) to cover a range of social and economic transformations that occurred in Britain during the first four centuries AD. It is clear that quite important changes did occur but there is less consensus over the ways in which these changes came about. It has traditionally been seen primarily from the Roman point of view, i.e. the Romans deliberately set out to change the nature of society in Britain in order to make it easier to rule, and to this end they introduced literacy, urbanism, a cash-based economy, etc. More recently (e.g. Millett 1990) such views have been criticised and a more active role for the indigenous Britons has been proposed (see chapter 3).

At an early stage in the research for this thesis it was hoped that the incidence of different copper alloys could shed light on the Romanisation question. In particular it was hoped that the incidence of brass may act as an 'index of Romanisation'. If brass was produced by an imperial monopoly and used largely for official purposes (coinage and the army) then the incidence of this alloy on a range of archaeological sites would reflect the degree of social and economic ties with the Roman Empire. This model would predict that the highest proportion of brass would be found on sites at the centre of the Empire and lowest on the fringes and outside. Within any one limited region the highest proportion of brass should be found on military and urban sites with the lowest proportion on small rural farmsteads.

The view that brass was produced only by state monopoly has already been compromised, however, by Justine Bayley's analysis of Roman brooches (Bayley 1992). Many early brooches were made of brass, and include Nauheim derivative, simple Gallic, and Colchester 'A' brooches (some of which may be as early as the earliest *orichalcum* coins). There is no suggestion that these brooches were produced by the state.

The analysis of 1212 Roman copper alloy samples for this thesis have allowed the comparison of the incidence of alloys on a range of Roman sites (figure 10:1). The alloy types are those defined in Chapter 6, the site types were discussed in Chapter 3 and will be discussed further below.

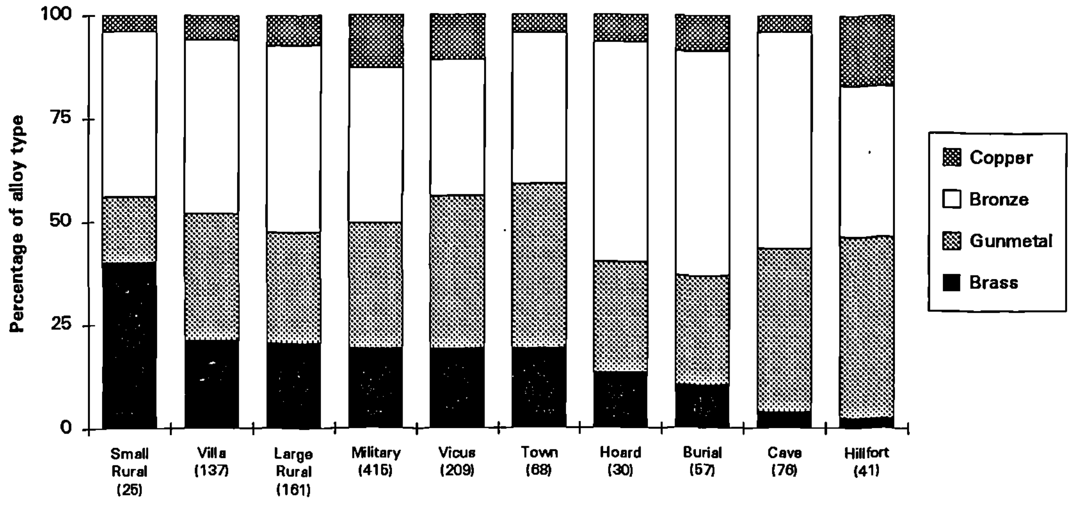

Figure 10:1. Alloys used on a range of Roman sites in northern Britain
(Actual numbers given in brackets)

It can be seen that the incidence of brass on a range of Romanised sites (forts, *vici*, towns, and villas) is broadly similar (about 20% of alloys from these sites are brasses). This suggests that there was little differentiation between these types of sites in terms of the availability of brass. The incidence of brass does not seem to reflect any military-civil or urban-rural settlement hierarchy. In fact the sites with the highest

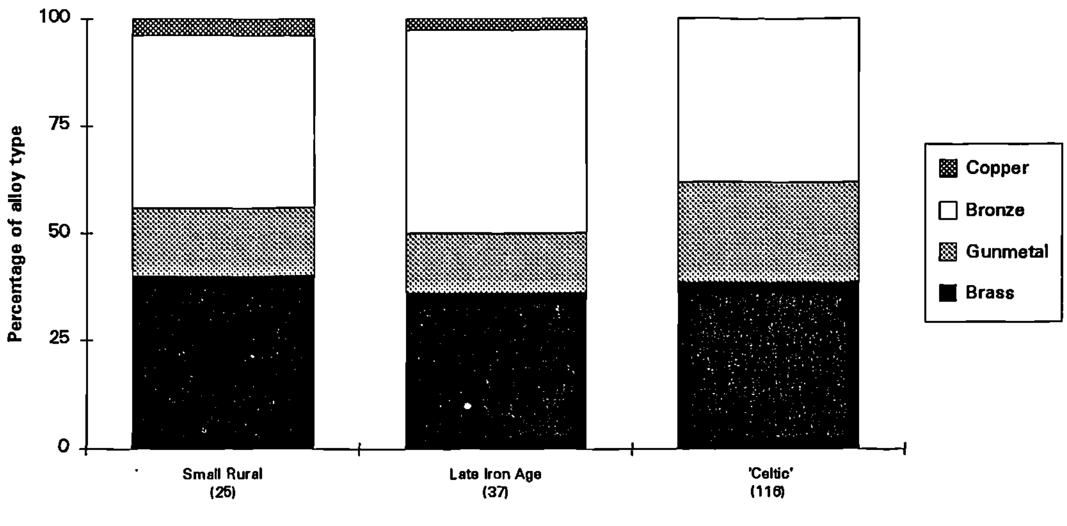

Figure 10:2. Alloys used in indigenous contexts
(Actual numbers given in brackets)

incidence of brass are the small isolated rural farmsteads. The high incidence of brass on these sites is the opposite of what might be expected from traditional imperialist explanations of the Roman occupation of Britain. The high incidence of brass at small rural sites seen here is similar to that seen in late Iron Age and 'Celtic' metalwork (figure 10;2). The use of brass in 'Celtic' and late Iron Age metalwork is discussed at greater length in Chapter 5. The widespread use of brass in the early Empire suggests that there was not an official monopoly on the production. Brass was widely available throughout northern Britain, even for indigenous manufacture.

The high incidence of brass in these contexts suggests that the indigenous inhabitants of northern Britain should not be seen as passively receiving those elements of Roman culture offered them. They apparently had more access to a 'Roman' metal than many more Romanised societies. The results of these copper alloy analysis should contribute to a wider discussion on the nature of indigenous societies in the Roman Empire, the nature of Roman society, and the ways in which these impinged on each other (Saddington 1991; Freeman 1993; Millett 1990).

There are a few classes of sites where much lower proportions of brass are found - especially hillforts and caves. Given the above discussion of indigenous metalwork, it would be difficult to argue that the low incidence of brass on these sites is due to a lack of access due to a lack of Romanisation. An alternative explanation is explored below in terms of different social rules regarding the nature of deposition on different sites.

Structured deposition and copper alloys

The few sites which show little use of brass (see figure 10:1) are hillforts, and caves (and to a lesser extent hoards and burials). While hillforts and caves in the Roman period have been interpreted as being peripheral to Roman control and Romanisation in Britain, this explanation does not seem appropriate here. As argued above, the highest incidence of brasses actually occurs in indigenous contexts and metalwork. In addition, the evidence from hillforts comes almost entirely from Traprain Law which has traditionally been seen as the capital of the Votadini and so would have had good contacts with the Roman world (e.g. Hanson 1987). This apparent contradiction can be resolved by arguing that material on these sites was carefully selected before deposition (Hill 1994; Millett 1993).

It has become increasingly accepted that the material culture of the Iron Age which survives in the archaeological record is highly influenced by active selections made by the depositors (e.g. Bewley 1994) and so cannot be 'taken at face value' (Hill 1994). The low levels of brasses from some Roman sites in northern Britain may reflect similar structured deposition. Sites which have produced low levels of brass include Traprain Law, the Settle Caves, Coventina's Well, and the Brougham cemetery. All four of these sites can be easily interpreted as arenas for ritual activities. Millett (1993) has demonstrated that the artefacts deposited in an early Roman cemetery were carefully selected and did not reflect the full range of artefacts available. Exactly the same process would seem to be operating in the deposition of copper alloys on a range of Roman 'ritual' sites. Brass may have been seen as an appropriate metal for deposition in some circumstances. Alternatively, some artefacts (which were only incidentally made of brass) may have been regarded as inappropriate.

The use of 'Romanisation' and structured deposition both provide interesting frameworks for the explanation of the differences seen in alloy use in northern Britain. It is necessary, however, to examine the selection of samples used. The previous chapter contained some warning that chronological comparisons in the Roman period may not be entirely valid as the source of the samples analysed changes over time. Conversely, when comparing different sorts of sites the different dating means that like is not being compared with like. Some of these problems are explored further below.

The problems of inter-site comparisons

The above discussion of the differences and similarities in the alloys found on a range of Roman sites in terms of Romanisation and settlement hierarchies assumes that the samples found on each site are comparable. The structured nature of the archaeological record (even in the Roman period) illustrates that the evidence from different sites may not be comparable in this way. Further problems arise with the nature of the samples selected for analysis. Some sites have produced relatively small numbers of objects (e.g. farmsteads, hillforts) and so the validity of the results from these may be questioned.

Further problems arise when the date of the samples from different sites are compared (figure 10:3). It can be seen that the date of the samples from each type of site vary considerably. It can be seen that some types of sites discussed are not included here, most notably small rural sites which are not included as only 4 samples from this type of site could be closely dated.

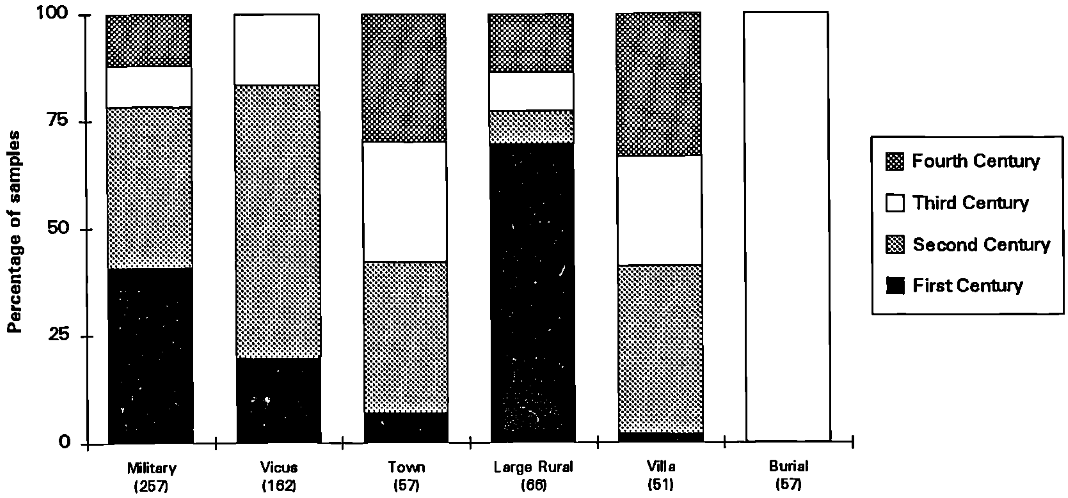

Figure 10:3. Dating of samples from a range of different sites
(Actual numbers given in brackets)

Military sites provide most evidence for the first two centuries AD, reflecting the considerable military activity that was carried out in this period. Large-scale troop movements occurred on a regular basis and new forts were frequently built and abandoned. The archaeological record is therefore rich in forts of the first and second centuries. The later Roman period saw a decline in the number of soldiers in Britain (James 1984) and those who remained generally remained where they were stationed. There was therefore less opportunity for the deposition of metalwork in the later Roman period.

Evidence from military sites forms the largest proportion of all the analyses carried out for this thesis. The range of alloys used on different sites can be seen in

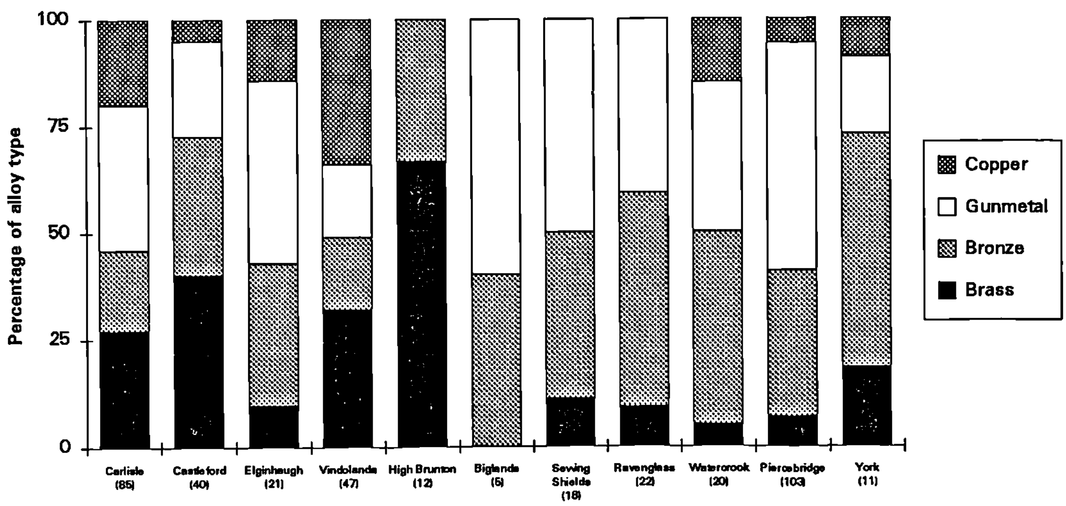

Figure 10:4. Proportions of alloys used in Roman forts
(Actual numbers given in brackets)

figure 10:4. Many first or second century sites, such as Castleford, Carlisle, Vindolanda and High Brunton (for references to individual sites see Appendix 3), show a high proportion of brass in use. Some of those sites which have a low proportion of brass are those where occupation was later (such as Ravenglass and Piercebridge). This strengthens the suggestion of a chronological zinc decline (chapter 9), but some first century sites also show low levels of brass, e.g. Elginhaugh. The reasons for differences in the alloys used on similar sorts of sites at approximately the same date are not clear. The lack of brass at Elginhaugh may reflect a real lack of brass in the fort due to supply problems. On the other hand, the apparent lack of brass may be due to differences in preservation conditions and excavation strategy. At Carlisle and Vindolanda large quantities of thin copper and brass sheet and wire were recovered. This is mostly scrap metal, probably awaiting remelting or reworking, and reflects the activities of smiths on the sites. Such quantities of scrap sheet and wire were not found at Elginhaugh. This may be because smithing was not common at Elginhaugh (occupation was short-lived), smithing areas were not excavated, or the soil conditions were too harsh to allow the preservation of thin fragments of metal. All three explanations are possible.

Vicus settlements provide most evidence in the 2nd century, but no evidence in the 4th century (see figure 10:3). In large part this reflects the history of these sorts of sites in northern Britain. The lower proportion of 1st century evidence (compared to forts) may reflect an occasional time-lag in the setting up of *vici* in newly conquered territory. The lack of 4th century evidence from *vici* results partially from problems of definition and classification. Daniels (1980) has argued that changes in

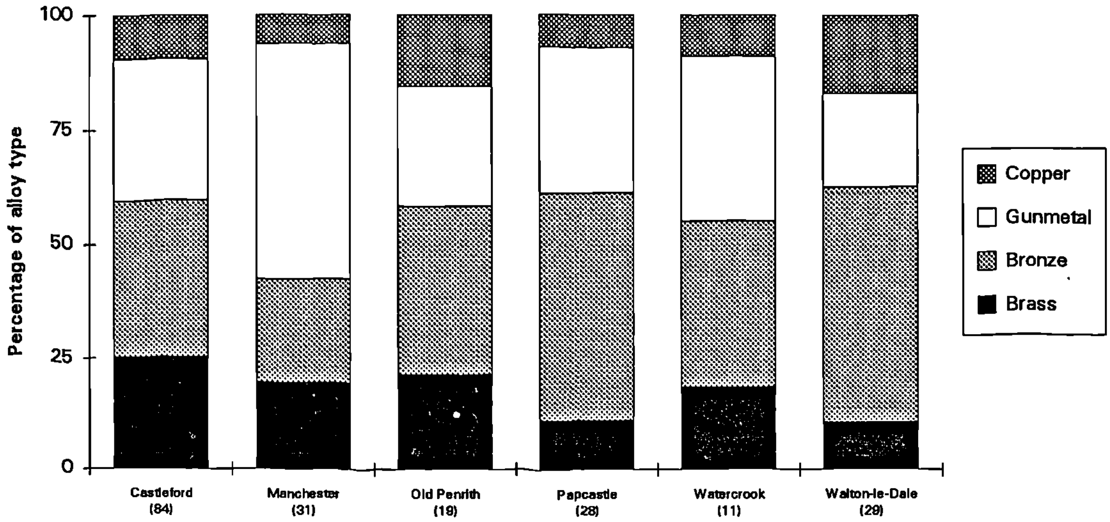

Figure 10:5. Proportions of alloys used in Roman *vici*
(Actual numbers given in brackets)

late Roman barrack architecture arise due to soldiers' dependants moving into forts and so *vici* may have been largely abandoned by the 4th century. At some sites the status of a *vicus* may change over time. Extra-mural settlement at Carlisle has been interpreted as a *vicus* in the first two centuries AD but as a town in the later Roman period (McCarthy 1990). There is a remarkable similarity in the range of alloys used in different *vici* (see figure 10:5). This may reflect the fact that the date range for these sites is not as wide as it is for military sites.

The relationship between the definition of *vici* and towns in northern Britain can be seen in figure 10:3. Little evidence comes from towns in the 1st century (because they hardly existed at this time), but there is some 4th century evidence (in contrast to *vici*). The date of the evidence from towns shows parallels with the evidence from villas (this may not be surprising as it has long been claimed that these two classes of settlement are socially and economically related, Salway 1965; Casey 1982; Millett 1990).

The evidence from Roman towns dates mostly from the second century onwards (see figure 10:3). This reflects the fact that any first century settlements displaying any urban characteristics are found outside forts and so would be classified

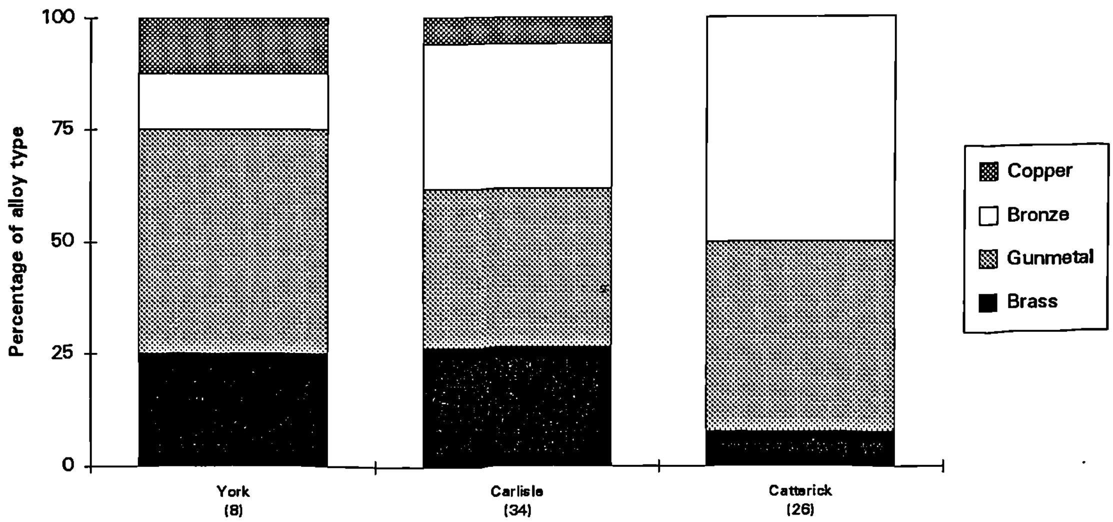

Figure 10:6. Alloys used in Roman towns
(Actual numbers given in brackets)

as *vici*. The range of alloys used in different towns is shown in figure 10:6. There are considerable differences between the three sites but this may reflect the relatively low number of samples from each site.

The evidence from burials comes entirely from the 3rd century. This is because the only large cemetery available for study was that at Brougham where all the burials belonged to the 3rd century. The range of alloys used in the cemetery at Brougham are similar to those found on other third century sites (see figure 10:7).

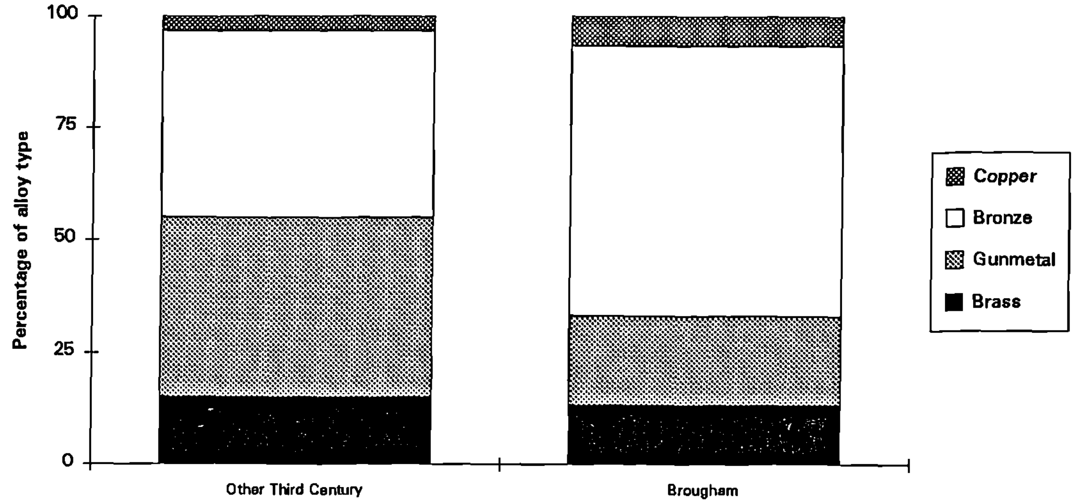

Figure 10:7. Comparison of the alloys used at brougham with those from other 3rd century sites

The differences seen between burials and other sites (figure 10:3) may be caused by the restricted date of the burial evidence.

Larger rural settlements (figure 10:3) provide considerable 1st and 4th century evidence but little from the 2nd or 3rd centuries. This reflects the occupation on those sites examined (Dragonby and Old Wintringham have considerable activity in the first century, while Shiptonthorpe and Bainesse Farm see most activity in the fourth

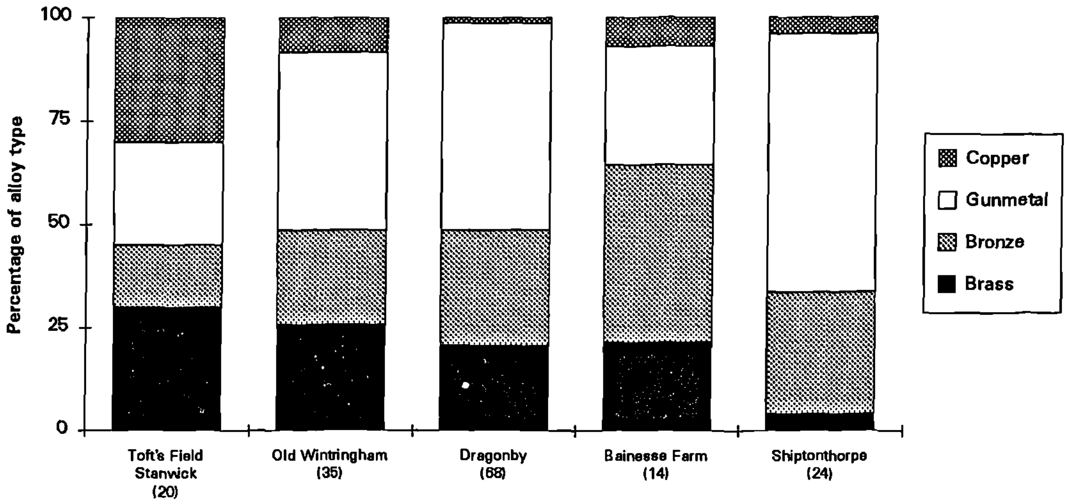

Figure 10:8. Alloys used on Larger Rural sites
(Actual numbers given in brackets)

century). It is unclear to what extent the restricted date of the evidence is a reflection of the limited excavations in northern Britain and limited sampling for analysis, and to what extent this class of site generally sees more activity in the early and later Empire but not in the middle years. The alloys used are shown in figure 10:8. It is striking that Bainesse Farm (which is occupied from the second century onwards) has just as much brass present as earlier sites, such as Dragonby. The only site which has noticeably lower brass levels is Shiptonthorpe. This may reflect the fact that most activity on the site belongs to the third or fourth century. Alternatively, the low brass levels at Shiptonthorpe may be another indication of the ritual nature of some of the activities on this site (Millett personal communication).

In northern Britain villas do not appear before the second century (figure 10:3). This is in line with the accepted view that such sites usually date to the second century or later. Southern England sees the emergence of some villas in the first

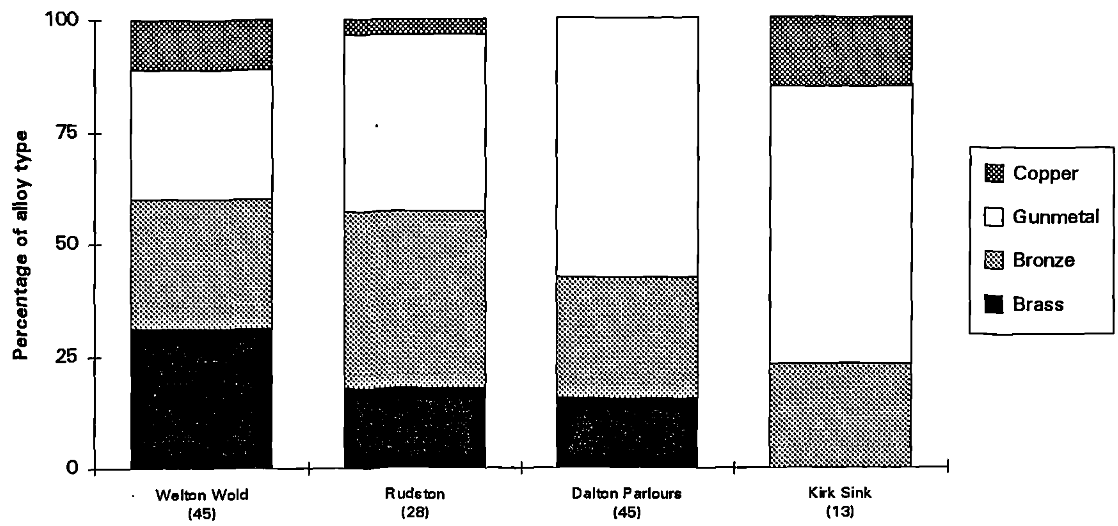

Figure 10:9. Alloys used on villa sites
(Actual numbers given in brackets)

century but the development of villas in northern Britain is slower. The range of alloys used at different villas (figure 10:9) varies considerably from site to site (Welton Wold sees high incidence of brass while Kirk Sink has no brass). Some of this variation may arise due to problems of defining these sites. The site at Welton Wold includes a rectilinear building which generally conforms to the villa type but most of the site consists of the sorts of enclosures and buildings which are found on non-villa sites. All of the finds from Rudston have been treated as if they were from the villa, but the villa buildings themselves belong to the fourth century. The status of the site before this period is uncertain. None of the finds from Kirk Sink could be context dated and some of the finds came from unstratified layers.

The above discussion of the range of alloys on different sites has highlighted some of the problems involved in inter-site comparisons. Differences between two sorts of sites may reflect 'real' differences between the alloys used on the two sites, or they may reflect differences in the chronologies of the two sites. It is possible that the

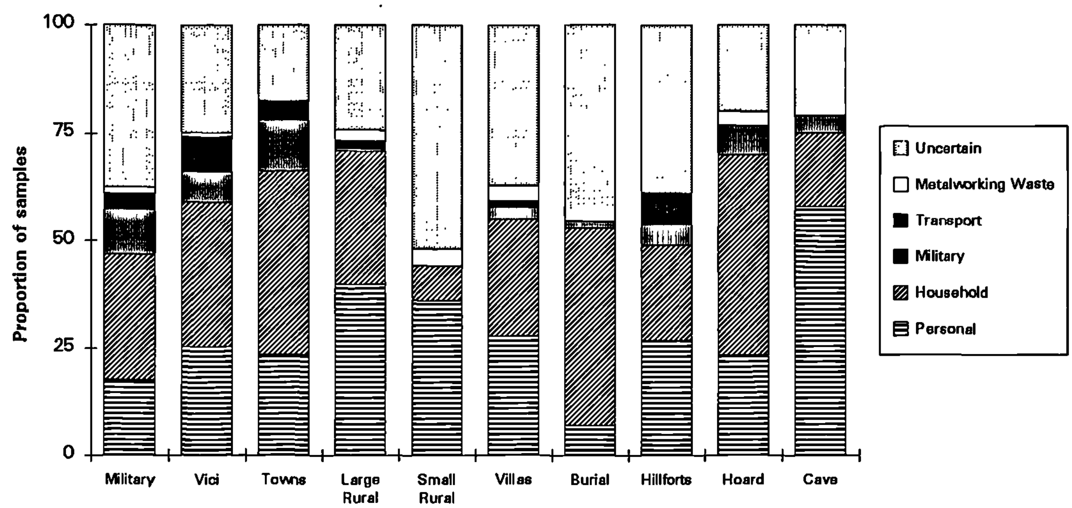

Figure 10:10. The categories of objects analysed from different sites in northern Britain.

Roman period in northern Britain sees chronological and cultural variations in alloy use. Such variation in two fields simultaneously is difficult to disentangle. Further complication arises if the nature of the artefacts compared is considered. Not all sites produce the same range of artefact types (figure 10:10) and the sorts of finds recovered change over time. Attempts to subdivide the total number of analyses by an ever increasing number of archaeological criteria (site type, chronology, artefact type, deposit type) leads to a fracturing of the data base until the number of results in any one field is so small that they cannot reliably be compared with another.

Summary

This chapter has examined the variations in alloys used on different sorts of sites in northern Britain. Particular attention has be focused on the incidence of brass. This metal is first used in Europe from the late first century BC onwards and first appears in Britain at the time of the Roman conquest (or shortly before). The production of brass for Roman military equipment and coinage has led many to suggest that it was produced by and for the state under an official monopoly. This model would therefore suggest that access to brass was restricted and controlled by the Empire. The incidence of brass on provincial Roman sites might therefore act as an 'index of Romanisation' for that site. The more Romanised the site was, the more a part of the Roman (as opposed to indigenous) economy it was, the more the site would have access to and use brass.

Analysis has shown that a wide range of artefacts were made of brass. These are found on a wide range of sites. There is no correlation between a traditional hierarchy of settlement types and metal use, i.e. those at the top (towns) having the highest levels of brass and those at the lowest (farmsteads) having the lowest. Most Roman settlement types have similar levels of brass. The one settlement type to have particularly high levels of brass is the un-Romanised small rural farmstead - those settlements at the 'bottom' of the assumed settlement hierarchy. The high incidence of brass in this indigenous context is also mirrored by the high incidence of brass in late Iron Age and 'Celtic' metalwork (Chapter 5). This suggests that the indigenous inhabitants of northern Britain were not as passive as they are sometimes made out to be. The indigenes were able to select artefacts and materials from the Roman world with considerable freedom. This may be of wider European significance in the light of a recent paper by Stos-Gale (1993) which indicates that the range of alloys from a Roman-period site in southern Poland included a higher proportion of brass than is usually found inside the empire.

There is no evidence for a state held brass monopoly in the early Empire but there is the possibility that state metal production in the late Empire did involve the production of brass. Nevertheless, brass continued to be produced and used in non-official circles.

Central to the sorts of inter-site comparisons carried out in this chapter is the assumption that the artefacts from each site are in some way representative of the activities which took place there. One school of thought (e.g. Binford 1983) assumes that the archaeological record is passively formed through the unconscious loss and discard of material culture. It is assumed that objects enter the archaeological record near their place of use and in the proportions in which they were used. This approach allows considerable reliability to be attached to the archaeological record - social life can be 'read off' from the archaeological record. While this has been qualified to a certain extent (e.g. Middle Range Theory) it is still assumed that there are straight-forward links between past life and the present archaeological record. While it has long been acknowledged that some parts of the archaeological record were deliberately constructed (e.g. deposits at temple sites), recent research (e.g. Hill 1994) shows that large proportions of the archaeological record may be deliberately constructed, even on settlement sites. Artefacts were carefully selected for inclusion in deposits and so may more accurately reflect the ideology of the society and beliefs of the individuals than the economy, raw materials, or technologies used. Such ideologies and beliefs may vary from site to site and change over time.

A final problem when attempting to consider the similarities and differences between sites (and between centuries) is the incommensurability of different sites. Differences may be identified in the alloys recovered from different sites but do these indicate differences in the alloys *used* ? This chapter contains a detailed examination of the way in which the chronological and cultural make up of the selected samples varies. Inter-site and chronological comparisons lose their validity if the sites and periods are made up of different sorts of samples.

CHAPTER 11
CONCLUSIONS

Introduction

This thesis presents the chemical analyses of over 1500 Iron Age and Roman copper alloys. These results have been considered in the light of previous analyses, metallurgical constraints and existing archaeological knowledge of the period being studied. This final chapter summarises and further discusses some of the key issues of the thesis. These range from the highly specific, such as the details of the cementation process in the production of Roman brass, to the general, such as the nature of time and cultural change.

Summary of the findings

The analysis of copper alloys has included nearly 300 Iron Age, late Iron Age, and 'Celtic' samples (Chapter 5). These results (and those of Northover and other researchers - see page 68) show that only one alloy was used in the pre-Roman Iron Age: a tin bronze which occasionally contains low levels of lead, usually contains some arsenic as an impurity, and almost never contains any zinc. This alloy is uniformly found throughout those areas of Britain where archaeometallurgical research has examined Iron Age copper alloys.

The vast majority (although not all) 'Celtic' metalwork, however, is not made from tin bronze. Instead this category of metalwork is made from a range of copper alloys containing zinc, tin, and/or lead. In this respect, 'Celtic' metalwork is more similar to Roman than Iron Age copper alloys. Most 'Celtic' metalwork has previously only been assigned the vaguest of dates (on typological/stylistic grounds) and it has been conceded that some was deposited (and may have been manufactured) after the Roman Conquest (e.g. Macgregor 1976). It can now be confidently stated that the vast majority of 'Celtic' metalwork was produced after (or shortly before) the Conquest. The exact date at which 'Celtic' metalwork in Britain began to be produced in alloys other than the traditional bronze is uncertain. Brass is first used widely in Europe from the time of Augustus's coin reforms (23 BC). 'Celtic' metalwork containing significant levels of zinc (more than a few percent ?) was probably produced using scrap Roman metal. 'Celtic' brass is therefore unlikely to pre-date 23 BC. It is possible that the first appearance of brass in northern Britain post-dates 23 BC by some years. The appearance of items far from the borders may take some time. In this respect brass is like many other items of Roman material culture which are found outside the bounds of the Roman Empire (Macready & Thompson

1984). The appearance of brass in Britain does predate the actual Roman Conquest (AD 43) as there is evidence for the production of brass brooches at Baldock (Stead & Rigby 1986). An exact date for the first use of brass in northern Britain is as yet unavailable.

It has long been known that Roman alloys are formed using a variety of alloying elements: zinc, tin, and lead (pages 8-11). Those alloys containing mostly zinc are known as brass, those containing mostly tin as bronze, and those containing both gunmetal. For this thesis alloys have been described as leaded if they contain more than 1% lead. A variety of ways in which the analytical results can be represented using graphs and tables are explored. In order to deal with the large number of samples produced for this thesis (Chapter 6) a 3-D chart was used (figure 6:4). The two horizontal axes represent the zinc and tin contents (as in the 2-D zinc and tin scatter charts seen in Craddock 1975, Caple 1986, and elsewhere). The third (vertical) axis of the 3-D chart used here represents the frequency of any particular combination of zinc and tin. Figure 6:4 shows a number of peaks in the distribution which relate to specific alloys (probably produced to a specific recipe), a number of troughs which indicate that some compositions were never aimed for (or obtained accidentally), and a broad 'low-lying' area. The three main peaks in this distribution of alloy types represent copper (little or no zinc or tin), bronze (tin, but little or no zinc), and brass (zinc, but little or no tin). The bronze was probably produced by mixing copper and tin together whereas brass was produced by the cementation process (see below). The fact that these three peaks are clearly visible suggests that they are significant and were deliberate. There is, however, no absolute separation of these alloys from each other. Figure 6:4 shows that the peaks are all connected to each other (through the 'low-lying' area discussed below). Any decision as to the exact limits of any peak/alloy type will be arbitrary to a certain extent. The use of a statistical method to define these alloy types, such as cluster analysis will not work as the clusters are semi-circular in their distribution.

The 'low-lying' area referred to above can be seen in figure 6:4 extending from the brass peak to the bronze peak. This area consists of alloys containing zinc and tin, i.e. gunmetal. The fact that this area extends from the brass peak to the bronze peak (and only between these two peaks) suggests that gunmetals were formed through the mixing of brass and bronze, rather than the mixing of tin and brass. The gunmetals form a continuum with the bronze and brass peaks; there are no peaks within the gunmetal distribution. This indicates that overall the mixing of brass and bronze was not carried out to a single recipe.

The troughs in the distribution of alloys are just as significant as the peaks. As Caple has pointed out (Caple 1986) these troughs indicate that some alloy types were never deliberately made or arrived at accidentally. Figure 6:4 shows that there are no alloys where the total zinc and tin content exceeds 30%, therefore tin (as opposed to bronze) was rarely added to brass. If tin had been mixed with brass then the more alloys with, for example 20% zinc and 20% tin would be expected. A second trough occurs in the region of between 2 and 10% zinc (and less than 2% tin). There are no low zinc brasses: if alloys do contain between 2 and 10% zinc they are always accompanied by at least 2% tin. This shows that brass was never mixed with copper or recycled on its own. If brass had been commonly recycled on its own then the oxidation/volatilisation of zinc would have caused progressive loss of zinc (Chapter 8). It is clear then that if brass was recycled/mixed with other alloys then it was always mixed with bronze.

Craddock (1975), Bayley (1992) and other have shown that some Roman artefacts were made to recipes that were adhered to with varying strictness. In some cases the alloy composition for a specific artefact type may have a standard deviation of 10% or less (e.g. some first century brooches) in other cases there is a little more than a general tendency for a general alloy type to be used (Chapter 7). In many cases there was no correlation between typology and alloy composition. This variation in the use of recipes for specific artefact types is seen in the overall alloys used. Bronze and brass were mixed to produce gunmetal but there is no peak in the gunmetal distribution. In general, there does not seem to have been a standard gunmetal in the same way as there is a standard bronze. On the other hand, the mixing of brass with bronze was the only way in which brass was recycled - it was never recycled on its own or with copper.

The use of three alloy elements in Roman alloys produces complex quaternary alloys which make interpretations more difficult than for the Iron Age. Nevertheless this thesis has continued to explore the possible 'grammar' which controlled the formation of copper alloys.

The Cementation process and the Production of Brass

It is now widely accepted that Roman brass was produced by the cementation process (Craddock 1978; Bayley 1984). The use of this rather involved process is indicated by the composition of Roman copper alloys, experiments, ancient and medieval accounts of brass production, the copper-zinc phase diagram, and crucible remains. The maximum zinc content using the cementation process would seem to be *c.* 28%. (A small number of unstratified artefacts, from Roman sites, were not included in this thesis because their zinc contents were too high - the objects are probably post-medieval.) If *c.* 28% zinc were the maximum zinc content of Roman brass then it is striking that alloys with 23-28% zinc are very rare (see figure 6:4; only 1 in 1000 of Roman alloys have more than 23% zinc). This lack of brasses with the sorts of zinc contents predicted by the cementation process can also be seen in the work of Craddock (1975) and Bayley (1992).

A number of possible solutions to this problem may be suggested. The experiments carried out to examine the oxidation/volatilisation of zinc (Chapter 8) have shown that molten brass will tend to lose a proportion of its zinc. Thus, if brass with a zinc content of (say) 28% was produced in a sealed cementation crucible, the metal would regularly be melted (in an open crucible ?) prior to casting actual artefacts, which would then have a lower zinc content. If 1/5 of the zinc was lost during casting then the zinc content of the cast artefact would be 22.4%. Zinc contents in excess of 23% might be regularly found, however, in artefacts which have been worked from solid cementation brass (which had not been remelted).

A second explanation for the low number of brasses with zinc in excess of 23% may also be suggested. The common brasses (15-23% zinc; see figure 6:4) are often (but not always) accompanied by small amounts of tin and/or lead. The presence of either of these two elements may interfere with the cementation process. Both modern experiments, and ancient and medieval accounts of the cementation process make it clear that the copper used was finely divided. This provided a large surface area for the zinc vapour to diffuse into. It has been surmised that the diffusion of zinc into the copper would continue satisfactorily only while the copper remained solid. Once the copper melted the surface area would decrease dramatically. The cementation process thus required the careful control of temperature. The temperature must be in excess of 907°C in order to volatilise the zinc but must not exceed 1083°C or the copper would melt. As the proportion of zinc in the copper increased its melting point would be lowered. Eventually the brass produced would melt and less zinc would diffuse into the molten brass. If the copper used in the cementation process was not pure, but contained some tin or lead then its melting point would already be lowered before and zinc was diffused into the copper. In this case the maximum zinc uptake into the copper would be somewhat less than 28%.

Two different explanations can, therefore, be suggested for the paucity of high zinc brasses. Both make use of the available analytical, metallurgical and experimental data, and both are plausible. This illustrates many situations (not only in archaeometallurgy) where a phenomenon may be explained by more than one cause. It may be impossible to decide that one is true and that the others are false.

Historical and Archaeological Time

The alloys selected for this thesis cover almost a whole millennium and it is possible to observe considerable chronological change. The alloys of the late Bronze Age are mostly leaded bronze, those of the Iron Age tin bronze, and those of the Roman period vary widely. The chronological changes in alloy compositions do not, however, match the conventional dates for the beginnings and ends of these periods. The alloys of the earliest

Iron Age in Britain (Staple Howe and Scarborough) are little different from those of the late Bronze Age. The alloy type referred to in this thesis as typical of the Iron Age is largely restricted to the 'Arras' culture burials and contemporary settlements. Iron Age alloys are, however, similar to Bronze Age ones in many respects. The only significant differences being the higher iron levels and the lower lead levels. The former probably reflects a change in smelting methods (Craddock & Meeks 1987), but the latter is difficult to explain. The higher lead levels in late Bronze Age and in Roman alloys shows that such use of lead could be beneficial. If the decreased use of lead was deliberate then it appears to be a technologically retrogressive step. On the other hand the decrease in leaded alloys may simply reflect a scarcity of lead (but then the scarcity of lead itself would require explanation).

Iron Age bronze gives way to the variety of alloys used in the Roman period (brass, bronze and gunmetal) but this change over does not occur with the Roman Conquest of Britain. There is abundant evidence for the use of brass artefacts in late Iron Age Britain, and for the working of brass metal. Although, as yet the only evidence for brass production is post-Conquest. Nevertheless the use of a range of alloy types in Roman Britain is established before the actual Conquest.

Chronological changes in copper alloys during the period of the Roman Empire might be expected on the basis of the analysis of Roman *orichalcum* coins by Caley (1964). The *sestertii* and *dupondii* of the Augustan reforms (and those for the following century or so) have high zinc contents (usually 20% or more). The zinc content of the later coins gradually declines until the mid third century when the coins contain no zinc. Regular late Roman coins (of any kind) almost never contain any zinc. Caley suggested that the zinc decline resulted from a loss of the cementation process. Fresh brass was no longer produced after the late first century AD and later coins could, therefore, only be produced by recycling old ones. As the recycling would cause some loss of zinc the zinc content of Roman coins would gradually decline. The overall shape of this zinc decline does not, however, match that which would be predicted by recycling losses (Chapter 9). In addition, later coins contain progressively more tin and lead. An alternative explanation for Caley's zinc decline can be suggested which takes into account contemporary changes in the composition of the gold and silver coinages. The content of these precious coinages were carefully and deliberately manipulated. I would suggest that the composition of *orichalcum* was similarly manipulated by mixing fresh brass with leaded bronze to produce an alloy of desired composition. The analysis of a range of copper alloy artefacts for this thesis has shown that there was a chronological decline in the proportion of brass used (Chapter 9). There was never a cessation of brass production and some typologically late Roman artefacts (e.g. late fourth century belt sets) were made of brasses which had never been recycled. The observed chronological decline in the proportion of brasses may be more apparent than real as the nature of the data set from which the samples were drawn itself undergoes chronological change. The later samples are not therefore strictly comparable with the early ones. This problems also emerges when attempts are made to compare samples from different sorts of sites.

The mis-match between the archaeometallurgical evidence and the conventional archaeological chronology casts doubt on the usefulness of the archaeological periods of the Three Age System and on the links between archaeological chronologies and historical ones. Collingwood (1993: 50) characterised such a system as viewing each era as unique and divided from each other era by a dramatic event or development. The Three Age system privileged the role of technology and materials in defining human history. Social life may, however, have only incidental connections with contemporary technology. Earlier prehistory has already seen the weakening of the Mesolithic-Neolithic and the Neolithic-Bronze Age dichotomies. The late Neolithic and the early Bronze Age are now seen as having more in common with each other than the advent of metal use might imply.

The mis-match between archaeological evidence and historical evidence can also be seen in Caple's study of the production of post-medieval pins (Caple 1986). Archaeology has often been regarded as an illustration of history rather than a historical discipline in its own right. Archaeologists, however, have become increasingly confident of their evidence and no longer automatically defer to historians or classicists. Within a processuralist framework such a situation is uncomfortable and archaeologists must decide whether they are right (or if it is the historians/classicists who are right). A post-processuralist/post-modernist perspective, however, avoids such a crisis by admitting diversity. Truth is not absolute but is localised (Hodder 1986; Shanks & Tilley 1987), and different disciplines can examine the same problem yet develop different explanations. These differences often say a lot about each discipline's starting assumptions.

Cultural Change

During the period studied for this thesis northern Britain underwent considerable cultural change. The most dramatic changes occur with the expansion of the Roman Empire and the Conquest of Britain. The Roman Empire was an alien social and economic system which had the capacity to transform both the societies it conquered and those which remained outside its borders. In some cases such transformation may have been deliberate, Rome seems to have been keen to devolve the day-to-day running of conquered societies into the hands of trusted locals (often members of the elite groups who ruled the societies prior to conquest). Local elites will have been encouraged to conform to Roman behaviour norms (at least while dealing with Romans). Rome was also capable of carrying out physical and economic warfare against neighbours who were regarded as potentially threatening. In other cases transformations occurred which were not deliberate. Comparisons with modern colonial and imperial situations suggests that the presence of the Roman army and the Mediterranean economy may have effected cultural changes which were not necessarily intended. The nature and causes of all of these changes have been of fundamental importance to Romano-British archaeology since Haverfield's (1912) *Romanization of Britain.*

The use of archaeometallurgy as a means of examining Romanisation is attractive as copper alloy artefacts are usually non-utilitarian and so may reflect ideology or personal choice, and they are small and so can be widely exchanged. This is in contrast to the majority of the evidence for the indigenous inhabitants of northern Britain during the Roman period. Most evidence consists of cropmark or earthwork sites (settlements and field systems). The landscape may suffer from 'cultural inertia' and so be relatively unchanged by the Roman Conquest (or the Anglo-Saxons or the Vikings). Copper alloy artefacts may be a better reflection of such changes. The potential usefulness of copper metallurgy in this way is strengthened by the appearance of brass in Europe in the Roman period. Brass was produced in considerable quantities for Roman coins and military equipment and it has often been assumed (e.g. Grant 1946) that Rome maintained a monopoly over the production of brass. Samples were therefore collected from a range of different sites to examine the exchange and diffusion of brass from the core of the state to its margins (particular effort was expended to ensure that small un-Romanised rural settlements (farmsteads) were included in the data set even though such sites are relatively poorly known in northern Britain).

The examination of the incidence of brass on a range of Roman sites has, however, produced unexpected results (Chapter 10). While a range of Roman sites have similar proportions of brass, the one class of settlement to have high proportions of brass is farmsteads. These are the sites which according to conventional explanations of Roman Britain occupy positions at the base of the socio-economic system. The high incidence of brass on these sites challenges the assumption that the inhabitants of such sites were poor, powerless, and had little control over their lives (let alone the province as a whole). The high incidence of brasses in the archaeological record of farmsteads may not necessarily be a direct reflection of the use of brasses on such sites, however. The work of J.D. Hill (1994) and others shows that the archaeological record is not necessarily a passive reflection of past activities. As such brasses may have been preferentially *deposited* rather than *used* on farmsteads.

Future Research

Further work can be suggested in two major directions: an expansion of the geographical horizons of study, and the detailed examination of single sites. A number of highly specific research projects are clearly needed, e.g. the analysis of more examples of early (i.e. pre-Neronian) and late (Septimius Severus and later) orichalcum coins, and cementation experiments using impure copper to examine the maximum zinc absorbed by such metal.

On a broader scale, there is still very little known about the Iron Age copper alloys of Scotland, Ireland or the continent. Similarly, relatively little is known about Roman copper alloys of other provinces of the Empire. Such data bases will help to clarify to what extent the alloys of northern Britain are peculiar to northern Britain.

While research can be recommended on a broad front there is also a need for small-scale examinations of single sites in order to examine the formation process which produce the archaeological record. This thesis has identified a number of difficulties in interpreting the range of alloys found on different archaeological sites. Social rules may have restricted the deposition of certain alloys in some contexts and encouraged in others. The possible role of taphonomy in determining which copper alloys are recovered from particular archaeological sites and contexts should be investigated through detailed examination of individual sites. Suitable sites (i.e. those with large area excavations) should provide large quantities of copper alloys from a range of different contexts. The interpretation of copper alloys should also consider the formation processes behind the contexts from which they originate, and the relationships between different contexts.

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APPENDIX 1
ANALYTICAL METHOD

Introduction

This appendix details the analytical system and sample preparation methods used to obtain the quantitative analyses presented in the thesis. The analytical instrument used was an energy dispersive X-ray fluoresence (EDXRF) spectrometer. X-ray fluorescence (XRF) is a well established technique, widely used in industry, which has been used for some time in archaeology for the examination of ancient metals (e.g. Hall 1960; Caple 1986; Cowell 1990). This description of the analytical method concentrates, on the practicalities of how EDXRF was used to obtain quantitative analyses of archaeological copper alloys, rather than XRF theory in general. The general theory and principles of XRF can be found in a number of standard reference works (e.g. Williams 1985; Jenkins, *et al.* 1981).

X-ray Fluorescence

The spectrometer used to obtain the analytical results is fitted with a Rhodium target. The target is excited by a stream of electrons. The target then emits X-rays of a range of different energies, which are directed onto the sample to be analysed. The incident X-rays can interact with the sample in a variety of ways. For the purposes of EDXRF only one phenomena is of interest - namely fluorescence. Incident X-rays can displace electrons from the inner shells of atoms in the sample, providing they have sufficient energy. The electronic structure of a atom with a displaced inner electron is unstable. In order to achieve a more stable arrangement an outer electron 'falls' from an outer orbit to the inner one. This can occur in a single step, or as a series of steps in those atoms with three or more electron shells. As an electron moves from an outer to an inner shell it emits energy. This is necessary as inner electrons always have less energy than outer ones. The energy which an electron can have in a particular shell is fixed. The energy emitted when an electron 'falls' from an outer shell to an inner shell is the energy difference between the two shells. Thus, whenever an electron moves from a particular outer shell to a particular inner shell in a specified atom the energy emitted is always the same.

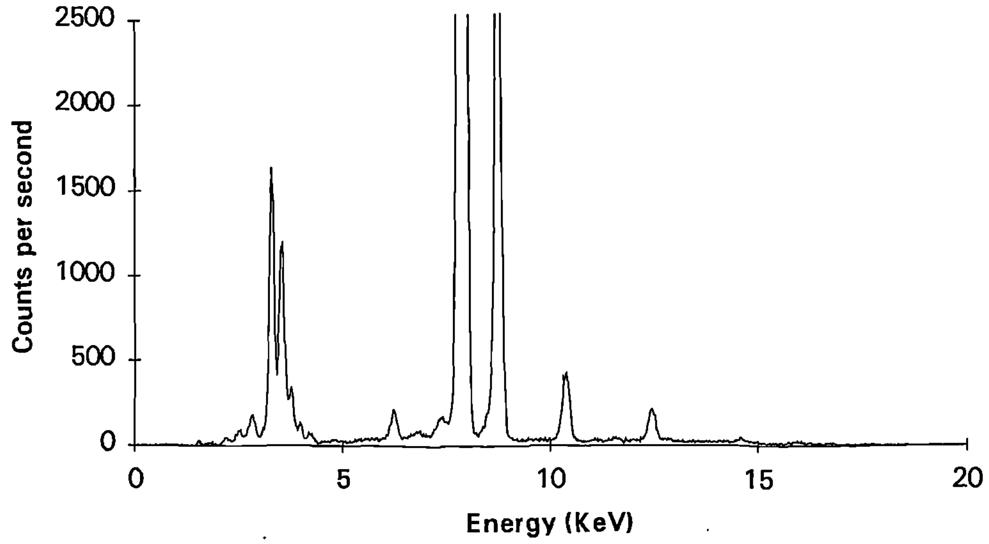

Figure A1:1. EDXRF Spectrum

When excited by X-rays copper always emits X-rays at 8.04 keV. The presence of a range of different elements in a sample produces a spectrum of X-rays with different energies (see figure A1:1). The peaks in this spectrum relate to the elements present in the sample. Thus, it is possible to note the presence of most elements from a single analysis. The height of any given peak is proportional to the amount of the element present in the sample. By matching the height of the peak (or for more accuracy the area under the peak) to those derived from the analysis of known standards it is possible to determine the proportion of that element present in the sample.

The EDXRF facility used was a Link Analytical XR200, with the following set up:

Voltage =	20kV	Current =	250μA
Source =	Rhodium	Collimator	2mm
Live time =	100 secs	No Filter	

Each spectrum was deconvoluted by the dedicated software provided. The output from the attached computer consisted of counts per second (cps) data for a selected peak for each of the elements under consideration. The number of elements that could be sought for in this way was limited to 25 by the software available. The presence of other elements could be visually checked by looking for peaks during spectra collection.

Elements

EDXRF spectra will show the presence of any element present in the sample (providing the atomic weight is over 11, that the voltage setting is sufficient to excite all elements, and that the element is present at a sufficient level). Nevertheless, the dedicated software allows the simultaneous detection and measurement of a maximum of 25 elements. The choice of which elements were to be sought was based on what might be expected in the archaeological samples (from previous programmes of work) and the composition of the available standards.

The most important elements sought were the alloying elements zinc, tin and lead. These elements were deliberately added to copper and so reflect the technological, social and economic influences of the period under study. The standards available for calibration were made for use in modern quality control of metal composition and so reflect the alloys presently in use. Archaeological alloys, however, often contain levels of some elements in excess of those found in modern alloys (e.g. speculum, a tin bronze with *c*.25% tin, used for the manufacture of mirrors in the Roman period. The maximum tin content of modern standards is only *c*.15%). The further implications of this are discussed in the discussion of error calculation in Appendix 2.

The standards also contained low or trace levels of other elements (Iron, Nickel, Manganese, Arsenic and Antimony). These other elements were also included in the analysis (initially) for the sake of completeness. Elements which were present in the standards and so could be calibrated are shown Table A1:1.

Element	Energy of peak used for calibration
Copper	8.04
Zinc	8.63
Lead	10.55
Tin	3.44
Iron	6.40
Nickel	7.47
Manganese	5.89
Arsenic	10.53

Table A1:1. Peaks used to calibrate each element

Cobalt was not present in any of the standards available, but previous work (e.g. Northover 1987) suggested that an estimation of cobalt content for Iron Age alloys would be useful. Five samples containing cobalt (which had been used for an inter-laboratory comparison; cobalt content = 0.01%-0.14%) were made available by Peter Northover and Brian Gilmour. These samples were only made available in the latter part of 1993 and so cobalt calibrations were mostly retrospective and were not carried out on Roman samples.

After approximately two thirds of the analyses had been carried out suspicions arose over the accuracy of the antimony data. Tests against samples used for inter-laboratory comparisons (kindly provided by Peter Northover and Brian Gilmour) confirmed these suspicions. The problem seems to have arisen through changes made (unknown to me) to the peak striping programme for silver, tin and antimony. These three elements produce emission peaks which overlap. Changes in the striping and de-convolution of one will influence the others. As a result the antimony determinations are not reliable. The changes in the peak stripping routine will have introduced systematic errors into the estimation of antimony content. The later results are systematically lower than the early ones. A simple multiplication factor for the later results would not be satisfactory as many later antimony determinations were below the minimum detectable level. As it is now impossible to check the peak stripping routine for the early determinations cannot be regarded as accurate. The time required to correct this unfortunate situation was felt to be excessive in terms of the possible uses of antimony data. An initial analysis of the data (made while data collection was still underway) revealed that antimony was not important in terms of the social and economic comparisons being made. For this reason no attempt was made to re-start the analysis or change the calibration of antimony. The antimony data are not included in Appendix 5.

The other elements analysed for but not calibrated included, gold, silver, aluminium, silicon, phosphorous, sulphur, and chlorine. The first two elements could not be calibrated as no standards containing these elements were available. The other elements were essential for the development of the sample preparation techniques. These elements are present in corrosion layers at moderate levels but are usually below the minimum detectable levels in the actual metal.

Sample Preparation

The effective penetration of X-rays is very shallow (typically 10-30 microns) and yet surface corrosion products are regularly in excess of 100 microns thick. Therefore the analysis of an uncleaned archaeological object is essentially an analysis of that object's corrosion products. Table A1:2 shows six analyses taken at different points on the same corroded surface (of Shiptonthorpe, Small Find no. 244). It can be

	Cu	Zn	Sn	Pb	Fe	Ca	Si	P	S
1st	85.0	1.7	0.8	0.8	1.5	0.9	7.4	1.1	0.7
2nd	75.0	1.2	0.0	0.7	1.6	2.3	17.3	1.8	0.0
3rd	64.2	1.0	0.0	1.0	2.5	3.7	32.9	2.4	0.0
4th	74.4	2.9	0.0	0.8	1.3	1.7	17.5	1.3	0.2
5th	73.2	2.1	0.0	1.5	1.1	2.4	16.7	1.7	0.3
6th	86.3	3.0	1.2	0.8	0.9	0.8	5.8	1.1	0.1

Table A1:2. Surface analyses on a corroded sample

seen that the analyses of the surface of an object can give widely varying results. (These analyses of corrosion products are not truly representative as the elements are present as oxides, carbonates, etc, and EDXRF cannot detect the presence of the lighter elements, e.g. oxygen and carbon).

Analyses of surface corrosion products can be used in a semi-quantitative fashion (Bayley 1983) to confirm the presence of major elements (copper, zinc, tin, lead). For the results to truly reflect the composition of the alloy it is necessary to obtain a sample of uncorroded metal. This can be done by cleaning off a sufficient depth and area of corrosion products and so revealing a small patch of uncorroded metal, or by drilling into the object and obtaining drillings of uncorroded metal from the core of the object. The latter method is the only one used in methods which dissolve samples in acid (e.g. Atomic Absorption Spectroscopy) and will be dealt with below. The removal of corrosion products (even from a small area) may be unpalatable to some curators of archaeological material and EDXRF has been used on uncleaned objects to obtain semi-quantitative results (Bayley 1983). EDXRF is also used qualitatively in the routine conservation of objects where the nature of a coating or the object itself may be unclear. Metal cleaning and quantitative analysis has been carried out (e.g. Caple 1986, Cowell 1991) in the past where it has been seen that the information to be gained outweighs the damage to archaeological material. Aesthetic considerations often affect the choices over what damage to an object can and cannot be accepted.

Corrosion

Ancient metal objects are rarely found in pristine condition. Their burial leads to chemical changes, especially at the surface where corrosion products build up. Corrosion begins with the alteration of metal atoms into metal ions which can then react to form corrosion products, i.e.,

$$M = M^{+} + e^{-}$$

This reaction is matched by another reaction which uses up the electrons produced by the metal to metal ion reaction, e.g.,

$$4e^{-} + O_2 + H_2O = 4OH^{-}$$

The amount of energy required to cause ionisation varies for each element,

Element	Volts (Hydrogen Scale)
$Au = Au^{3+} + 3e^{-}$	+1.50
$Ag = Ag^{+} + e^{-}$	+0.799
$Cu = Cu^{+} + e^{-}$	+0.522
$Cu = Cu^{2+} + 2e^{-}$	+0.337
$Pb = Pb^{2+} + 2e^{-}$	-0.126
$Sn = Sn^{2+} + 2e^{-}$	-0.136
$Ni = Ni^{2+} + 2e^{-}$	-0.250
$Fe = Fe^{2+} + 2e^{-}$	-0.440
$Zn = Zn^{2+} + 2e^{-}$	-0.763

Table A1:3. Electrode potentials

From this it can be seen that in any given alloy, the metals lower down the scale will be likely to react to form metal ions before metals higher up the scale (less noble elements react before the more noble ones). Thus in a brass, the zinc will react before the copper. In copper alloys in general, the alloying elements react before the copper. This transformation takes place at and near the surface of the metal. The metal ions at the surface will react with available anions (e.g. O^{-2}, OH^{-}, Cl^{-}, CO_3^{2}). The metal compounds formed have widely varying properties and characteristics which will influence the future corrosion of the metal. Some corrosion products are very soluble and so may be removed completely through the action of ground water (e.g. zinc). This will lead to a surface depletion of these elements. Where the corrosion products are stable and insoluble, and so surface enrichment of these elements can take place (e.g. lead).

The properties and characteristics of metals and their corrosion products can vary widely. The surface condition of an archaeological copper alloy object depends on its original composition and the burial circumstances. It is rare for the surface composition of an object to be identical to its core, and it is difficult to predict actual composition from an analysis of the corrosion products.

The quantitative analyses obtained for this thesis were achieved by analysing samples of metal rather than corrosion products. Two methods were used to obtain uncorroded metal for analysis: firstly, abrading/polishing the surface to remove corrosion products; secondly, drilling to remove a sample of metal from the core of the object. The choice of sample preparation method depended on the shape, size and condition of the artefact to be analysed and the wishes of the custodian.

Polishing

Samples which were to be prepared by abrading/polishing, firstly had the corrosion products removed using an air abrasion machine (Cronyn 1990). The surface was then polished using a series of progressively finer silicon-carbide polishing sheets (final one 6 microns). In order to investigate the degree of abrading/polishing that was required one sample (Shiptonthorpe, SF 244) was progressively ground down and polished. The sample was analysed at each stage until the composition matched that known from the previous analyses. Figure A1:2 shows the changes in detected alloy

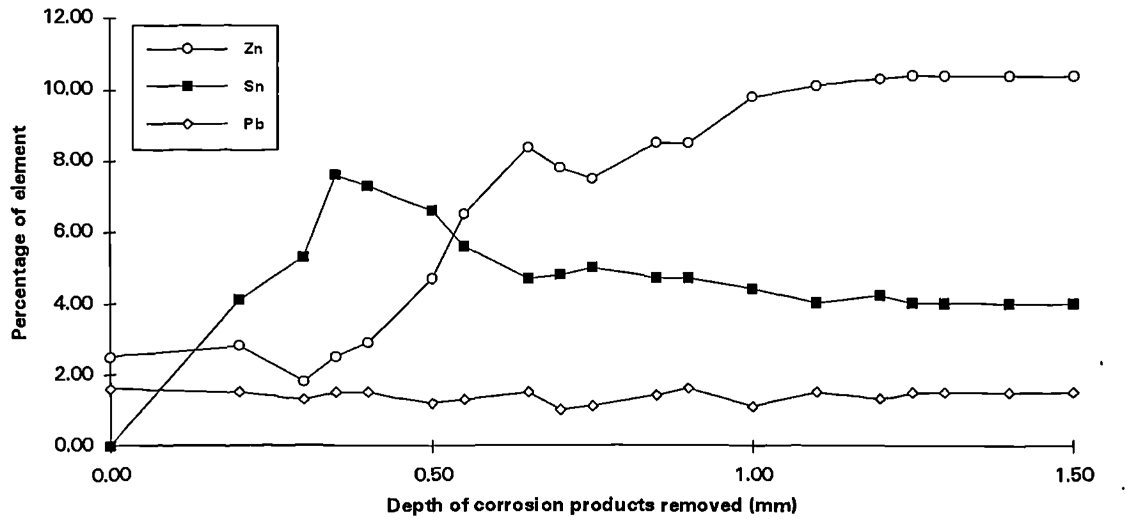

Figure A1:2. Changes in analysed composition as corrosion products are removed

composition as the sample was cleaned. As the surface was cleaned the zinc and tin contents increased. The analytical results compare well with conventional understanding of copper corrosion (e.g. Cronyn 1990, 217-219). It can be seen that the composition of the surface of the corroded object is not the same as the composition of the metal itself.

In practice, most polished samples were prepared in the following way: a sample was removed from the artefact, all corrosion products were removed using an air abrasion machine, the cleaned sample was then mounted in epoxy resin, finally the mounted sample was polished. The mounted specimens have been retained in the Department of Archaeology, University of Durham (except those belonging to the National Museum Scotland which were returned to the museum). These samples are available for further study (e.g. lead isotope, metallography).

The polish method was essential for the analysis of any artefacts which were too small to be drilled (e.g. sheet and wire).

Drillings

The polishing method could not be carried out on many objects as the removal of a fragment was not acceptable, cleaning an area 3-4mm across would be unacceptable, or the artefact was too large to be placed in the EDXRF analysis chamber. In these cases a sample of metal was removed from the core of the artefact using a drill. A portable mini-drill fitted with a 1.1 mm diameter Tungsten-carbide drill bit was used to remove 3-5mg of metal from the core of the object. The spot to be drilled was cleaned before hand to ensure that no corrosion products contaminated the drillings to be analysed.

The drillings were placed in a plastic cup which was fitted with a Mylar film base. The Mylar film is thin enough to have little effect on the X-ray peaks of interest (i.e. 3 keV or more). It was found that the method was accurate and precise to an acceptable degree using as little as 5 mg of metal.

The drilled samples were not destroyed during analysis and were retained in the Department of Archaeology, University of Durham (except those from the British Museum and the National Museum of Scotland which were returned).

Quantification

The percentage of each element present in a sample is proportional to the area under the peak measured in counts per second (cps). The cps results can be converted into percentages by comparison with standards (calibrated). The range of elements present in each of the standards used for the calibration is shown in Table A1:2. The composition of these modern standards reflects contemporary metallurgical needs. The majority of these alloys are brasses or gunmetals. Even those alloys which are bronzes tend to have at least some zinc present. Zinc is added to most modern alloys to act as an anti-oxidant. Many prehistoric alloys, however, have no detectable zinc (Chapter 5).

Even more problematic are those elements whose range falls short of the range found in archaeological alloys. The maximum tin content found in Roman alloys is around 26% (in speculum bronze used for mirrors). The maximum tin content in the available standards falls considerably short of this. The Ancient Monuments Laboratory (through Justine Bayley) kindly provided a sample of a high tin bronze (tin = 24%) which was used to examine the extrapolation of the calibration function (see below). The maximum lead content found in archaeological alloys far exceeds that found in the

Standard	Cu	Zn	Sn	Pb	Fe	Ni	As	Mn
NBS 1103	59.27	35.72	0.88	3.73	0.26	0.15	0.00	0.00
NBS 1109	82.20	17.40	0.10	0.07	0.05	0.10	0.00	0.00
NBS 1111	87.10	12.80	0.02	0.02	0.01	0.02	0.00	0.00
NBS 1116	90.30	9.40	0.04	0.04	0.05	0.05	0.00	0.00
NBS 1118	75.10	21.90	0.00	0.02	0.06	0.00	0.01	0.00
C42x01	66.00	32.52	0.83	0.12	0.19	0.10	0.05	0.11
C71x11	82.88	6.00	5.90	4.00	0.12	0.54	0.19	0.06
C71x21	83.56	4.90	5.20	5.30	0.00	1.00	0.00	0.00
C50x31	75.75	0.57	9.60	11.10	0.25	1.60	0.14	0.02
C50x34	77.59	1.00	11.60	8.20	0.17	0.72	0.08	0.19
C30.05	70.10	29.90	0.00	0.00	0.00	0.00	0.00	0.00
C52.05	60.46	39.54	0.00	0.00	0.00	0.00	0.00	0.00
C52.21	59.69	35.64	1.54	0.00	0.00	0.00	0.00	0.00
C50.01	76.17	0.63	9.20	10.70	0.06	2.00	0.20	0.04
C42.23	74.50	22.39	1.40	0.55	0.32	0.13	0.17	0.01
C54.06	84.72	0.19	12.70	0.16	0.18	0.80	0.02	0.16
C51.13	89.44	0.33	0.19	0.07	1.90	0.02	0.23	0.79
C51.14	89.29	0.56	0.08	0.00	0.73	0.20	0.36	0.52
NIGEL	89.00	5.20	3.36	1.01	0.30	0.19	0.64	0.00

Table A1:4. Composition of the standards used

calibration standards (some Roman alloys appear to contain 40% or more lead - Chapter 6). The extrapolation of this and other calibration is discussed in Appendix 2. The maximum levels of nickel, iron and manganese in archaeological alloys are usually below the maximum levels in the calibration standards. The maximum arsenic levels in archaeological alloys, however, usually exceeds those found in the standards.

The calibration functions for each element were calculated using SPSS. In most cases the function was a simple linear relationship (figure A1:3), in others the linear relationship was influenced by another element. This problem usually arose where the peaks used for calibration overlapped (e.g. antimony and tin). The formulas used for calibration are shown in table A1:5.

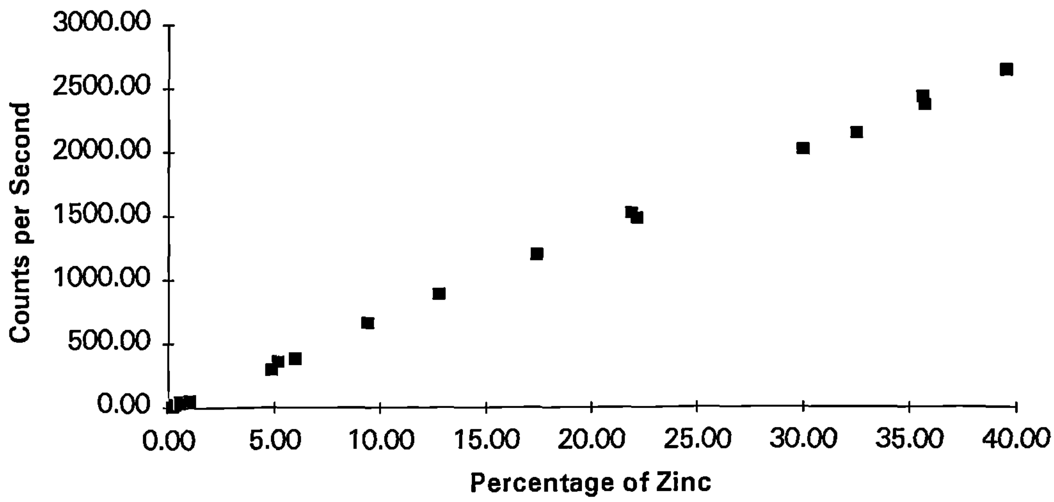

Figure A1:3. Relationship between zinc content and measured cps for standards

	Polished method	Drilled method
Zinc	=Zn.*cps**0.01966 + 0.016	=Zn.*cps**0.02217 + 0.0016
Tin	=Sn.*cps**0.03887 + 0.0129	=Sn.*cps**0.06725 + 0.0137
Lead	=Pb.*cps**0.07339 + 0.0487	=Pb.*cps**0.08047 + 0.0112
Iron	=Fe.*cps**0.005981 - 0.0404	=Fe.*cps**0.008548 - 0.0497
Nickel	=Ni.*cps**0.009556 - 0.0653	=Ni.*cps**0.01419 - 0.0474
Arsenic	=As.*cps**0.03409 + Pb.*cps**0.00103 - 0.0024	=As.*cps**0.05851 + Pb.*cps**0.00124 - 0.0176
Manganese	=Mn.*cps**0.006631 - 0.0031	=Mn.*cps**0.00977 - 0.00485
Cobalt	=Co.*cps**0.005778 + 0.0048	=Co.*cps**0.009284 - 0.0061

Table A1:5. Calibration functions used for each preparation method.

The nature of the sampling methods necessitated the normalisation of raw cps prior to calibration. The size of polished samples varied somewhat (some, such as wire, were smaller than the area usually excited by the X-ray beam, others, such as sheet, were thinner than the depth usually penetrated by X-rays). In addition the weight of drillings varied from sample to sample. In order to ensure that all samples were quantified in the same way the total raw cps data for each sample was normalised (to 7000 cps for polished samples, to 5000 cps for drilled samples) prior to calibration.

The calculation of regression equations for copper was faced by a number of difficulties. The 'best fit' equation involved the use of four factors (the cps data for copper, zinc, tin and lead). This procedure worked well for samples with low or moderate levels of alloying elements but was much less satisfactory where alloy element content was high (the errors from each different element would be combined). A more reliable calculation of copper content was by difference (i.e. 100% - sum of all other elements). This procedure is reliable here as corroded samples have not been included and the raw cps data has been normalised prior to calibration.

The collection of counts per second data for each peak and its calibration was repeated for the full range of standards. Each standard was prepared in both of the ways used for analysis: as a solid polished sample, and as 5 mg of drillings. This was necessary as spectra were collected from samples using both of the methods.

Minimum Detectable levels

A number of different methods were used to estimate the minimum detectable levels (MDL) of the elements sought. One method involved estimating the variation in the background around a peak and relating this to the calibration function for that element. This method tends to underestimates the minimum detectable levels of the elements sought. Most element peaks overlap to a certain extent and this introduces extra variation in the background. In addition, calculating the variation in the background is difficult as the background radiation is not uniform - the absorption edge of each element will give rise to a variation in the background on the low energy side of each peak (Statham 1977). A second method used the data supplied by the EDXRF spectrometer. Each result is accompanied by a relative standard deviation (RSD) figure based on the variation in the background either side of the peak in question. The RSD is inversely proportional to the amount of the element present. The MDL can be estimated by plotting the RSD against known percentage of element. The MDL occurs when RSD equals 50%. A third method of estimating the MDL makes

ELEMENT	Minimum Detectable Level
Zinc	0.10%
Lead	0.15%
Tin	0.10%
Iron	0.04%
Nickel	0.05%
Manganese	0.01%
Arsenic	0.10%

Table A1:5. Minimum detectable levels.

use of the fact that some elements are not present in all the standards. At any percentage level the measured cps varies. By measuring the variation in the cps of an element at 0% it is possible to estimate the MDL. All three methods were in approximate agreement but the highest estimates for each element were used as MDL for this thesis. The estimates of MDL were similar for both polished and drilled methods.

Summary

EDXRF has been used to analyse the copper alloy samples for this thesis. As EDXRF is essentially a 'surface' analysis method the samples have been prepared by polishing or drilling. The raw cps for each sample were converted into percentages by comparison with standards of known composition.

APPENDIX 2
THE ESTIMATION OF CONFIDENCE LIMITS

by

David Dungworth and Peter Craig

The EDXRF analysis of archaeological samples will be subject to a wide range of errors (the most important of which are 'noise' and errors in fitting the calibration data to a function). Errors in analytical techniques in archaeological science are rarely dealt with at any length. This appendix contains some attempts to calculate the confidence limits for the analytical results listed in Appendix 5.

The regression equations used to calculate the composition (see Table A1:5) take the form:-

$$y = a + bx + cz + \Sigma e$$

Where
- y = the percentage of the element present
- x = the counts per second for the element being calculated
- z = the counts per second for the influencing element (this factor is not present in all regression equations)
- Σe = the sum of all the sources of error.
- a, b, c are all constants

The total sources of error = $s.d.(\sum e) = S_{ind\hat{Y}} \doteq \sqrt{(S)^2 + (S_{\hat{Y}})^2 + V(e)}$

- S = 'Standard Error' of the regression analysis
- $S_{\hat{Y}}$ = the error of the regression equation at any one point
- $V(e)$ = the variance (or imprecision) of any single analysis.

It can be seen from the results shown below that the Standard Error is the most significant term in determining confidence limits.

Each of the three error factors can be calculated separately.

The Standard Error can easily be calculated $S^2 = \frac{\sum(y_i - \hat{y}_i)^2}{D.F.}$
and is regularly provided by statistical computer applications (see Shennan 1988: 136 for a discussion). The Standard Error is usually the largest contributor to the estimated error limits in this case but it is constant. The total error for the regression should be at a minimum at the centre of the known compositions and increase as the regression is extrapolated.

The error in the regression analysis at any one point can be estimated using a matrix calculation of the variance (Var) and co-variance (Cov) values from the regression analysis. The variance is the square of the standard deviation, the co-variance is the product of two factors standard deviations and their correlation coefficient (see Blalock 1972: chapters 16 &17).

$$S_{\hat{Y}}^2 = \left[(\mathrm{Var_a}) + 2(x.\mathrm{Cov_{a.b}}) + 2(z.\mathrm{Cov_{a.c}}) + 2(x.z.\mathrm{Cov_{b.c}}) + (x^2.\mathrm{Var_b}) + (z^2.\mathrm{Var_c})\right]^2$$

This function provides an additional error for the regression analysis. $S_{\hat{Y}}^2$ is very small near the centre of the known compositions but increases geometrically as the regression is extrapolated.

The two terms S^2 and $\mathrm{S}_{\hat{Y}}^2$ provide estimates of the accuracy of the regression equations used in Table A1:5, but an additional factor $V(e)$ has to be considered. This is the variance of any single reading. This factor has to be included as the regression equations were based on repeat analysis of standards but the unknowns are based on a single determination. The repeat analyses of the standards does, however, provide an indication of the relationship between the variance of individual readings and the level of the element present (see figure A2:1). The relationship between the variance and level of each element was estimated using a least square fit. The slope and intercept for each element varies (but in each case both are positive).

These estimates were then used to calculate $V(e)$.

$$V(e) = b^2.\mathrm{var}(x) + c^2.\mathrm{var(z)}$$

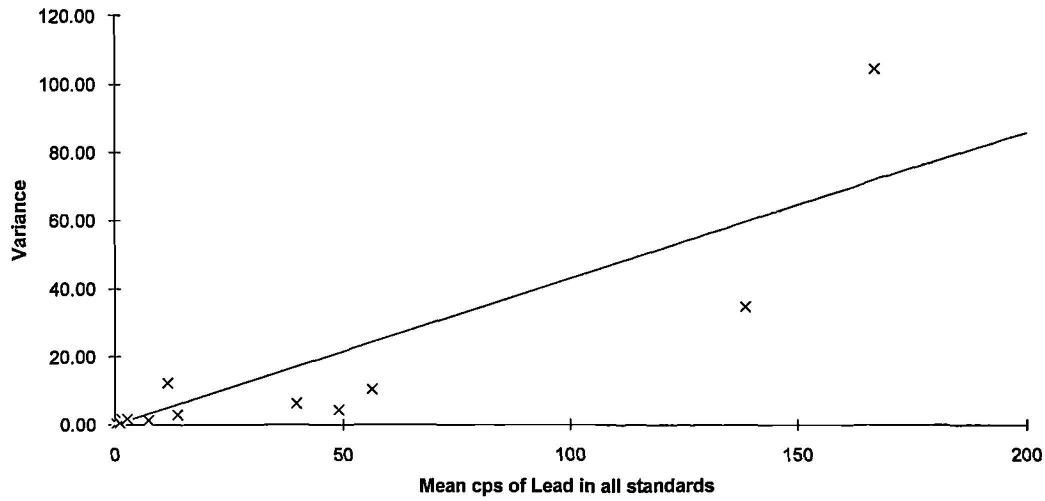

Figure A2:1. Variance of Lead determinations.

The use of the above three estimates of error provides a total error estimate which should provide confidence limits for the results provided in Appendix 5 (including those results which lie outside the range of compositions in the standards. The confidence limits are discussed below.

Zinc

The above method of estimating the errors provides a changing error estimate for zinc.

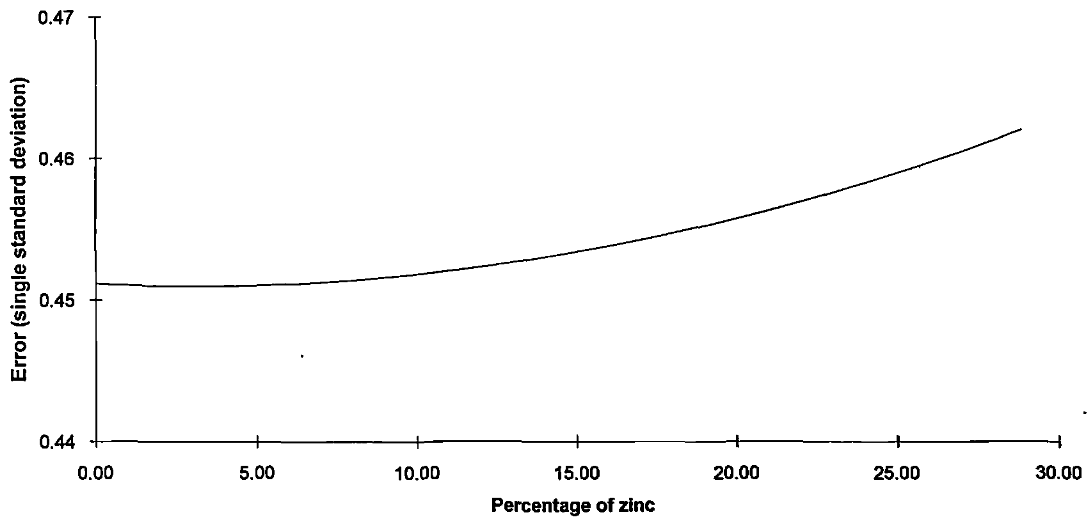

Figure A2:2. Error estimate for zinc.

It can be seen that the estimated error is low for low zinc contents but increases as zinc content increases. Nevertheless the total variation in the error estimate is low throughout the range of compositions found in Appendix 5. For all cases the zinc content can be expressed as ±0.45% (single standard deviation).

Tin

The large number of standards with little or no tin produces an error estimate function

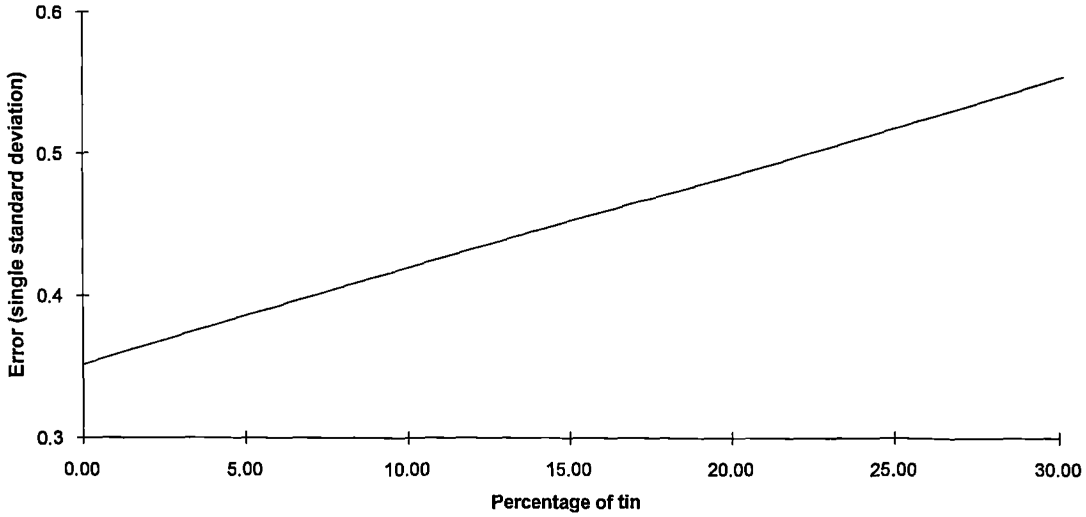

Figure A2:3. Error estimate for tin.

which is lowest for small amounts of tin but increases considerably above 15% (the limit of the composition found in the standards). For most bronzes (e.g. those of the Iron Age the results are accurate to ±0.40% (single standard deviation - 65% probability). Results for speculum bronze (tin over 20%) are accurate to ±0.50%.

Lead

The error estimates for lead (figure A2:4) are also fairly low when little lead is present but increase rapidly as the amount of lead detected increases beyond the compositions found in the calibration standards. The inhomogeneity of lead is such that these error figures should be taken as a minimum. A relative standard deviation of 10% has been suggested for most lead determinations due to inhomogeneity. Above 15% lead there is an increasing tendency for 'macro-segregation' to occur. The core of the cast object can have a lead content anywhere between 15 and 100% while the outer portion maintains a maximum of 15% or so lead. From this it can be seen that there are considerable problems in attempting to quantify the lead content when over about 15%. In such cases only a 'wet chemistry' analysis of the entire object could determine the overall lead content.

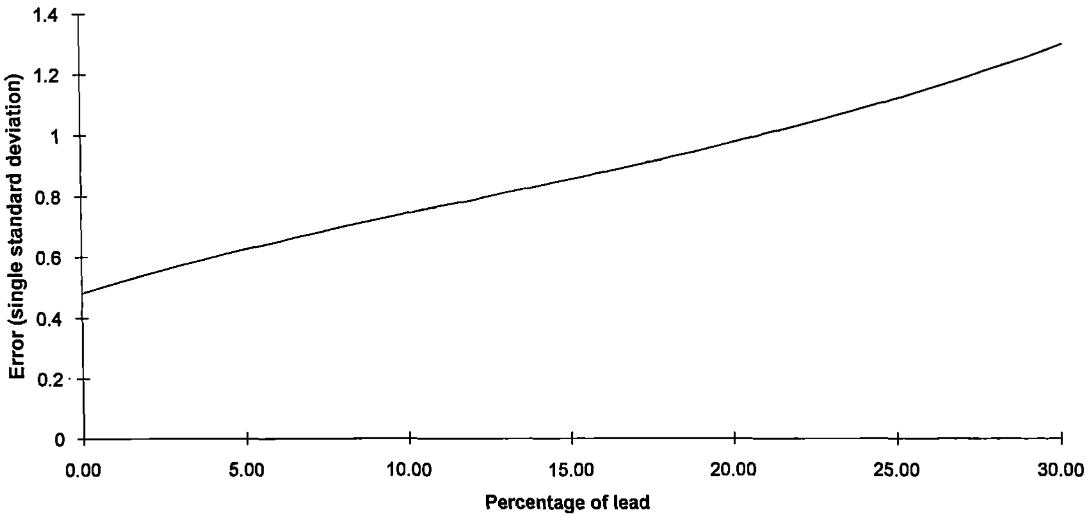

Figure A2:4. Error estimate for lead.

At very low levels (less than 1% lead) the results are accurate to ±0.5% (single standard deviation). At 95% probability (two standard deviations) the accuracy is ± 1.0%. At higher lead levels the error increases considerably. At 10% lead the error limits (at 95% probability) are ±1.5%, at 20% lead the error limits (95% probability) are ±2.0%.

Iron

The variation in the error estimates for iron is very low for the range over which most

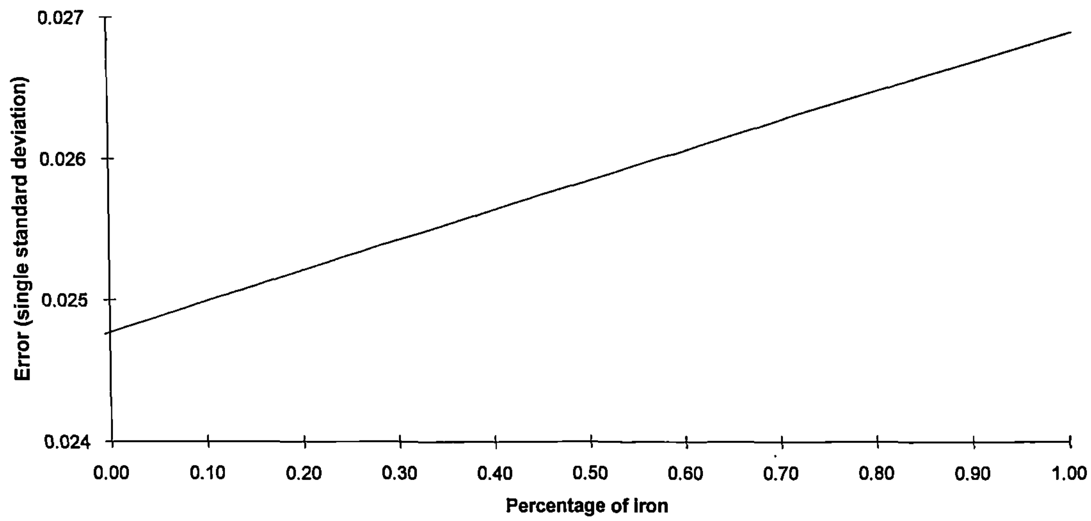

Figure A2:5. Error estimate for iron.

of the archaeological samples have been determined. This is because many of the standards contain much higher levels of iron than most archaeological alloys. For the entire range of iron compositions found in Appendix 5 the error estimate is ±0.05% (two standard deviations).

Nickel

Like iron, the variation in the error estimate for nickel is very low for the range of

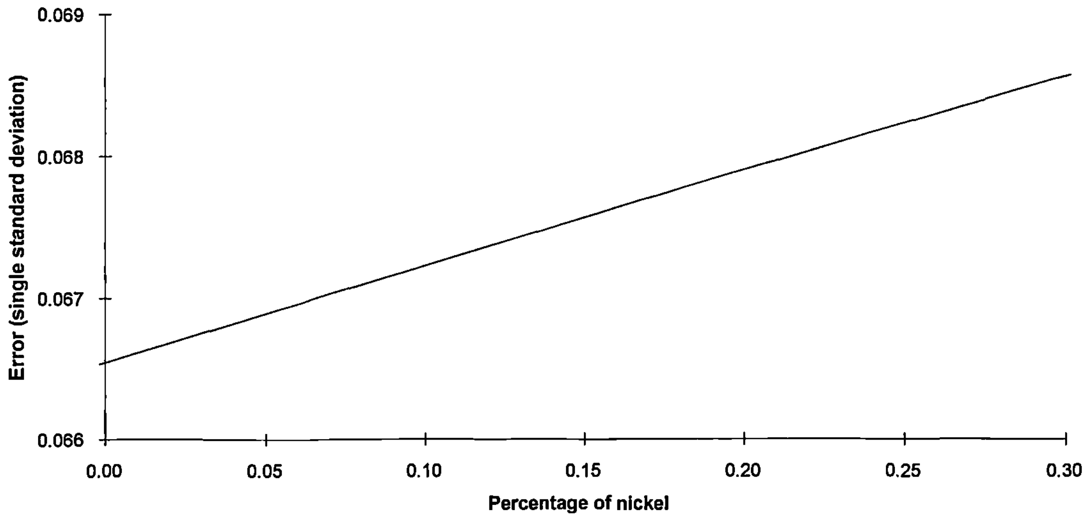

Figure A2:6. Error estimate for nickel.

compositions found in Appendix 5. This is again because some of the standards contain relatively high levels of nickel. For the results in Appendix 5 the error estimate is ±0.13% (two standard deviations).

Manganese

As with iron and nickel, the error estimates for manganese are uniform throughout the

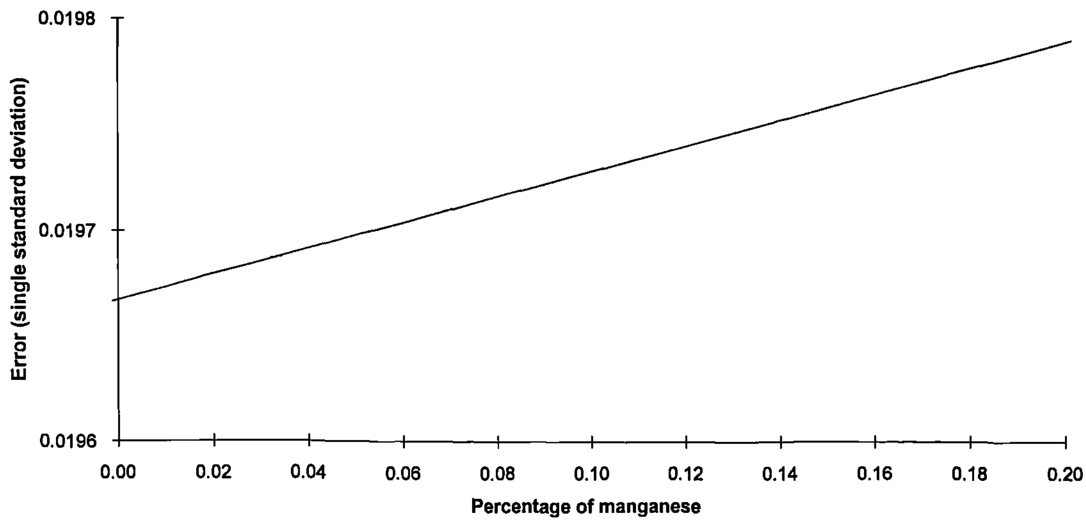

Figure A2:7. Error estimate for manganese.

range of compositions found in Appendix 5 (again this is because some of the standards contain much higher levels of manganese). For all the results in Appendix 5 the error estimate is ±0.04% (two standard deviations).

Arsenic

The variation in the error estimate for arsenic varies depending on the level of arsenic

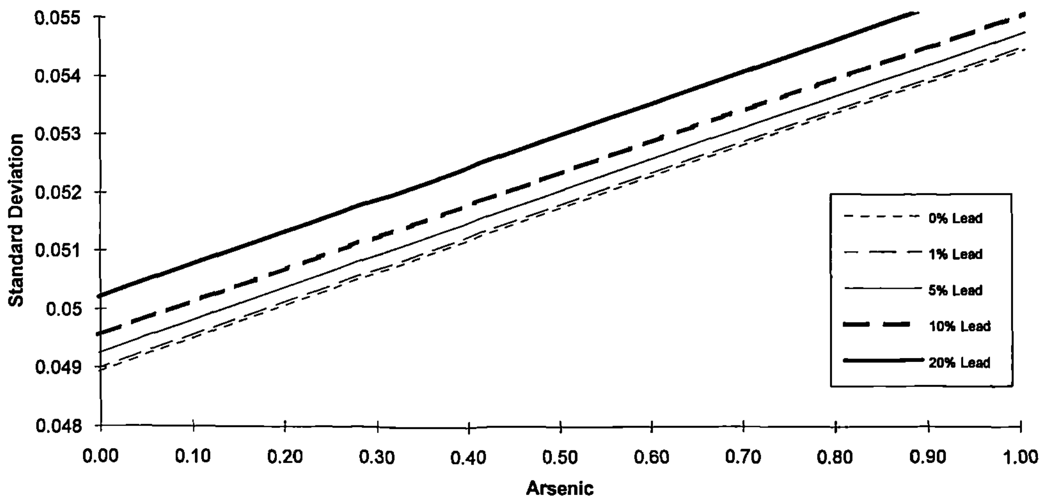

Figure A2:8. Error estimate for arsenic.

and on the level of lead present. The error estimates are, however, all roughly ±0.1% (two standard deviations).

Other elements

The other elements reported in Appendix 5 are not provided with estimates of the errors. Copper was calculated by difference and so no reliable estimate of the errors can be made. Cobalt calibration was based on a few 'standards' which were analysed at a late date and no attempt has been made to estimate the errors (a 'guestimate' of ±0.05% might be appropriate).

Summary

The method of estimating the errors associated with the use of regression analysis in predicting the composition of unknown samples starts with the Standard Error but also includes two extra factors: one which reflect the varying accuracy of the regression analysis at different points along the regression function, and a second which estimates the uncertainty involved in taking anyone single EDXRF measurement. This method is applied to each of the elements reported in Appendix 5 (except copper, antimony, and cobalt). A summary of these results is shown in table A2:1

ELEMENT	one sd (65% probability)	two sd (95% probability)
Zinc	±0.45%	±0.90%
Tin (0-15%)	±0.35%	±0.7%
Tin (15-30%)	±0.4%	±0.8%
Lead (0-10%)	±0.5%	±1.0%
Lead (10-15%)	±0.6%	±1.2%
Lead (15% +)	more than ±0.6%	more than ±1.2%
Iron	±0.02%	±0.04%
Nickel	±0.06%	±0.12%
Manganese	±0.02%	±0.04%
Arsenic	±0.36%	±0.72%

Table A2:1. Summary of error estimates for the results in Appendix 5

APPENDIX 3
CATALOGUE LISTING OF ALL SITES AND SAMPLES

This appendix gives a listing of all of the sites examined and a list of each of the analytical reference codes (XRFID) for each sample. Each site is listed alphabetically using the four-letter site codes (SITEID) used in the full listing of the analytical results (Appendix 5). The main sites (using full names) are also shown on figure 2:1. At the end of this appendix all the SITEID codes are listed under the SITETYPE categories.

Each entry in this Appendix takes the following form:-

SITEID (4 letter code). All entries are in alphabetical order using this code.
Full name of the site, County.
National Grid Reference number.
A brief description of the site and its history.
Publication references (if to 'Roman Britain in 19xx', *Britannia* then usually just to the most recent entry).
A LIST OF ALL THE XRFID NUMBERS FOR SAMPLES FROM THIS SITE.

ARRS
Arras, North Humberside.
NGR SE 930 413.
Iron age cemetery. Type site for the 'Arras' culture. Analysed finds include horse harness fittings and jewellery items.
Stead 1979.
1743a, 1743b, 1743c, 1745, 1754, 1755, 1757, 2001a, 2001b, 2001c, 2213, 2214, 2215, 2216, 2217a, 2217b, 2218, 2220a, 2220b, 2220c, 2221, 2222, 2223a, 2223b, 2224a, 2224b, 2228.

BIGL
Biglands, Cumbria.
NGR NY 208 618.
Fortlet on the Cumbrian coastal extension of Hadrian's Wall. Occupied in the second century only.
Potter 1977.
1025, 1026, 1027, 1028, 1029.

BLML
Blackburn Mill, Cockburnspath, Lothian.
NGR NT 780 710 (vicinity).
Hoard of metalwork (including a variety of vessels and horse harness) from a 'watery' context.
Piggott 1952-3.
1926, 1928, 1929, 1930, 1931, 1948a, 1948b, 1949, 2489.

BRGH
Brough Castle, Cumbria.
NGR NY 538 289 (vicinity).
Found in the 19th century (?) near the Roman fort.
Macgregor 1976.
1750.

BRHM
Brougham, Cumbria.
NGR NY 538 289.
Roman auxiliary fort which has not been excavated. Finds come from the third century cremation cemetery to the east associated with the fort or the *vicus*.
Wilson 1968: 179. Fitzpatrick forthcoming.
2368b, 2368c, 2369a, 2369b, 2370a, 2370b, 2371, 2372, 2373a, 2373b, 2374, 2375, 2376a, 2376b, 2378a, 2378c, 2379a, 2379b, 2379c, 2380a, 2381a, 2385, 2387a, 2388, 2389b, 2390a, 2392, 2393, 2395, 2396, 2397, 2398a, 2398b 2399, 2400, 2401, 2402, 2404, 2405, 2406, 2407, 2408, 2410, 2411, 2412, 2413a, 2413b, 2414, 2415, 2417a, 2418a, 2418b, 2420, 2421a, 2422, 2423, 2424.

BRXM
Broxmouth, Lothian.
NGR NT 710 775.
Iron Age hillfort. Long history of occupation beginning in the early Iron Age (or possibly earlier ?) and ending in the Roman period.
Hill 1982
1915, 1916, 1917, 1918, 1919, 1921, 1922, 1923, 1924, 1925,

BUGT
Bugthorpe, North Humberside.
NGR SE 773 580 (vicinity).
Stray find of an Iron Age sword.
Stead 1979.
1760a, 1760b.

BURT
Burton Fleming, North Humberside
NGR TA 094 702.
Iron Age cemetery (see also RUDG).
Stead 1991.
1350, 1353, 1354.

CAAN
Annetwell Street, Carlisle, Cumbria.
NGR NY 396 561.
Gateway, defences and barracks of a Roman fort. Most occupation evidence relates to the first and second centuries AD.
McCarthy 1984. Caruana forthcoming.
1128, 1129, 1130, 1131a, 1131c, 1132, 1133, 1134, 1135, 1137, 1138, 1139, 1140, 1141, 1142, 1143, 1144, 1145, 1146, 1147, 1148, 1149, 1150, 1152, 1153, 1154, 1155, 1156, 1157, 1158, 1159, 1160, 1161, 1162, 1163, 1164, 1165, 1166, 1167, 1168, 1169a, 1169b, 1170, 1171, 1226, 1227, 1228, 1230, 1233, 1235, 1237, 1238.

CABL
Blackfriars, Carlisle, Cumbria.
NGR NY 396 561.
Strip buildings facing the Roman road leading to the fort at Annetwell Street. Occupation throughout the Roman period and after. Activity probably civilian in nature. First two centuries classified as vicus, last two as town.
McCarthy 1990
1055, 1056, 1057, 1058, 1059, 1060, 1061, 1062, 1063, 1064, 1065, 1066, 1067, 1068, 1070, 1072, 1073, 1074, 1075, 1077, 1078, 1079, 1081, 1082, 1083, 2291, 2292, 2293.

CACA
Castle Street, Carlisle, Cumbria.
NGR NY 396 561.
Small excavation immediately outside the fort at Annetwell Street. Possibly an annexe or a *vicus*. Later activity certainly civilian. As at Annetwell most activity is early Roman rather than later. Industrial activity including scrap copper alloys.
McCarthy 1991.
1084, 1085a, 1085b, 1086, 1087, 1088, 1089, 1091, 1092, 1094, 1095, 1096, 1097, 1098, 1099, 1100, 1101, 1102, 1103, 1104, 1105, 1106, 1107, 1108, 1109, 1111, 1112, 1113, 1114, 1115, 1116, 1117, 1118, 1119, 1120, 1121, 1123, 1124, 1126, 1231, 1232, 1234, 1236.

CASD
Castleford, West Yorkshire.
NGR SE 426 258
Roman fort and vicus settlement of the first and second centuries AD. Civil settlement seems to continue after the abandonment of the fort.
Sumpter 1984, Frere 1986: 385.
1561, 1562a, 1562b, 1564, 1566, 1568, 1569a, 1571a, 1571b, 1571c, 1572, 1573, 1574a, 1574b, 1576, 1577, 1578, 1579, 1580, 1581, 1582a, 1582b, 1583, 1584, 1586, 1587, 1588, 1590, 1592, 1595, 1596, 1597, 1598, 1599, 1600, 1601, 1602, 1603, 1604, 1762, 1763, 1764, 1765, 1766, 1767, 1768, 1769, 1770, 1771, 1772, 1773, 1774, 1775, 1776, 1777, 1778, 1779, 1781, 1782, 1783, 1784, 1785, 1787, 1789, 1790, 1791a, 1791b, 1792, 1793, 1794, 1795, 1796, 1797a, 1798, 1799, 1800, 1802, 1803, 1804, 1805a, 1805b, 1806, 1808, 1809, 1810, 1811, 1812a, 1812b, 1875, 1876, 1877, 1878a, 1878b, 1879a, 1879b, 1880, 1881, 1882, 1884, 1885, 1886, 1887, 1889, 1890, 1891, 1892, 1893, 1895, 1897, 1898, 1899, 1900, 1901, 1902, 1903, 1904, 1905a, 1905b, 1906, 1907, 1908, 1909, 1910, 1911, 1913a, 1913b.

CATB
Bainese Farm, Catterick, North Yorkshire.
NGR SE 241 973.
Small roadside settlement two miles south of the Roman town of Catterick.
Wilson 1984.
1245, 1247, 1249, 1250, 1252, 1253, 1256, 1257, 1259, 1262, 1263, 1264, 1265, 1266.

CATT
Catterick, North Yorkshire.
NGR SE 225 991 (vicinity).
Late Roman Belt plate and buckle found in the 1950's ?
Hawkes & Dunning 1961: Type IV B (fig 22).
2025a, 2025b

CATW
Catterick, North Yorkshire.
NGR SE 225 991.
A Roman fort established in the late first century. this goes out of use in the second century when the first signs of a civil settlement appear. This is fortified in the fourth century.
Burnham & Wacher 1990: 111-7. Wilson forthcoming.
1246, 1248, 1254, 1255, 1258, 1269, 1270, 1271, 1272, 1273, 1274, 1275, 1276, 1277, 1278, 1280, 1281, 1282, 1283, 1285, 1286, 1287, 1289, 1290, 1291, 1293.

CHST
Chesters, Northumberland.
NGR NY 912 702.
Stray find the Roman fort (19th century ?).
Macgregor 1976.
2273, 2274, 2275

CLWK
Carlingwark Loch, Dumfries & Galloway.
NGR NX 770 610 (vicinity).
Hoard of metalwork (a variety of vessels) from a 'watery' context.
Piggott 1952-3
1933, 1940, 1941, 1942, 1943, 1944, 1946a, 1946b, 1946c, 1947a, 1947b, 1947c.

CNGF
Cairngryfe, Strathclyde.
NGR NS 850 450 (vicinity).
Stray find (linch pin) from a hillfort.
Macgregor 1976.
1927.

CORB
Corbridge, Northumberland.
NGR NY 982 648 (vicinity).
Roman fort, vicus and town. Stray finds (horse harness equipment) discovered in the 19th century.
Macgregor 1976
2268, 2269, 2270, 2272.

COVW
Coventina's Well, Northumberland.
NGR NY 859 712.
Temple site immediately behind Hadrian's Wall. The 'hoard' of metalwork and other items were recovered in the 19th century.
Allason-Jones and Mackay 1985.
2237, 2238, 2239, 2240, 2242, 2243, 2246, 2247, 2248, 2250, 2253, 2254, 2255, 2256, 2258, 2259, 2260, 2261, 2262, 2263, 2265, 2266.

CRHM
Carham, Borders.
NGR NT 790 380 (vicinity).
Stray find (a sword) from the river Tweed, discovered in the 19th century.
Macgregor 1976.
1758

CWLM
Cowlam, North Humberside.
NGR SE 984 667.
Iron Age burial/cemetery ?.
Stead 1979.
1753, 1761.

DALT
Dalton Parlours, West Yorkshire.
NGR SE 402 445.
Roman villa. Built on the site of an Iron Age settlement. Possible continuity but no Iron age copper alloy finds. The Roman finds date to the later Roman period.
Wrathmell & Nicholson 1990.
2295a, 2295b, 2295c, 2295d, 2295e, 2296, 2297, 2298, 2299a, 2299b, 2300, 2301, 2302, 2303, 2304, 2306, 2307, 2308, 2309, 2310, 2311, 2312, 2313, 2314, 2315, 2316, 2317, 2318, 2319, 2320, 2321, 2322, 2323, 2324, 2325, 2326, 2327a, 2327b, 2328, 2329, 2330, 2331, 2332, 2333, 2334, 2335.

DBSD
Doubstead, Scremerston, Northumberland.
NGR NT 995 510.
Small rural settlement.
Jobey 1982.
1242.

DNGL
Dungyle Camp, Kelton, Dumfries & Galloway.
NGR NX 850 550 (vicinity).
Stray find (a torc) from the vicinity of the camp ?
Macgregor 1976.
1932.

DNGR
Danes Graves, North Humberside.
NGR TA 018 633.
Iron age burials (cemetery ???).
Stead 1979.
1752, 2225, 2226.

DODL
Dod Law, Northumberland.
NGR NU 007 317.
Iron age hillfort with occupation continuing down to the first century AD.
Smith 1990.
1240, 1244a, 1244b.

DRAG
Dragonby, South Humberside.
NGR SE 905 138.
Large rural settlement with occupation starting in the Iron age but continuing in to the late Roman period.
May 1970.
1639, 1640, 1641, 1642, 1643, 1644, 1645, 1646, 1647, 1648, 1649, 1650, 1652, 1653, 1654, 1656, 1657, 1658, 1659, 1660, 1661, 1662, 1664, 1665, 1666, 1667, 1668, 1669, 1670, 1671, 1672, 1673, 1674, 1676, 1677, 1678, 1679, 1680, 1681, 1682, 1683, 1684, 1685a, 1685b, 1686, 1687, 1688, 1689, 1690a, 1690b, 1691, 1692, 1693, 1694, 1695, 1696, 1697, 1698, 1699, 1700, 1701, 1702, 1703, 1704, 1705, 1706, 1707, 1708, 1709, 1710, 1711, 1712, 1713, 1714, 1715, 1716, 1717, 1718, 1719, 1720, 1721, 1723, 1724, 1725, 1726, 1727, 1728, 1729, 1730a, 1730b, 1731, 1732, 1733, 1734, 1735, 1736, 1737, 1738, 1739, 1740, 1741, 1742, 2073, 2074.

EDCS
Edinburgh Castle, Lothian.
NGR NT 251 733.
Iron age hillfort with occupation continuing in the Roman and post-Roman period.
Selkirk 1992. Driscoll forthcoming.
1437, 1438, 2487, 2488.

ELGN
Elginhaugh, Lothian.
NGR NT 231 674.
Roman fort and annexe. Very short-lived Flavian occupation.
Selkirk 1987. Hanson forthcoming.
1182, 1183, 1185, 1186, 1188, 1189, 1190, 1191, 1192, 1193, 1194, 1195, 1196, 1198, 1200, 1201, 1202, 1203, 1204, 1206, 1207.

EMBL
Embleton, Cumbria.
NGR NY 160 300 (vicinity).
Stray find (a sword) found in the 19th century.
Macgregor 1976.
1759a, 1759b, 1759 c.

GLBF
Glebe Farm, Barton-on-Humber, North Humberside.
NGR TA 047 222.
Enclosed rural settlement which starts in the second century AD. Continues into the fourth century.
Esmonde Cleary 1993: 287.
1446, 1447, 1448, 1449, 1450, 1451.

GRMT
Grimthorpe, North Humberside.
NGR SE 816 535.
Stray find (a sword) found in the 19th century.
Macgregor 1976.
1751a, 1751b.

HBRN
High Brunton, Northumberland.
NGR NY 922 698.
Turret 26b on Hadrian's Wall. Occupied in the second century only. Possible small-scale metalworking activities in the turret.
WoodField 1965.
2343, 2344, 2345, 2346a, 2347a, 2347b, 2347c, 2348a, 2348b, 2348c, 2349, 2350.

HKHO
Huckhoe, Northumberland.
NGR NZ 080 835.
Farmstead situated between Hadrian's Wall and the Vallum, occupied in the second century AD.
Jobey 1959.
1243.

HOLM
Holme House, North Yorkshire.
NGR NZ 221 152.
Late Iron Age round house and Roman villa abandoned c.AD 200.
Harding 1984.
1173, 1174, 1176, 1177, 1178a, 1178b, 1179, 1180.

HSTD
Housesteads, Northumberland.
NGR NY 790 688 (vicinity).
Stray find (a terret) from the Roman fort.
Macgregor 1976.
2271.

INGL
Ingleton, North Yorkshire.
NGR SD 700 700 (vicinity).
Stray find (a handle of a mirror).
Macgregor 1976.
2005a, 2005b.

KIRK
Kirkburn, North Humberside.
NGR SE 985 580.
Iron age vehicle burial.
Stead 1991.
1341, 1342, 1343, 1344, 1345, 1346, 1347a, 1347b, 1348a, 1348b, 1349, 1439a, 1439b, 1440a, 1440b, 1441, 1442, 1443, 1444, 1445.

KKSN
Kirk Sink, Gargrave, North Yorkshire.
NGR SD 939 536.
Roman villa probably built in the third century.
Goodburn 1976: 317-8.
1209, 1210, 1211, 1212, 1213, 1214, 1215, 1216, 1218, 1219, 1220, 1222, 1224.

LCMN
Whitehills Moss, Lochmaben, Dumfries & Galloway.
NGR NY 090 820 (vicinity).
Stray find (a cauldron) from a 'watery' context. Found in the 19th century.
Macgregor 1976.
1950.

LOMS
Lochar Moss, Dumfries & Galloway.
NGR NY 080 710 (vicinity).
Stray find (a torc) from a 'watery' context. Found in the 19th century.
Macgregor 1976.
1746a, 1746b, 1746c.

MANC
Manchester.
NGR SJ 833 976.
Roman extra-mural occupation, an annexe or a *vicus*.
Jones & Greasley 1974. Bryant *et al.* 1986. Goodburn 1976: 291.
1393, 1394, 1395, 1396, 1397, 1398, 1400, 1402, 1404, 1405, 1406, 1408, 1409, 1410, 1411, 1412, 1413, 1415, 1418, 1419, 1420, 1421, 1423, 1424, 1425, 1426, 1427, 1428, 1430, 1432, 1433, 1434, 1436.

MILK
Milking Gap, Northumberland.
NGR NY 772 678.
Small second century rural settlement between Hadrian's Wall and the vallum.
Kilbride-Jones 1938.
1392.

MUCL
Muircleugh, Lauder, Borders.
NGR NT 530 770 (vicinity).
Stray 'hoard' of terrets.
Macgregor 1976.
1935, 1936, 1937, 1938, 1939.

NCAV
North Cave, North Humberside.
NGR SE 878 322.
Small Iron Age and Roman rural site.
Dent 1989.
1464, 1497.

NEWC
Newcastle, Tyne and Wear.
NGR NZ 250 639.
Roman fort built in the second century (?) occupied into the fourth century.
Frere 1991: 232-4.
1951, 1952, 1953, 1954, 1955, 1957, 1958, 1959, 1960, 1962, 1964, 1965, 1966, 1967, 1968, 1969, 1970, 1971, 2336, 2337, 2338, 2339, 2340, 2341, 2342.

OLDW
Old Wintringham, South Humberside.
NGR SE 945 213.
Roadside settlement on the south side of the Humber. Most activity is first century.
Stead 1976.
1605, 1606, 1607, 1608, 1609, 1610, 1611, 1613, 1614, 1615, 1616, 1617, 1618, 1619, 1620, 1621, 1622, 1623, 1624, 1625, 1626, 1627a, 1627b, 1628, 1629, 1630, 1631, 1632, 1633, 1634a, 1634b, 1634c, 1635, 1636, 1637, 1638.

OPEN
Old Penrith, Cumbria.
NGR NY 494 384.
Roman fort occupied from the first to the fourth century (with possible interruptions). *Vicus* occupied for similar period.
Austen 1991.
2232, 2233, 2234, 2235, 2236, 2276, 2277, 2279, 2280, 2281a, 2281b, 2281c, 2282, 2283, 2285, 2286, 2287, 2288, 2290.

PAPC
Papcastle, Cumbria.
NGR NY 110 315.
Roman fort. Considerable extra-mural activity. Initially industrial but later replaced by a temple.
Frere 1985: 276.
2457, 2459, 2460, 2461, 2462, 2463, 2464, 2466, 2467, 2468, 2469, 2470, 2472, 2473, 2474, 2475, 2476, 2477, 2478, 2479, 2480, 2481a, 2481b, 2481c, 2482, 2483, 2484, 2485.

PIER
Piercebridge, County Durham.
NGR NZ 211 157.
Large late Roman fort and extra-mural settlement.
Frere 1983: 292-3. Fitzpatrick forthcoming.
2058, 2059, 2060, 2061a, 2061b, 2062, 2064a, 2065, 2066, 2067, 2068, 2069, 2070, 2071, 2072, 2075, 2076, 2077, 2078, 2079, 2081, 2082, 2083, 2084, 2085, 2087, 2088, 2089, 2131, 2132, 2134, 2135, 2136, 2137, 2138, 2139, 2140, 2141, 2142, 2144, 2145, 2146, 2147, 2148, 2149, 2150, 2151, 2152, 2153, 2154, 2155, 2156, 2157, 2158, 2161, 2162a, 2162b, 2163, 2164, 2165, 2166, 2167, 2168a, 2168b, 2168c, 2169a, 2169b, 2170, 2171, 2172, 2173, 2175, 2176, 2177, 2178, 2179, 2180, 2181, 2182, 2183, 2185a, 2186, 2187, 2188, 2189, 2190, 2191, 2192, 2194, 2195, 2196, 2197, 2198, 2199, 2201, 2202, 2204, 2205, 2207, 2208, 2209, 2210, 2211, 2212.

PLFL
Place Fell, Cumbria.
NGR NY 410 170 (vicinity).
Stray find (a horse bit).
Macgregor 1976.
1756a, 1756b, 1756c.

PLMS
Pilling Moss, Lancashire.
NGR SD 410 490 (vicinity).
Stray find (a dagger) from a 'watery' context?
Macgregor 1976.
2057a, 2057b, 2057c, 2057d.

RAVE
Ravenglass, Cumbria.
NGR SD 088 958.
Roman fort on the Cumbrian coast occupied from the second to the fourth century but with interruptions.
Potter 1979.
1032, 1033, 1034, 1035, 1036, 1037, 1038, 1039, 1040, 1041, 1043, 1044, 1045, 1046, 1047, 1048, 1049, 1050, 1051, 1052, 1053, 1054.

RDCL
Redcliff, North Humberside.
NGR SE 982 250.
Late Iron Age settlement on the north bank of the Humber. May have been a gateway community.
Crowther 1987. Willis, Crowther & Creighton forthcoming.
1001, 1002, 1004, 1005, 1006, 1007, 1008, 1009, 1010, 1012, 1014, 1015, 1016, 1017, 1018, 1019, 1020, 1021, 1022, 1023, 2596.

RISE
Rise, North Humberside.
NGR TA 150 420 (vicinity).
Stray find (a horse bit) from a 'watery' context ?
Macgregor 1976.
1744a, 1744b, 1744c.

RUDG
Rudston, North Humberside.
NGR TA 096 696.
Iron Age cemetery (see BURT).
Stead 1991.
1351, 1352.

RUDV
Rudston, North Humberside.
NGR TA 089 667.
Iron Age settlement which continues to be occupied into the Roman period. A villa is built in the fourth century.
Stead 1980.
2090, 2091, 2092, 2093a, 2093b, 2094, 2095, 2096, 2097, 2098, 2099, 2100, 2101, 2102, 2103, 2104, 2105, 2106, 2107, 2108, 2109, 2110a, 2110b, 2111, 2112, 2114a, 2114b, 2115a, 2114b, 2114c, 2114d, 2114f, 2116, 2117, 2118, 2119, 2120.

SCAR
Castle Hill, Scarborough, North Yorkshire.
NGR TA 052 892.
Iron Age hillfort on a promontory. Metalwork comes from a land surface cut by pits containing early Iron Age pottery.
Smith 1927; Rutter 1959.
2121, 2122, 2123, 2124, 2127, 2128, 2130.

SDBG
Sadeberge, County Durham.
NGR NZ 316 179 (vicinity).
Stray find (a sword) from a 'watery' context.
Macgregor 1976.
1748a, 1748b, 1748c.

SETA
Attermire Cave, Settle, North Yorkshire.
NGR SD 842 642.
Cave with Roman activity/occupation. Finds from excavations in 1930.
Lord nd
1506, 1509, 1511, 1512, 1513, 2040, 2041, 2042, 2043, 2044, 2045, 2046, 2047, 2048.

SETC
Greater Kelco Cave, Settle, North Yorkshire.
NGR SD 810 646.
One of the Settle Caves. Roman occupation material. Excavations poorly reported.
Raistrick 1939.
1528, 1529, 2050.

SETJ
Settle Caves (Jackson Collection), North Yorkshire.
NGR SD 810 650 (vicinity).
Material from the investigation of a number of caves in the Settle area, but usually not assignable to any particular cave.
Lord personal communication.
1530, 1972, 1973, 1974, 1975, 1976, 1977, 1978, 1979, 1980, 1981, 1982, 1983, 1984, 1985, 1986, 2033, 2034.

SETK
Kinsey Cave, Settle, North Yorkshire.
NGR SD 804 657.
One of the Settle Caves. Roman occupation material. Finds from excavations 1925-31.
Lord nd
1514.

SETS
Sewell's Cave, Settle, North Yorkshire.
NGR SD 786 666.
One of the Settle Caves. 1933-4 excavations recovered Roman period material.
Lord nd
1515, 1516, 1517, 1518, 1519, 1520, 1521, 1522, 1524, 1525, 1526, 1527.

SETV
Victoria Cave, Settle, North Yorkshire.
NGR SD 838 650.
One of the Settle Caves. Roman occupation material.
Branigan & Dearne 1991: 105-113.
1531, 1532, 1533, 1534, 1535, 1987a, 1987b, 1988, 1989, 1990, 1991, 1992, 1993a, 1993b, 1995, 1996, 1997, 1998, 1999, 2000, 2035, 2036, 2037, 2038, 2039, 2229, 2230, 2231.

SHIP
Shiptonthorpe, North Yorkshire.
NGR SE 854 425.
Roman roadside settlement between York and Brough-on-Humber. Occupation begins in the second century and continues in to the late Roman period.
Frere 1992: 274-5; Millet forthcoming.
1537, 1539, 1540, 1541, 1542, 1543, 1544, 1545, 1546, 1547, 1548, 1549, 1550, 1551, 1552, 1553, 1554, 1555, 1556, 1557, 1558, 1559, 1560, 2294.

SKRN
Skerne, North Humberside.
NGR TA 067 549 (vicinity).
Stray Find (a torc) from a 'watery' context (?).
Macgregor 1976.
2579a, 2579b.

STAN
Stanwick Hoard, North Yorkshire.
NGR NZ 199 102.
Hoard of late Iron Age metalwork discovered in the 19th century two miles outside the Stanwick earthworks complex see TOFT).
Macgregor 1962; Haselgrove *et al.* 1990: 11-13.
1747a, 1747b, 1747c, 2002a, 2002b, 2003, 2004a, 2004b, 2006, 2007, 2008, 2009, 2010, 2011a, 2011b, 2012a, 2013a, 2013b, 2014, 2015, 2016, 2017, 2018, 2019a, 2019c, 2020, 2021a, 2021b, 2022, 2023, 2024, 2026, 2027, 2028, 2032a, 2032b, 2542, 2543, 2544, 2545a, 2545b, 2546, 2547, 2549, 2550, 2551, 2552, 2553, 2554, 2555, 2556, 2557, 2558, 2559, 2561, 2562, 2563, 2564, 2565, 2566, 2567, 2568, 2569, 2570, 2572a, 2572b, 2573, 2574, 2575, 2576.

STHW
Staple Howe, North Yorkshire.
NGR SE 890 750.
Small early Iron Age farmstead.
Brewster 1963.
2029, 2030, 2031.

SWDN
Sawdon, North Yorkshire.
NGR SE 940 850.
Stray find (?) possibly from an 'Arras' burial.
Stead 1979.
2227.

SWSH
Sewing Shields, Northumberland.
NGR NY 805 702.
Roman Milecastle 35 on Hadrian's Wall. Occupation starts in the second century but continues in to the late Roman period.
Haigh & Savage 1984.
2351, 2352, 2353, 2354, 2355, 2356, 2357, 2358, 2359, 2360, 2361, 2362a, 2362b, 2362c, 2363, 2364, 2365, 2366.

THTW
Thorpe Thewles, Cleveland.
NGR NZ 405 235.
Small Iron Age and Roman rural settlement.
Heslop 1987.
2051, 2052, 2053, 2055, 2056

TOFT
Toft's Field, Stanwick, North Yorkshire.
NGR NZ 184 118.
Iron Age settlement at the centre of a large earthworks complex. Activity continues into the early Roman period.
Haselgrove 1990; Haselgrove *et al.* forthcoming
1842, 1843, 1844, 1845, 1846a, 1846b, 1847, 1849, 1850, 1851, 1852, 1853, 1854, 1855a, 1855b, 1856, 1857, 1859, 1861, 1862, 1863, 1867, 1868, 1869, 1871, 1872, 1873, 1874.

TPLW
Traprain Law, Lothian Region.
NGR NT 581 746.
Hillfort occupied during the Iron Age and the Roman period. Possibly religious activity.
Hogg 1951. Hill 1982. Burley 1955.
1814, 1815, 1816, 1817, 1818, 1819, 1820, 1821, 1822, 1823, 1824, 1825, 1826, 1827, 1828, 1829, 1830, 1831, 1832, 1833, 1834, 1835, 1836, 1837, 1838, 1839, 1840, 1841, 2490, 2491, 2492, 2493, 2494, 2495, 2496, 2497, 2498, 2499.

VIND
Vindolanda, Northumberland.
NGR NY 771 664.
Roman fort and *vicus* occupied from the first century to the fourth century. The samples come from the early timber fort.
Birley 1974; Birley forthcoming.
1295, 1296, 1297, 1298, 1299, 1300, 1301, 1302, 1303, 1304, 1305, 1306, 1307, 1308, 1309, 1310, 1311, 1312, 1313, 1314, 1315, 1316, 1317, 1318, 1319a, 1319b, 1320, 1321, 1322, 1323, 1324, 1325, 1326, 1327, 1328, 1329, 1330, 1331, 1332a, 1332b, 1333, 1334, 1335, 1336, 1337, 1338, 1339, 1340.

WATC
Watercrook, Cumbria.
NGR SD 515 908.
Roman fort established in the first century (date of abandonment uncertain). Civil settlement outside.
Potter 1979.
1356, 1357, 1358, 1359, 1361, 1362, 1363, 1365, 1366, 1367, 1368, 1369, 1370, 1371, 1372, 1373, 1374, 1375, 1376, 1377, 1378, 1379, 1381, 1382, 1383, 1384, 1385, 1386, 1387, 1388, 1390, 1391.

WDEK
Wooden Eckford, Borders.
NGR NT 710 250 (vicinity).
Hoard of metal work (including a terret) from a 'watery' context.
Piggott 1952-3
1934.

WEWO
Welton Wold, North Humberside.
NGR SE 974 279.
Iron Age and Roman rural settlement. Extensive series of enclosures. One of these contains a small villa-like building in the Roman period.
Frere 1977: 383-4; Mackey forthcoming.
1453, 1454, 1455, 1456, 1458, 1459, 1460, 1461, 1462, 1463, 1465, 1466, 1467, 1468, 1469, 1470, 1471, 1472a, 1472b, 1473, 1474, 1476, 1477, 1478, 1479, 1482, 1483, 1484, 1485, 1486a, 1486b, 1487, 1488, 1489, 1490, 1491, 1492, 1494, 1496, 1498, 1499, 1500, 1502, 1503, 1504, 1505.

WLBY
Weelsby Avenue, Grimsby, South Humberside.
NGR TA 270 080.
Small rural Iron Age settlement with a late phase which has considerable copper alloy working evidence. Most of the copper alloy samples consist of droplets of metal.
Sills & Kinsley 1990.
2501, 2502, 2503, 2504, 2505, 2506, 2507, 2508, 2509, 2510, 2511, 2512, 2513, 2514, 2515, 2516, 2517, 2518, 2519, 2520.

WLDL
Walton-le-Dale, Lancashire.
NGR 551 282.
Industrial roadside settlement. Starts in the first century AD so may be military cf Holt or Heronbridge. Furnaces, etc but little evidence for their purpose.
Frere 1984: 284-5.
2425, 2426, 2427, 2428, 2429, 2430, 2431, 2432, 2433, 2434, 2435, 2436, 2437, 2438, 2439, 2441, 2442, 2443, 2444, 2445, 2446, 2447, 2449, 2450, 2451, 2452, 2454, 2455, 2456, 2471.

WRTN
Warton, Lancashire.
NGR SD 500 720 (vicinity).
Stray find (a sword).
Macgregor 1976.
1749a, 1749b, 1749c.

WTWG
Wetwang and Garton Slacks, North Humberside.
NGR TA 920 580.
Iron Age settlement and cemetery. the settlement continues in use into the Roman period. Most of the copper alloy samples are from the Roman period.
Dent 1982. Dent 1983.
2578, 2580, 2581, 2582, 2583, 2585a, 2585b, 2586, 2587, 2588, 2589, 2590, 2591, 2592, 2593, 2594, 2595, 2597, 2598, 2600, 2601, 2602, 2603, 2604a, 2604b, 2604c.

YORK
City of York.
NGR SE 604 520.
Fortress established in the first century and continues in use to the fourth century. A civil settlement on the left bank of the Ouse (canabae) and on the right bank (colonia).
Ottaway 1994.
2521, 2522, 2523, 2524, 2525, 2526, 2527, 2528, 2529, 2530, 2531, 2532, 2533, 2534, 2535, 2536, 2537, 2538, 2539, 2540, 2541, 2548.

Below is given a list of all the SITID codes under their respective SITETYPE categories.

MILITARY
BIGL, CAAN, CACA, CASD, ELGN, HBRN, MANC, NEWC, PIER, RAVE, SWSH, VIND, WATC, YORK.

VICUS
CABL, CASD, MANC, OPEN, PAPC, WATC, WLDL.

TOWN
CABL, CACA, CATW, YORK.

VILLA
DALT, HOLM, KKSN, RUDV, WEWO.

NUCLEATED RURAL SETTLEMENT
CATB, DRAG, OLDW, RDCL, SHIP, TOFT.

SMALL RURAL SETTLEMENT (FARMSTEAD)
DBSD, GLBF, HKHO, NCAV, STHW, THTW, WLBY, WTWG.

HILLFORT
BRXM, DODL, EDCS, SCAR, TPLW.

BURIAL
ARRS, BRHM, BUGT, BURT, CWLM, DNGR, KIRK, RUDG, SWDN.

HOARD
BLML, CLWK, COVW, STAN.

CAVES
SETA, SETC, SETJ, SETK, SETS, SETV.

STRAY FINDS
BRGH, CATT, CHST, CNGF, CORB, CRHM, DNGL, EMBL, GRMT, HSTD, INGL, LCMN, LOMS, PLFL, PLMS, RISE, SDBG, SKRN, WDEK, WRTN.

APPENDIX 4
CATALOGUE LISTING OF ALL OBJECT TYPES AND SAMPLES

This appendix gives a list of all the XRFID numbers under artefact type headings. This allows the isolation of all the analytical results for a particular artefact type of interest. Each object type is listed under the abbreviation (FINDTYPE) used in Appendix 5. Also given is a full description of the type and sub-types. A published reference is also given.

FINDTYPE (up to 6 letter code). All entries are in alphabetical order using this code.
Publication reference(s).
Full name of object type.
A brief description of the object.
A LIST OF ALL THE XRFID NUMBERS FOR SAMPLES OF THIS OBJECT TYPE.

ARBK
Bishop & Coulston 1993
Armour buckle
Part of the *lorica segmentata.*
1056.

ARTP
Bishop & Coulston 1993
Armour Tin Pin
Part of the *lorica segmentata.*
1133, 1146, 1148, 1150, 2070, 2204, 2320.

ARMLET
Bracelets and Armlets
Crummy (1983), Wheeler & Wheeler (1932), Allason-Jones & Miket (1984).
1 Solid. Crummy type 4; Allason-Jones & Miket type 17 or 18.
1107, 1366, 1664, 1715, 1837, 1978, 1980, 1995, 2121, 2333, 2459.
2 Wire, spiral. Crummy type 2; Allason-Jones & Miket type 15.
1032, 1352, 2337.
3 Wire, plain. Crummy type 2; Allason-Jones & Miket type 8 and 9.
1179, 1541, 1688, 2132, 2397, 2456.
4 Decorated with notches (mostly late Roman). Wheeler & Wheeler types G, H, K, L, P, Q, R and S; Crummy type 5 and 6.
1254, 1285, 1448, 1559, 1915, 2072, 2078, 2153, 2156, 2163, 2198, 2318, 2528, 2532.

5 Wire, twisted. Crummy type 3; Allason-Jones & Miket types 10-13.
1173, 1627a, 1627b, 2186, 2301.
6 Crenellated (mostly late Roman). Crummy type 5; Wheeler & Wheeler type M.
1471, 1641, 2087, 2116, 2142, 2168b, 2172.
7 Ring and dot decoration (mostly late Roman). Crummy type 8; Wheeler & Wheeler types D, E, G, H and K.
1687, 2071, 2298.
8 Knobbed (Iron Age). Stead 1979
1753, 1754, 2214.
9 Ribbed (Iron Age). Stead 1979
1755, 1970, 2213, 2478.
10 Tongue-in-glove (Iron Age). Stead 1979
1761, 2215, 2216, 2228.
11 Miscellaneous.
1847, 1892, 1979, 2065, 2144, 2147, 2148, 2154, 2173, 2261, 2262, 2277.

AXE
Socketed axe (late Bronze Age).
Burgess 1968
2127, 2130.

B&L
Button-and-Loop Fasteners
Horse harness fittings or dress fasteners.
Wild 1970
2 'II'
1832, 2003, 2009, 2552, 2565, 2570.
23 'II/III'
1161.
3 'III'
1047, 1196, 1358, 1770, 1819, 1820, 2429, 2432, 2441.
5 'V'
1817.
6 'VI'
1821, 1823.
9 'IX'
1138, 1773.
Unclassified
1342, 2094, 2566.

BB
Bow Brooches
Bayley & Butcher forthcoming.
1 Involuted (Iron Age).
1351, 1752, 2225.
2 La Tène, Arched (Iron Age).

1353, 1649, 2217a, 2217b.
3 Flattened (Iron Age).
1350.
4 La Tène III, one-piece (e.g. Nauheim derivative).
1230, 1674, 2501.
5 Colchester A
1010, 1016, 1022, 1057, 1201, 1711, 2097, 2585a.
7 Polden Hill and Dolphin.
1015, 1383, 1396, 1427, 1605, 1630, 1632, 1633, 1634a, 1634b, 1634c, 1659, 1692, 1709.
8 Early Hinged (e.g. Aucissa and Hod Hill).
1644, 1647, 1844, 1851.
9 Trumpet (cast headloop).
1026, 1262, 1517, 1973, 1975, 1988, 1989, 2044, 2108.
10 Trumpet (loose headloop).
1021, 1023, 1126, 1185, 1209, 1222, 1227, 1234, 1265, 1362, 1363, 1365, 1371, 1378, 1397, 1415, 1428, 1512, 1516, 1518, 1548, 1557, 1771, 1792, 1812a, 1812b, 1878a, 1878b, 1972, 2040, 2109, 2118, 2487, 2536.
11 Headstud (cast headloop).
1421, 1424, 1425, 1434, 1447, 1487, 1576, 1635, 1677, 1678, 1700, 1723, 1731, 1766, 1785, 1791a, 1791b, 1810, 1886, 1905a, 1905b, 1974, 2231.
12 Headstud (loose headloop).
1063, 1498, 1543, 1587, 1590, 1631, 1638, 1986, 1990, 2229, 2589.
13 Crossbow.
1811, 2240, 2246, 2393.
14 Reeded.
1017, 1018.
15 Knee.
1060, 1228, 1270, 1546, 2042, 2356.
16 Headstud or Trumpet (mostly incomplete, e.g. foot only).
1075, 1192, 1224, 1553, 1868.
18 Rosette.
1450.
19 Beaked (Birdlip).
1629, 1650, 1691.

BEAD
Some pierced discs, some tubular.
1354, 2180, 2199, 2395, 2604a, 2604b, 2604c.

BELL
May have been ritual.
2183, 2235, 2237, 2238, 2449.

BRACKT
Bracket
From a casket ?
1359.

BTPL
Belt plate (military ?)
Bishop & Coulston 1993
1 Solid (early Roman).
1145.
2 Openwork (lattice and scroll).
1152, 1246, 1453, 1596, 1954, 2034, 2282.
3 Open bar.
1052, 1736, 2363, 2485.
Miscellaneous
1472a, 1893, 2299a.

BTRG
Bit ring
Horse harness.
1375.

BTSF
Belt stiffener
Strip of metal fitted to leather belt and/or fittings.
Bishop & Coulston 1993
1092, 1132, 1215, 1238, 1250, 1286, 1291.

BTSLID
Belt slide
Similar to belt stiffener but wrapped around the belt to allow movement along the belt.
Bishop & Coulston 1993
1059, 2477.

BUCKLE
Some are ordinary belt buckles (military and civilian) some are smaller and are part of the *lorica segmentata* (Bishop & Coulston 1993).
1323, 1562b, 1960, 1962, 1971, 2025a, 2025b, 2060, 2073, 2074, 2145, 2185a, 2187, 2242, 2263, 2288.

BUGLE
Bugle-shaped fitting (toggle ?). cf Megaw & Simpson 1979: figure 6.43.
1344.

BUTTON
1274.

CHAIN
Mostly very fine, for connecting pairs of brooches.
1332b, 1499, 1500, 1502, 2592.

CHATEL
Chatelaine
Toilet set suspension loop
1574a.

CHISEL
Bronze Age.
2030.

D-CLIP
Diamond-shaped clip.
Small sheet fitting used to repair tears in cauldrons, etc.
Cool 1990.
1302, 2058, 2302, 2322, 2332.

DAGGER
Shorter versions of Sword.
Piggott 1950.
2057a, 2057b, 2057c, 2057d.

DROPHD
Drop Handle.
Furniture or casket fitting/ handle.
Laurenze & Riederer 1974.
1282, 1326, 1607, 2254, 2428, 2481c.

DROPLT
Droplet.
Metalworking waste (or remains from cremations).
1183, 1188, 1193, 1194, 1295, 1308, 1310, 1317, 1385, 1386, 1474, 1479, 1549, 1550, 1551, 1581, 1668, 1706, 1867, 1869, 1871, 1872, 1873, 1874, 1966, 2053, 2055, 2056, 2111, 2112, 2114a, 2114b, 2115a, 2114b, 2114c, 2114d, 2114f, 2117, 2290, 2354, 2378c, 2385, 2389b, 2408, 2414, 2415, 2446, 2461, 2464, 2504, 2505, 2506, 2507, 2508, 2509, 2510, 2511, 2512, 2513, 2514, 2515.

FSHEET
Folded sheet metal.
1099, 1101, 1361, 1411, 1458, 1465, 1652, 1676, 2067, 2425, 2467, 2594.

GOUGE
Bronze Age.
2124

HANDLE
Miscellaneous vessel and implement handles.
1539, 1940, 1968, 2005a, 2005b, 2033.

HMOUNT
Harness Mount.
1370, 1405, 1409.

HOOK
Could be just bent wire.
1088, 1941, 2574.

HSBT
Horse bit. Mostly 3-link bits, Iron Age or 'Celtic'.
Palk 1984.
1347a, 1347b, 1439a, 1439b, 1743a, 1743b, 1743c, 1744a, 1744b, 1744c, 1756a, 1756b, 1756c, 1881, 2001a, 2001b, 2001c, 2013a, 2013b, 2014, 2220a, 2220b, 2220c, 2545a, 2545b, 2557, 2558, 2562, 2563.

INGOT
Raw metal cast into blocks (rarely very large).
1464, 1765, 1802, 1853, 2489, 1782.

JET
Casting jet.
2128.

JNTLP
Roman cavalry Junction Loop.
Means of joining a number of leather straps to a ring.
Bishop & Coulston 1993.
1142, 1324, 1763, 1877, 2281c, 2457.

JNTRNG
Roman cavalry Junction Ring.
Means of joining leather straps and junction loops.
Bishop & Coulston 1993.
1569a, 2281a.

KEY
Lever lock type key.
1245, 1781, 1790, 1809, 1899, 2209, 2294, 2300, 2451, 2454, 2481b, 2482, 2525.

KEYSLB
Slide lock type key.
1684.

KNIFE
Knife handle.
1162, 1170, 1336, 1642.

LINCHP
Linch pin.
Pin used to hold wooden wheel onto the axle. Usually Iron Age or 'Celtic'.
1348a, 1348b, 1374, 1440a, 1440b, 1927, 1929, 1931, 2004a, 2004b, 2020, 2026, 2224a, 2224b, 2550, 2551, 2561, 2568, 2569.

LMOUNT
Looped Mount.
Roman cavalry harness fitting with two loops on the rear. Mostly decorative rather than functional ?
1054, 1163, 1564, 1818, 1822, 1838, 1839, 1841, 1916, 2006, 2008, 2189, 2253, 2272, 2443, 2466, 2542, 2544, 2553, 2555, 2564, 2567, 2575.

LOHG
Lorica Segmentata Hinge.
Hinge used to join sheets of iron armour together.
Bishop & Coulston 1993.
1283, 1571a, 1571b, 1571c, 1577, 1805a, 1879a, 2066.

LOHK
Lorica Segmentata Hook.
Hook used to join sheets of iron armour together.
Bishop & Coulston 1993.
1082.

LOLP
Lorica Segmentata Loop.
Loop used to join sheets of iron armour together.
Bishop & Coulston 1993.
1321, 1394, 1885.

MAILFS
Mail Fastener.
Reversed S-shaped fitting used to hold part of a suit of mail armour together.
Bishop & Coulston 1993.
2024.

MIRROR
Speculum hand mirrors.
1 Round
1097, 1618, 1619, 1636, 1774, 1789.
2 Rectangular
1073, 1889.
? Uncertain
1381, 1662, 1701, 1890.

MORTAR
Cosmetic Mortar
Usually with a suspension loop. May be decorative rather than functional.
Jackson 1985
1685b, 1895, 2455.

MOUNT
Cavalry harness fitting.
Bishop & Coulston 1993.
1078, 1149, 1155, 1178a, 1547, 1579, 1840, 1951, 1997, 2196, 2265, 2279, 2303, 2323, 2424, 2435, 2442.

NEEDLE
Riederer 1974b
1231, 1337, 1670, 1724, 1733, 1803, 1923, 2151, 2155, 2202, 2529, 2531.

PAB
Penannular brooch
Fowler 1960
1 Cast/moulded terminals
1012, 1029, 1068, 1124, 1167, 1226, 1330, 1436, 1437, 1486a, 1497, 1504, 1505, 1566, 1582a, 1794, 1846a, 1908, 1918, 2043, 2100, 2110a, 2299b, 2524, 2537.

2 Twisted/bent terminals
1074, 1654, 1690a, 1696, 1697, 1699, 1702, 1703, 1767, 1906, 2091, 2522.
3 Sheet terminals
1143, 1356, 1402, 1646.

PATERA
'Saucepan'
den Boesterd 1956.
1154, 1186, 1583, 1926, 2233, 2291, 2292.

PEND
Pendant.
Roman Cavalry decorative fitting
Bishop & Coulston 1993.
1 Lunate
1058, 1901.
2 Heart-shaped
1070, 1174, 1489.
3 Circular, oval.
1160, 1189, 1555, 1584.
4 Bi-fid/leaf
1277.
? Miscellaneous
1433, 1902, 2176, 2201, 2417a, 2447.

PENDWT
Pendant or weight
1377.

PESTLE
Cosmetic pestle.
Jackson 1985.
1683, 1685a, 2436.

PHALER
Phalera
Roman Cavalry decorative fitting
Bishop & Coulston 1993.
1768, 1928.

PHBC
Phalera backing (crescent-shaped)
1085a.

PHBO
Phalera backing (circular)
1111.

PIN
Crummy 1983.
1 Shaft with no head (incomplete). Some may be needles.
1002, 1008, 1106, 1113, 1116, 1177, 1216, 1278, 1280, 1281, 1338, 1462, 1484, 1713, 1735, 1921, 2161, 2179, 2342, 2472.
2 Orthogonal head.
1578.
3 Bead-and-reel head.
1072, 1248, 1623, 1624.
4 Miscellaneous shaped head.
1249, 1778, 1831, 1833, 2226, 2227, 2297, 2306, 2490, 2491, 2492, 2535, 2596.
? Uncertain head.
1048, 1340, 1438, 1658, 1842, 2167.

PLB
'Plate brooch'
1 Disc-shaped (flat)
1035, 1049, 1258, 1266, 1382, 1393, 1511, 1514, 1580, 1850, 1969, 1976, 1991, 1992, 2035, 2046, 2248, 2250, 2366.
2 Orthogonal
1043, 1552.
3 Zoomorphic
1037, 1367.
4 Skeuomorphic
1014.
5 Dragonesque
1252, 1384, 1388, 1392, 1509, 1519, 1528, 1529, 1637, 1836, 1913a, 1913b, 1987a, 2036, 2041, 2230, 2488.
6 Disc-shaped (projecting)
1041, 1044, 1588, 1977.
7 Cruciform
1595, 1876.
8 Wheel-shaped
1599.

POLECP
Stead 1979
'Pole cap'
2218.

PTSE
Plain strap end
Metal reinforcing strip for leather belt, etc. some are late Roman.
Bishop & Coulston 1993; Hawkes & Dunning 1961.
2162a, 2162b, 2164, 2165, 2169b.

RAZOR
Halstatt razor.
2029, 2031.

RING
Henig 1978; Crummy 1983
1 Bezelled finger ring
1168, 1255, 1592, 1625, 1626, 1830, 1903, 2150, 2582.
2 Plain (many may not be finger rings)
1028, 1104, 1169a, 1178b, 1214, 1253, 1256, 1410, 1430, 1446, 1454, 1520, 1671, 1796, 1804, 1829, 1967, 1985, 1996, 2122, 2123, 2255, 2259, 2329, 2355, 2365, 2374, 2379b, 2388, 2445, 2475, 2476, 2578, 2600, 2602.
3 Spiral finger ring
1128, 1513, 1795, 2119, 2141, 2307.
4 Spiral ear-ring
1814, 2136.
5 Ring key
1157, 1628.
6 Sheet ring
1176, 1293, 1331, 2308.
7 Tubular ring
2527.

RSWORD
Roman military sword (mostly fittings)
Bishop & Coulston 1993.
1891, 1897, 2361.

SCALP
Scalpel
Jackson 1986
1153, 1389.

SCAR
Scale armour.
Bishop & Coulston 1993.
1112, 1235, 1322, 1328, 1329, 2169a, 2205, 2316, 2538, 1586.

SCRN
Scabbard runner
Bishop & Coulston 1993.
1166, 1275, 1423, 2047, 2135, 2188, 2293.

SEALBX
Sealbox
1055, 1061, 1064, 1065, 1067, 1141, 2171.

SHEET
Sheet (i.e. less than 1mm in thickness)
1100, 1117, 1118, 1169b, 1182, 1297, 1299, 1303, 1306, 1307, 1309, 1313, 1315, 1319a, 1320, 1327, 1391, 1459, 1461, 1466, 1469, 1473, 1482, 1485, 1488, 1496, 1521, 1522, 1524, 1526, 1527, 1544, 1562a, 1614, 1669, 1679, 1705, 1712, 1716, 1725, 1734, 1739, 1784, 1843, 1855a, 1856, 1942, 1943, 1981, 2011b, 2032b, 2061a, 2081, 2089, 2190, 2194, 2197, 2296, 2309, 2313, 2315, 2317, 2321, 2345, 2347b, 2347c, 2348b, 2349, 2351, 2362a, 2362b, 2369b, 2370b, 2372, 2376b, 2380a, 2381a, 2401, 2404, 2418a, 2421a, 2426, 2481a, 2493, 2494, 2495, 2496, 2497, 2499, 2519, 2576, 2583, 2586, 2590, 2593, 2595.

SLB
Slide lock bolt
1034, 1195, 1376, 1395, 1887, 2285, 2450.

SNT
Studs, nails, rivets and tacks.
1 Spherical-headed nail
1046, 1091, 1137, 1165, 1476, 1568, 1600, 1615, 1620, 1775, 1798, 1982, 1983, 2101, 2104, 2339, 2433, 2437, 2526.
2 Miscellaneous
1025, 1121, 1140, 1211, 1219, 1573, 1613, 1740, 2023, 2175, 2311, 2336, 2530.
3 Round-headed, flat, cast
1050, 1139, 1332a, 1334, 1418, 1608, 1738, 1764, 1824, 2079, 2084, 2266, 2407, 2434, 2591.
4 Round-headed, flat, cast (decorated)
1038, 1066, 1263, 1373, 1408, 1426, 1531, 1532, 1533, 2276.
5 Hollow domed stud (boat-shaped)
1051, 2399.
6 Hollow, hemispherical stud (wrought)
1095, 1130, 1158, 1159, 1335, 1616, 1799, 1857, 2064a, 2095, 2120, 2281b, 2327a, 2346a, 2352, 2360, 2474, 2533.
7 Round-headed, flat, wrought
1131a, 1298, 2327b, 2334.
8 Bell-shaped stud (Allason-Jones 1985)

1036, 1276, 1289, 1369, 1530, 1534, 1535, 1603, 1964, 2138, 2158, 2191, 2232, 2243, 2256, 2260, 2353, 2359, 2411.
9 Round, slightly domed (cast)
1123, 1247, 1264, 2092, 2283, 2357, 2523.
10 Shaft with no head
1639, 1776, 1924, 2304, 2324.
11 Cast rivet
1477, 1805b, 1879b, 1907, 1911, 2061b, 2090, 2098, 2149, 2379c, 2405.
12 Wrought (sheet) rivet
1085b, 1300, 1301, 1304, 1312, 1319b, 1455, 1463, 1467, 1601, 1708, 1855b, 2083, 2343, 2362c, 2418b.
13 Hemispherical (cast)
1039, 1271, 1854.
14 Lion-headed stud
1081, 1545
15 Washer
1084, 1086, 1998.
16 Round-headed stud with flange (cast)
1131c, 1164, 1609, 2069, 2413a, 2413b.

SPOON
Table spoons (round bowls)
Riha & Stern 1982
1087, 1098, 1237, 1259, 1604, 1666, 1777, 2328.

SPUR
Cavalry spur
2131

STEND
Strap end (various shapes)
1134, 1147, 1213, 2540, 2548.

STJN
Strap junction (most 'Celtic')
Macgregor 1976
1232, 1341, 1445, 2007, 2010, 2017, 2018, 2211, 2543, 2554, 2556, 2573.

STRIP
Like sheet but significantly longer than wide. Up to 1mm in thickness
1001, 1009, 1027, 1079, 1094, 1103, 1105, 1114, 1212, 1218, 1314, 1318, 1460, 1472b, 1490, 1525, 1572, 1643, 1657, 1673, 1714, 1720, 1721, 1741, 1845, 1862, 1875, 1910, 1919, 1925, 2019a, 2019c, 2021a, 2021b, 2022, 2037, 2052, 2059, 2076,

2088, 2102, 2107, 2146, 2157, 2166, 2168c, 2208, 2210, 2326, 2340, 2423, 2439, 2444, 2452, 2460, 2470, 2516, 2518, 2572b, 2580.

STYLUS
Writing implement
1257, 2539.

SUMBO
Shield Umbo (boss)
1233

SWORD
Sword ('Celtic')
Piggott 1950
1747a, 1747b, 1747c, 1748a, 1748b, 1748c, 1749a, 1749b, 1749c, 1750, 1751a, 1751b, 1758, 1759a, 1759b, 1759c, 1760a, 1760b, 1762, 2002a, 2002b, 2273, 2274, 2275.

TLIM
Toilet implement
1 Long handle, short round bowl
1089, 1115, 1339, 2484.
2 Short handle, short round bowl
1648, 1680, 2039, 2075, 2181.
3 Long handle, small elongated bowl
1779.
4 Short handle, small elongated bowl
1004, 1561.
5 Long handle (probe)
1006, 1273, 1617, 1621, 1622, 1698, 1797a, 2178, 2521.
6 Tweezers
1419, 1653, 1660, 1693, 1707, 1793, 1825, 2096, 2195, 2430, 2480.
8 Handle, long bowl
1077, 1602, 2534.
9 Nail cleaner
1558, 1574b, 2038, 2541.
? Miscellaneous, uncertain
1007, 1379, 1451, 1537, 1665, 1800, 2182, 2236.

TOGGLE
Dumbell shaped fitting (Bronze Age origins ?)
1343, 1449, 1667, 2027.

TONGS
1372.

TORC
Iron Age/'Celtic' neck ornament
1746a, 1746b, 1746c, 1932, 2045, 2085, 2579a, 2579b.

TRT
Terret
Reign ring
Macgregor 1976
1 Knobbed
1243, 1345, 1346, 1442, 1443, 1444, 1742, 1834, 1934, 1935, 1936, 1937, 1938, 2270, 2271, 2330.
2 Plain
1083, 2016, 2269.
3 Looped
1210, 1554, 1783, 1939.
4 Mini
1349, 1441, 2212, 2223a, 2223b.
5 Lipped
1757, 2015, 2221, 2222, 2438, 2546, 2547, 2549, 2559.
6 Pole-mounted
1787, 1898, 1904, 2468.
7 Platform
1835, 1880.
8 Massive
2268.

U-BIND
U-sectioned binding used for edging on wood, etc
1120, 1240, 1325, 1413, 1610, 1611, 1686, 1689, 1710, 1726, 1806, 1815, 1816, 1884, 1917, 1922, 1944, 2048, 2050, 2068, 2103, 2105, 2106, 2177, 2286, 2344, 2348c, 2379a, 2469, 2479, 2483, 2498.

V.FIT
Vessel fitting
1404.

VESSEL
Vessel (not including Paterae)
Hawkes 1951
1119, 1135, 1171, 1180, 1198, 1206, 1207, 1387, 1483, 1492, 1506, 1556, 1598, 1769, 1826, 1930, 1933, 1946a, 1946b, 1946c, 1947a, 1947b, 1947c, 1948a, 1948b,

1949, 1950, 2012a, 2099, 2134, 2314, 2368b, 2368c, 2369a, 2370a, 2373b, 2375, 2376a, 2378a, 2387a, 2390a, 2396, 2398a, 2400, 2402, 2410, 2420, 2422, 2462.

WEIGHT
1108, 1144, 1597, 1957.

WIRE
1096, 1156, 1694, 1718, 1719, 1859, 2082, 2139, 2140, 2287, 2338, 2502, 2503, 2517, 2520, 2581, 2587, 2598.

APPENDIX 5
LIST OF ALL ANALYTICAL RESULTS

This Appendix lists all 1517 analytical results obtained for this thesis. The results are listed in XRFID number order, and each entry is accompanied by archaeological information (such as, name and type of site, class, type, description, published reference and date of object) and the analytical information (level of each element).

The following information is shown for each entry in this Appendix.

XRFID A four-figure reference number. Some reference numbers have single letter suffix (this usually arises where analysis has been carried out on two parts of a single artefact).

SITEID A four-letter code for each site. All of the site codes are listed in Appendix 3 (where they are accompanied by a full site name, NGR, published references etc).

SITETYPE A two-letter code which identifies the type of site. The codes used are as follows:-

- **BL** Burial (Brougham)
- **CV** Cave (Settle)
- **FT** Fort (e.g. Castleford, Ravenglass, Elginhaugh, Vindolanda)
- **HD** Hoard (e.g. Stanwick, Coventina's Well)
- **HF** Hillfort (e.g. Traprain Law)
- **MC** Hadrian's Wall Milecastle (i.e. Sewing Shields)
- **NS** Nucleated Rural Settlement (e.g. Dragonby, Shiptonthorpe)
- **SF** Stray Find (i.e. finds without detailed provenance/context)
- **SR** Small Rural Settlement - 'Farmstead' (e.g. Milking Gap, Thorpe Thewles, Doubstead)
- **TR** Hadrian's Wall Turret (i.e. High Brunton)
- **TW** Town (e.g. Carlisle, York)
- **VC** Vicus (e.g. Castelford, Old Penrith)
- **VL** Villa (e.g. Dalton Parlours, Rudston)

CLASS

Class of object, using the following categories:-

- **P** Personal (e.g. Brooches, bracelets, rings)
- **H** Household (e.g. Furniture fittings, vessels)
- **T** Transport (e.g. Bridle fittings)
- **M** Military (e.g. weapon and armour fittings)
- **?** Uncertain (i.e. objects which do not fall into any recognisable category)

In addition the above symbols are used to categorise objects which could fulfil a number of different functions.

OBJECT TYPE

Letter code (up to 6 letters) for the object type.
The letter codes (and their full descriptions are given in Appendix 4.

DESCRIPTION

This entry contains free text information as required. Mostly extra information describing the artefact.

CATALOGUE, etc

Figure number or catalogue number for any object which has been published. The source of the reference is given in Appendix 3 under the SITEID.
Where artefacts come from unpublished excavations (or were not catalogued in the publication) this entry gives:-
Small Find Numbers, thus:- < >
Context Numbers, thus [ ]

DATE

Context date for the artefact (where available). This is modified by the typological date if it was more precise.

EACH ELEMENT

Cu, Zn, Pb, Sn, Fe, Ni, Mn, As, Co.
For each element the composition is given in percentage terms to two decimal places. The following letter codes are used:-

- nd not detected (i.e. below the Minimum Detectable Level.
- ND Not Determined (i.e. cobalt in Roman alloys)

XRFID	SITEID	SITETYPE	CLASS	O-TYPE	REF	DESCRIPTION	CATALOGUE, etc	DATE	Cu	Zn	Pb	Sn	Fe	Ni	Mn	As	Co
1001	RDCL	NS	?	STRIP		PUNCHED DECORATION	<502> [315]	LIA	85.60	1.39	0.88	11.66	0.08	nd	nd	nd	ND
1002	RDCL	NS	P	PIN	1	PLAIN MOULDING	[780]	LIA	87.78	0.12	0.27	11.30	0.23	nd	nd	nd	ND
1004	RDCL	NS	H	TLIM	4	BARLEY SUGAR HANDLE	<265> [251]	LIA	84.70	11.61	0.43	3.01	0.26	nd	nd	nd	ND
1005	RDCL	NS	?	?		PELTA SHAPE	[804]	LIA	68.94	nd	20.53	9.81	nd	0.05	nd	nd	ND
1006	RDCL	NS	H	TLIM	5	SPATULA	[804]	LIA	91.65	3.21	0.43	4.27	0.43	nd	nd	nd	ND
1007	RDCL	NS	H	TLIM		OLIVARY END ONLY	[780]	LIA	89.45	nd	0.30	10.03	0.22	nd	nd	nd	ND
1008	RDCL	NS	H	PIN	1	SHAFT WITH GROOVE	<302> [593]	LIA	90.02	1.93	1.61	6.26	0.17	nd	nd	nd	ND
1009	RDCL	NS	?	STRIP		BENT	[756]	LIA	77.79	21.61	nd	0.18	0.35	0.06	nd	nd	ND
1010	RDCL	NS	P	BB	5	EARLY TYPE?	Mackreth 4 <587> [344]	LIA	78.40	20.65	0.65	0.12	0.17	nd	nd	nd	ND
1012	RDCL	NS	P	PAB	1	A3	Mackreth 16 <479> [377]	LIA	86.96	1.83	1.69	9.05	0.06	nd	nd	nd	ND
1014	RDCL	NS	P	PLB	4	SANDLE	Mackreth 15 [793]	LIA	79.17	20.59	nd	0.15	0.08	nd	nd	nd	ND
1015	RDCL	NS	P	BB	7	DOLPHIN	Mackreth 5 <83>	LIA	85.37	9.59	0.15	4.44	0.15	nd	0.01	nd	ND
1016	RDCL	NS	P	BB	5		Mackreth 2 <46> [36]	LIA	78.34	20.47	0.16	0.44	0.60	nd	nd	nd	ND
1017	RDCL	NS	P	BB	14	LANGTON DOWN	Mackreth 9 <1000>	LIA	80.05	16.13	1.09	2.33	0.25	nd	nd	nd	ND
1018	RDCL	NS	P	BB	14	LANGTON DOWN	Mackreth 10 <1007>	LIA	81.06	15.17	1.13	1.77	0.90	nd	nd	nd	ND
1019	RDCL	NS	P	BB	?	CONTINENTAL ONE-PIECE	Mackreth 11 [768]	LIA	79.19	20.02	0.23	0.28	0.27	nd	nd	nd	ND
1020	RDCL	NS	P	PAB	?	PIN ONLY	Mackreth 20 <300> [585]	LIA	93.52	0.40	nd	5.95	0.13	nd	nd	nd	ND
1021	RDCL	NS	P	BB	10	NO ACANTHUS ALL	Mackreth 6 [779]	LIA	85.90	13.41	0.15	0.40	0.12	nd	nd	nd	ND
1022	RDCL	NS	P	BB	5		Mackreth 1 <75> [41?]	LIA	79.25	19.74	0.48	0.12	0.40	nd	nd	nd	ND
1023	RDCL	NS	P	BB	10	NO ACANTHUS ALL	Mackreth 7 [855]	LIA	79.49	20.06	0.24	nd	0.13	nd	nd	nd	ND
1025	BIGL	TR	P	SNT	2	FLAT, RIM CENTRAL	<2>	C2AD	86.12	12.43	0.89	0.15	0.10	0.07	nd	0.24	ND
1026	BIGL	TR	P	BB	9		<12>	C2AD	85.03	nd	2.98	11.52	0.16	nd	nd	nd	ND
1027	BIGL	TR	?	STRIP		FRAG OF TUBE ?	<15>	C2AD	73.83	0.41	11.81	13.30	0.23	0.16	nd	nd	ND
1028	BIGL	TR	H	RING	2	CIRCULAR	<21>	C2AD	57.20	0.89	22.93	18.43	0.21	nd	0.02	nd	ND
1029	BIGL	TR	P	PAB	1	A4	<25>	C2AD	73.89	6.36	8.76	10.63	0.16	nd	nd	nd	ND
1032	RAVE	FT	P	ARMLET	2		Fig 27, 39 <134>	C4AD	81.86	nd	0.29	17.40	0.07	nd	nd	nd	ND
1033	RAVE	FT	T?	?		LOOP AND ROD	Fig 26, 20 <237>	C2AD	72.87	1.90	14.40	10.73	0.10	nd	nd	nd	ND
1034	RAVE	FT	H	SLB			Fig 26, 25 <242>	C2AD	75.53	9.68	4.26	9.90	0.13	nd	0.01	0.10	ND
1035	RAVE	FT	P	PLB	1		Fig 26, 8 <128>	LROM	80.41	0.61	9.44	9.44	0.10	nd	nd	nd	ND
1036	RAVE	FT	H	SNT	8	TYPE 2	Fig 27, 29 <174>	LROM	82.49	9.90	2.80	4.55	0.27	nd	nd	nd	ND
1037	RAVE	FT	H	PLB	3	SEA CREATURE	Fig 26, 3 <99>	C4AD	78.23	9.14	6.64	5.49	0.28	nd	nd	nd	ND
1038	RAVE	FT	H	SNT	4	NOTCHES AROUND RIM	Fig 27, 38 <211>	C4AD	84.96	1.71	6.05	7.18	0.10	nd	nd	nd	ND
1039	RAVE	FT	H	SNT	13		Fig 27, 35 <137>	C4AD	71.24	17.46	5.05	4.68	1.58	nd	nd	nd	ND
1040	RAVE	FT	?	?		CROSS AND CIRCLE	Fig 26, 18 <222>	C2AD	87.34	9.27	1.22	1.84	0.33	nd	nd	nd	ND
1041	RAVE	FT	P	PLB	6		Fig 26, 7 <160>	C4AD	82.49	6.44	1.20	9.40	0.26	nd	nd	nd	ND
1043	RAVE	FT	P	PLB	2		Fig 26, 6 <200>	LROM	81.50	2.07	6.90	9.01	0.10	nd	nd	nd	ND
1044	RAVE	FT	P	PLB	6		Fig 26, 2 <278>	C2AD	81.40	0.91	9.05	8.12	0.07	nd	nd	nd	ND
1045	RAVE	FT	H	SNT	?	LORICA STUD ?	Fig 27, 36 <250>	LROM	83.45	12.79	0.75	2.08	0.62	nd	nd	0.12	ND
1046	RAVE	FT	H	SNT	1		Fig 27, 45 <276>	LROM	78.13	nd	8.68	12.78	0.08	nd	nd	nd	ND
1047	RAVE	FT	T	B&L	3		Fig 26, 24 <272>	C2AD	93.49	0.19	0.98	5.06	0.06	nd	nd	0.11	ND
1048	RAVE	FT	P	PIN	?	BALUSTER MOULDING +FE	Fig 27, 43 <288>	LROM	81.57	3.29	10.63	4.20	0.15	nd	nd	nd	ND

XRFID	SITEID	SITETYPE	CLASS	O-TYPE	REF	DESCRIPTION	CATALOGUE, etc	DATE	Cu	Zn	Pb	Sn	Fe	Ni	Mn	As	Co
1049	RAVE	FT	P	PLB	1		Fig 26, 5 <90>	C4AD	84.97	2.88	1.59	9.99	0.15	nd	0.03	nd	ND
1050	RAVE	FT	H	SNT	3		Fig 27, 37 <115>	C4AD	84.79	7.87	4.37	2.51	0.32	nd	nd	nd	ND
1051	RAVE	FT	H	SNT	5		Fig 27, 34 <91>	C4AD	70.66	2.35	19.44	7.19	0.16	nd	nd	nd	ND
1052	RAVE	FT	M	BTPL	3		Fig 26, 13 <208>	C3AD	75.83	0.15	14.95	8.60	0.21	nd	nd	nd	ND
1053	RAVE	FT	T?	?		KNOB AND RING	Fig 26, 19 <219>	C4AD	75.50	12.38	6.37	5.07	0.55	nd	nd	nd	ND
1054	RAVE	FT	T	LMOUNT		2 DISHES	Fig 27, 28 <93>	C4AD	79.30	17.98	0.63	1.67	0.21	nd	nd	nd	ND
1055	CABL	TW	H	SEALBX			Fig 106, 36 <156> [318]	C4AD	75.47	5.35	12.26	6.25	0.68	nd	nd	nd	ND
1056	CABL	TW	M	ARBK			Fig 122, 114 <259> [99]	C1AD	77.41	21.75	nd	0.69	0.15	nd	nd	nd	ND
1057	CABL	VC	P	BB	5		Fig 100, 2 <265> [466]	C1AD	79.29	17.43	0.92	2.03	0.30	nd	0.01	nd	ND
1058	CABL	TW	T?	PEND	1		Fig 109, 49 <198> [462]	C3AD	73.27	13.28	9.31	3.51	0.44	nd	nd	nd	ND
1059	CABL	TW	M/T	BTSLID			Fig 108, 45 <168> [480]	C3AD	76.72	0.54	13.74	8.80	0.04	nd	0.01	nd	ND
1060	CABL	TW	P	BB	15		Fig 101, 13 <86> [93]	C4AD	76.79	4.17	8.77	9.53	0.38	nd	nd	nd	ND
1061	CABL	TW	H	SEALBX			Fig 106, 36 <155> [318]	C4AD	74.00	1.67	15.27	8.62	0.23	nd	nd	nd	ND
1062	CABL	TW	H	SNT	?		Fig 108, 40 <191> [625]	C3AD	78.53	10.53	5.88	3.79	1.29	nd	nd	nd	ND
1063	CABL	TW	P	BB	12	HEADSTUD	Fig 100, 6 <148> [355]	C3AD	83.18	14.46	1.05	1.12	0.18	nd	nd	nd	ND
1064	CABL	TW	H	SEALBX			Fig 106, 34 <192> [625]	C3AD	79.22	0.37	8.44	11.34	0.28	nd	nd	nd	ND
1065	CABL	TW	H	SEALBX			Fig 106, 35 <107> [245]	C4AD	79.36	12.43	4.57	2.61	1.00	nd	0.02	nd	ND
1066	CABL	TW	H	SNT	4		Fig 108, 58 <195> [615]	C2AD	75.19	0.66	14.60	8.92	0.33	nd	nd	nd	ND
1067	CABL	TW	H	SEALBX			Fig 106, 30 <245> [220]	C2AD	78.22	0.17	13.62	7.68	0.10	nd	nd	nd	ND
1068	CABL	TW	P	PAB	1	A2	Fig 103F, 23 <145>	C3AD	85.52	2.80	2.17	8.98	0.11	nd	nd	nd	ND
1070	CABL	TW	M/T	PEND	2		Fig 109, 51 <113> [268]	C3AD	74.75	23.98	nd	0.62	0.64	nd	nd	nd	ND
1072	CABL	TW	P	PIN	3		Fig 125F, 130 <173>	C2AD	81.97	0.18	6.86	10.48	0.11	nd	nd	nd	ND
1073	CABL	TW	H	MIRROR	2	?	Fig 120F, 102 <140>	C4AD	62.26	0.60	11.52	24.26	0.28	nd	nd	nd	ND
1074	CABL	VC	P	PAB	2	D6	Fig 103F, 27 <256>	C1AD	90.08	3.45	0.58	5.58	0.19	0.13	nd	nd	ND
1075	CABL	TW	P	BB	16	FOOT OF TRUMPET	Fig 100, 10 <178> [615]	C2AD	85.98	4.69	3.25	5.73	0.10	nd	0.02	nd	ND
1077	CABL	TW	H	TLIM	8		Fig 124F, 126 <118>	C1AD	90.38	4.29	0.35	4.36	0.28	nd	nd	0.14	ND
1078	CABL	TW	T	MOUNT		STRIP AND BOSS	Fig 111, 60 <250> [336]	C2AD	99.61	nd	0.18	0.21	nd	nd	0.01	nd	ND
1079	CABL	TW	?	STRIP		BUCKLE PRONG ?	Fig 123F, 122 <100>	C4AD	83.57	12.60	0.31	3.19	0.33	nd	nd	nd	ND
1081	CABL	TW	H	SNT	14		Fig 113, 72 <258> [306]	C1AD	71.25	7.85	14.75	5.06	0.69	nd	0.03	nd	ND
1082	CABL	VC	M	LOHK			Fig 109, 47 <255> [275]	C1AD	94.13	nd	nd	5.68	0.18	nd	nd	nd	ND
1083	CABL	VC	M	TRT	2		Fig 112, 69 <261> [451]	C1AD	85.86	nd	4.74	9.07	nd	nd	nd	nd	ND
1084	CACA	FT	H	SNT	15		<308> B [894]	C2AD	87.21	0.32	0.62	10.44	0.93	nd	nd	0.10	ND
1085 a	CACA	FT	M/T	PHBC			Fig 92, 143 <213>	C1AD	99.66	nd	0.15	0.11	0.06	0.10	0.01	nd	ND
1085 b	CACA	FT	M/T	SNT	12		Fig 92, 143 <213>	C1AD	100.00	nd	nd	nd	nd	nd	nd	nd	ND
1086	CACA	FT	H	SNT	15		<334> [1228]	C1AD	88.06	nd	nd	11.57	0.12	nd	nd	0.10	ND
1087	CACA	FT	H	SPOON	1		Cat 65 <285> [937]	C2AD	96.44	0.84	nd	2.33	0.40	nd	nd	nd	ND
1088	CACA	FT	?	HOOK			<328> [610]	C2AD	78.33	20.99	0.24	0.38	0.21	nd	0.01	nd	ND
1089	CACA	TW	H	TLIM	1		Fig 74, 55 <126> [513]	C2AD	80.60	18.78	nd	0.56	0.24	nd	nd	nd	ND
1091	CACA	FT	H	SNT	1		Cat 98 <103> [328]	C3AD	83.06	4.88	4.64	6.92	0.17	nd	nd	nd	ND
1092	CACA	TW	M	BTSF		?	Cat 156 <291> [757]	C2AD	76.94	21.78	nd	1.15	0.14	nd	nd	nd	ND
1094	CACA	TW	?	STRIP			<313> [757]	C2AD	83.49	13.13	0.84	1.62	0.73	nd	nd	nd	ND

XRFID	SITEID	SITETYPE	CLASS	O-TYPE	REF	DESCRIPTION	CATALOGUE, etc	DATE	Cu	Zn	Pb	Sn	Fe	Ni	Mn	As	Co
1095	CACA	FT	H	SNT	6		Cat 103 <300> [1144]	C1AD	97.98	0.00	1.01	1.01	nd	nd	nd	nd	ND
1096	CACA	FT	?	WIRE		HOOK	Cat 199 <287> [1280.2]	C1AD	78.38	21.21	0.27	nd	0.22	nd	0.02	nd	ND
1097	CACA	FT	H	MIRROR	1		Fig 75, 60 <277> [1559]	C1AD	67.50	0.56	10.36	21.19	0.24	nd	nd	0.14	ND
1098	CACA	FT	H	SPOON	1		Fig 76, 64 <271> [1392]	C1AD	96.86	1.04	0.32	1.46	0.32	nd	nd	nd	ND
1099	CACA	FT	?	FSHEET			Fig 103, 202 <270>	C1AD	79.04	20.30	nd	0.57	0.13	nd	nd	nd	ND
1100	CACA	FT	?	SHEET			<256> [1237]	C1AD	97.81	nd	0.27	1.80	0.11	nd	nd	nd	ND
1101	CACA	FT	?	FSHEET			Fig 100, 177 <251>	C1AD	100.00	nd	nd	nd	nd	nd	nd	nd	ND
1102	CACA	FT	M/T	?		EAR PROTECTOR	Cat 152 <246> [1232]	C1AD	96.52	nd	nd	3.25	0.07	nd	nd	nd	ND
1103	CACA	FT	?	STRIP			Cat 181 <241> [1232]	C1AD	99.22	nd	0.15	0.62	nd	nd	nd	nd	ND
1104	CACA	FT	P/H	RING	2	CIRCULAR	Cat 81 <231> [1232]	C1AD	73.57	0.36	15.42	9.66	0.70	nd	0.05	nd	ND
1105	CACA	FT	?	STRIP			Cat 184 <216> [1239]	C1AD	98.96	nd	0.22	0.77	0.05	nd	nd	nd	ND
1106	CACA	TW	P	PIN	1		Cat 44 <133> [532]	C2AD	80.23	16.65	0.33	1.99	0.47	nd	nd	0.11	ND
1107	CACA	FT	P/H	ARMLET	1		Cat 86 <123> [485]	C2AD	85.71	nd	2.84	10.64	0.04	0.14	nd	nd	ND
1108	CACA	FT	H	WEIGHT			Fig 84, 77 <110> [333]	C3AD	84.36	11.23	1.69	2.54	0.20	nd	nd	nd	ND
1109	CACA	FT	?	FRAG			<118> [396]	C3AD	72.05	2.34	14.95	10.23	0.21	nd	nd	nd	ND
1111	CACA	FT	M/T	PHBO			Fig 93, 146 <189>	C1AD	87.21	nd	0.26	12.26	0.07	nd	nd	nd	ND
1112	CACA	FT	M	SCAR			Fig 96, 157 <192>	C1AD	99.67	nd	nd	0.12	0.21	nd	nd	nd	ND
1113	CACA	FT	H	PIN	1		Cat 41 <179> [1124]	C1AD	96.82	0.94	0.21	1.57	0.45	nd	nd	nd	ND
1114	CACA	FT	S	STRIP			Fig 100, 179 <177>	C1AD	98.78	nd	0.28	0.94	nd	nd	nd	nd	ND
1115	CACA	FT	H	TLIM	1		Cat 50 <170> [1119]	C1AD	81.72	16.64	nd	1.11	0.36	nd	nd	nd	ND
1116	CACA	TW	H	PIN	1		Cat 40 <141> [636]	C2AD	81.09	17.99	nd	0.62	0.30	nd	nd	nd	ND
1117	CACA	TW	?	SHEET			<135> [532]	C2AD	80.06	18.87	nd	0.94	0.15	0.06	0.01	nd	ND
1118	CACA	FT	?	SHEET			<160> [1093]	C1AD	89.90	nd	1.56	7.88	0.11	0.13	nd	nd	ND
1119	CACA	FT	H	VESSEL		RIM	Fig 79, 69 <185> [1124]	C1AD	72.73	nd	19.11	8.15	nd	nd	nd	nd	ND
1120	CACA	FT	H	U-BIND			Cat 160 <100> [327]	C3AD	89.24	0.10	nd	10.21	0.13	nd	nd	0.11	ND
1121	CACA	FT	M?	SNT	2		Fig 96, 155 <107> [365]	C3AD	73.32	17.32	5.26	3.64	0.40	nd	nd	nd	ND
1123	CACA	TW	H	SNT	9		Cat 108 <87> [520]	C2AD	79.29	15.45	0.67	3.82	0.60	nd	0.01	0.17	ND
1124	CACA	FT	P	PAB	1	A3	Cat 18 <286> [1511]	C1AD	81.26	18.23	0.19	nd	0.22	nd	nd	nd	ND
1126	CACA	FT	P	BB	10	NO ACANTHUS HALF	Fig 63, 9 <273> [1544]	C1AD	79.30	18.89	0.72	0.93	0.15	nd	nd	nd	ND
1128	CAAN	FT	P	RING	3		<838> [2578]	C2AD	78.96	19.12	0.45	1.26	0.20	nd	nd	nd	ND
1129	CAAN	FT	H/M	?		HANDLE	<820> [2225]	C2AD	77.31	21.52	nd	0.86	0.21	nd	nd	nd	ND
1130	CAAN	FT	H	SNT	6		<1029> [5936]	C1AD	80.41	18.94	0.31	0.19	0.34	nd	nd	nd	ND
1131 a	CAAN	FT	H	SNT	7		<1005> [5601]	C1AD	79.47	19.50	0.18	0.43	0.31	nd	0.01	nd	ND
1131 c	CAAN	FT	H	SNT	15	WASHER	<1005> [5601]	C1AD	87.11	nd	0.21	12.01	nd	nd	nd	nd	ND
1132	CAAN	FT	M	BTSF			<976> [5095]	C1AD	75.15	17.44	5.24	1.53	0.63	nd	nd	nd	ND
1133	CAAN	FT	M	ARTP			<590> [1007]	C3AD	76.72	2.21	12.28	8.38	0.16	nd	nd	nd	ND
1134	CAAN	FT	M	STEND			<628> [1175]	C3AD	92.42	nd	nd	7.45	0.13	nd	nd	nd	ND
1135	CAAN	FT	H?	VESSEL		? HANDLE	<600> [1092]	C3AD	90.21	0.49	1.94	6.91	0.20	nd	nd	nd	ND
1137	CAAN	FT	H	SNT	1		<858> [2763]	C2AD	83.75	15.29	0.27	0.53	0.24	nd	nd	nd	ND
1138	CAAN	FT	P/T	B&L	9		<1040> [6058]	C1AD	77.51	18.39	2.07	1.32	0.72	nd	nd	nd	ND
1139	CAAN	FT	H	SNT	3		<650> [1195]	C3AD	77.82	6.01	10.33	5.37	0.47	nd	nd	nd	ND

XRFID	SITEID	SITETYPE	CLASS	O-TYPE	REF	DESCRIPTION	CATALOGUE, etc	DATE	Cu	Zn	Pb	Sn	Fe	Ni	Mn	As	Co
1140	CAAN	FT	H	SNT	2		<1087> [1759]	C1AD	83.31	nd	8.54	7.95	nd	nd	nd	nd	ND
1141	CAAN	FT	H	SEALBX			<946> [4688]	C1AD	81.13	7.87	4.01	6.35	0.64	nd	nd	nd	ND
1142	CAAN	FT	T	JNTLP		BISHOP 1	<906> [1759]	C1AD	83.15	14.12	0.55	1.90	0.29	nd	nd	nd	ND
1143	CAAN	FT	P	PAB	3		<587> [1034]	C3AD	87.09	1.18	0.43	10.35	0.11	nd	nd	nd	ND
1144	CAAN	FT	H	WEIGHT			<679> [1322]	C3AD	75.78	12.11	7.12	4.32	0.49	nd	nd	nd	ND
1145	CAAN	FT	M	BTPL	1		<851> [2787]	C2AD	76.31	0.41	9.94	12.47	0.51	nd	nd	0.18	ND
1146	CAAN	FT	M	ARTP			<779> [2065]	C2AD	79.13	3.21	8.65	8.66	0.31	nd	0.03	nd	ND
1147	CAAN	FT	M/T	STEND			<640> [1195]	C3AD	80.83	4.86	6.59	6.80	0.72	nd	nd	nd	ND
1148	CAAN	FT	M	ARTP			<632> [1017]	C3AD	74.42	2.57	13.52	8.90	0.24	nd	nd	nd	ND
1149	CAAN	FT	T	MOUNT			<636> [1198]	C3AD	75.99	0.14	11.51	11.83	0.08	nd	nd	nd	ND
1150	CAAN	FT	M	ARTP			<603> [1053]	C3AD	75.96	1.11	12.64	9.69	0.10	nd	nd	nd	ND
1152	CAAN	FT	M	BTPL	2		<677> [1389]	C3AD	83.18	12.37	1.10	2.78	0.56	nd	nd	nd	ND
1153	CAAN	FT	H	SCALP			<656> [1237]	C3AD	85.79	0.11	7.18	6.76	0.17	nd	nd	nd	ND
1154	CAAN	FT	H	PATERA		HANDLE	<849> [2770]	C2AD	73.18	0.74	15.24	10.50	0.33	nd	nd	nd	ND
1155	CAAN	FT	M	MOUNT			<621> [1121]	C3AD	72.69	2.03	12.00	12.27	0.53	nd	nd	nd	ND
1156	CAAN	FT	?	WIRE			<709> [1545]	C2AD	78.47	20.34	nd	0.85	0.25	nd	nd	nd	ND
1157	CAAN	FT	P/H	RING	5		<1017> [5698]	C1AD	83.01	9.95	3.76	2.97	0.25	0.07	nd	nd	ND
1158	CAAN	FT	H	SNT	6		<734> [1723]	C2AD	80.75	17.79	0.31	0.75	0.40	nd	nd	nd	ND
1159	CAAN	FT	H	SNT	6		<1062> [2183]	C2AD	80.18	19.60	nd	0.10	0.17	0.05	nd	nd	ND
1160	CAAN	FT	M/T	PEND	3		<844> [2105]	C2AD	82.73	15.72	nd	1.12	0.43	nd	nd	nd	ND
1161	CAAN	FT	P/T	B&L	23		<978> [5094]	C1AD	93.36	nd	1.65	4.77	0.05	nd	nd	nd	ND
1162	CAAN	FT	H	KNIFE			<960> [4969]	C1AD	79.63	14.46	2.07	2.91	0.89	nd	nd	nd	ND
1163	CAAN	FT	T	LMOUNT		DOUBLE BOSS AND PETAL	<843> [2629]	C2AD	81.30	18.37	0.24	0.00	0.09	nd	nd	nd	ND
1164	CAAN	FT	H	SNT	16		<977> [5062]	C1AD	96.28	nd	nd	3.36	0.08	nd	0.01	nd	ND
1165	CAAN	FT	H	SNT	1		<599> [1071]	C3AD	66.40	nd	27.96	4.75	nd	0.08	nd	nd	ND
1166	CAAN	FT	M	SCAR	?		<727> [1614]	C2AD	97.40	nd	nd	2.20	0.14	nd	0.01	nd	ND
1167	CAAN	FT	P	PAB	1	A2?	<691> [1473]	C2AD	85.94	2.80	0.32	10.70	0.11	nd	nd	nd	ND
1168	CAAN	FT	P	RING	1	HENIG XII	<975> [5062]	C1AD	81.16	17.88	nd	0.44	0.25	0.15	nd	nd	ND
1169 a	CAAN	FT	?	RING	2	CIRCULAR (WITH SHEET)	<818> [2232]	C2AD	54.12	0.18	34.57	11.06	0.08	nd	nd	nd	ND
1169 b	CAAN	FT	?	SHEET			<818> [2232]	C2AD	83.05	14.04	0.45	2.02	0.42	nd	0.02	nd	ND
1170	CAAN	FT	H	KNIFE			<841> [2547]	C2AD	74.57	9.30	9.97	5.56	0.39	nd	nd	nd	ND
1171	CAAN	FT	H	VESSEL			<729> [1679]	C2AD	80.44	0.19	12.03	7.26	0.06	nd	0.02	nd	ND
1173	HOLM	VL	P	ARMLET	5		Cat 47 <13>	ROMN	87.65	11.71	0.00	0.30	0.29	nd	nd	0.18	ND
1174	HOLM	VL	M	PEND	2		Cat 309 <19>	MROM	79.43	16.94	3.37	0.12	0.25	nd	nd	nd	ND
1176	HOLM	VL	?	RING	6	?	<16> [M10 24]	?	87.55	nd	nd	12.19	0.05	nd	nd	nd	ND
1177	HOLM	VL	H	PIN	1		<110> [Y14 3]	?	81.20	15.96	0.48	2.11	0.27	nd	nd	nd	ND
1178 a	HOLM	VL	H	MOUNT		cf POLDEN HILL	Cat 219 <124>	LIA	84.84	nd	nd	13.85	0.14	nd	nd	0.93	ND
1178 b	HOLM	VL	H	RING	2	CIRCULAR ATTACHED 117	Cat 219 <124>	LIA	84.61	nd	nd	13.81	0.15	nd	nd	0.82	ND
1179	HOLM	VL	P	ARMLET	3		Cat 48 <44>	ROMN	90.24	3.92	0.66	4.97	0.22	nd	nd	nd	ND
1180	HOLM	VL	H	VESSEL		HANDLE	Cat 229 <93>	ROMN	76.72	21.58	nd	1.38	0.32	nd	nd	nd	ND
1182	ELGN	FT	?	SHEET			<AT> [1AC 339]	C1AD	99.33	nd	0.26	0.36	0.04	nd	nd	nd	ND

XRFID	SITEID	SITETYPE	CLASS	O-TYPE	REF	DESCRIPTION	CATALOGUE, etc	DATE	Cu	Zn	Pb	Sn	Fe	Ni	Mn	As	Co
1183	ELGN	FT	W?	DROPLT			<AG> [1AC 0036]	C1AD	83.66	0.13	8.03	8.04	0.15	nd	nd	nd	ND
1185	ELGN	FT	P	BB	10	ACANTHUS ALL	<EE> [1AC 00003]	C1AD	79.79	17.24	1.21	1.40	0.20	nd	nd	nd	ND
1186	ELGN	FT	H	PATERA		HANDLE	<AD> [2BC 406]	C1AD	82.27	0.14	8.23	8.73	0.25	nd	nd	nd	ND
1188	ELGN	FT	W?	DROPLT			<AB> [1AC 1404]	C1AD	87.72	6.69	1.74	3.54	0.22	nd	nd	nd	ND
1189	ELGN	FT	M	PEND	3		<AH> [1BC 1543]	C1AD	81.69	7.90	3.50	6.57	0.16	nd	0.02	nd	ND
1190	ELGN	FT	W?	FRAG			<AA> [1AC 581]	C1AD	85.05	nd	4.04	10.64	0.10	nd	nd	nd	ND
1191	ELGN	FT	W?	LUMP			<DS> [1AC 207]	C1AD	81.41	14.46	1.97	1.86	0.24	0.06	nd	nd	ND
1192	ELGN	FT	P	BB	16	FOOT OF TRUMPET	<AM> [1AB 00001]	C1AD	85.76	6.78	1.08	6.03	0.13	nd	nd	nd	ND
1193	ELGN	FT	W?	DROPLT			<SZ> [1AC 0003]	C1AD	85.15	6.20	3.57	4.86	0.22	nd	nd	nd	ND
1194	ELGN	FT	W?	DROPLT			<AE> [1AC 154]	C1AD	83.33	15.13	0.80	0.49	0.20	nd	nd	0.10	ND
1195	ELGN	FT	H	SLB			<CV> [2BC 0419]	C1AD	79.91	2.21	7.53	9.64	0.69	nd	0.01	nd	ND
1196	ELGN	FT	P/T	B&L	3		<UY> [1AC 207]	C1AD	86.62	0.95	4.68	7.66	0.09	nd	nd	nd	ND
1198	ELGN	FT	H	VESSEL			<GE> [1BC 00001]	C1AD	76.89	nd	11.13	11.74	0.07	nd	nd	nd	ND
1200	ELGN	FT	W?	LUMP			<AK> [1AC 479]	C1AD	77.52	8.37	7.54	6.40	0.17	nd	nd	nd	ND
1201	ELGN	FT	P	BB	5	EARLY TYPE	<AM> [1BB 2402]	C1AD	86.57	2.16	3.07	7.89	0.05	nd	nd	nd	ND
1202	ELGN	FT	W?	LUMP			<AN> [1AC 601]	C1AD	100.00	nd	nd	nd	nd	nd	nd	nd	ND
1203	ELGN	FT	W?	LUMP			<AE> [1AC 106]	C1AD	88.03	2.35	0.74	8.66	0.04	nd	nd	nd	ND
1204	ELGN	FT	W?	LUMP			<AC> [1AC 1404]	C1AD	81.65	13.70	0.67	3.67	0.14	nd	0.01	nd	ND
1206	ELGN	FT	H	VESSEL		HANDLE	<NR> [1AB 920]	C1AD	83.17	nd	5.87	10.81	nd	nd	nd	nd	ND
1207	ELGN	FT	H	VESSEL		HANDLE	<AJ> [1BC 534]	C1AD	86.04	nd	9.94	4.06	nd	nd	nd	nd	ND
1209	KKSN	VL	P	BB	10	ACANTHUS ALL	<15> [17]	ROMN	80.85	0.82	3.51	14.58	0.24	nd	nd	nd	ND
1210	KKSN	VL	T	TRT	3		<14> [11]	ROMN	82.13	0.78	6.13	10.64	0.11	nd	nd	nd	ND
1211	KKSN	VL	H	SNT	2	CONICAL, APEX MISSING	<88> [6]	ROMN	75.97	3.15	10.16	9.83	0.42	nd	nd	nd	ND
1212	KKSN	VL	?	STRIP			<17> [1A]	ROMN	87.38	nd	0.78	11.08	0.06	0.09	nd	nd	ND
1213	KKSN	VL	M?	STEND			<85> [2]	ROMN	77.62	8.96	6.79	6.28	0.35	nd	nd	nd	ND
1214	KKSN	VL	P/H	RING	2	D PENANNULAR	<86> [3]	ROMN	53.26	0.40	31.69	13.71	0.29	nd	nd	nd	ND
1215	KKSN	VL	M?	BTSF			<87> [1]	ROMN	84.47	nd	2.53	13.00	nd	nd	nd	nd	ND
1216	KKSN	VL	P/H	PIN	1		<76> [23]	ROMN	84.71	9.60	1.06	3.98	0.66	nd	nd	nd	ND
1218	KKSN	VL	?	STRIP			<61> [7]	ROMN	97.75	nd	0.84	1.20	0.20	nd	nd	nd	ND
1219	KKSN	VL	P	SNT	2	FLAT, RIM, PERFORATED	<60> [1]	ROMN	91.57	6.31	1.12	0.30	0.31	nd	nd	0.38	ND
1220	KKSN	VL	W	LUMP			<63> [1]	ROMN	90.16	0.80	5.92	2.94	nd	nd	nd	nd	ND
1222	KKSN	VL	P	BB	10	ACANTHUS ALL	<78> [2]	ROMN	83.60	1.21	8.36	6.72	0.10	nd	nd	nd	ND
1224	KKSN	VL	P	BB	16	ACANTHUS ALL	<82> [13]	ROMN	79.31	0.13	7.75	12.50	0.31	nd	nd	nd	ND
1226	CAAN	FT	P	PAB	1	cf A3 or A4	<952> [4890]	C1AD	78.91	20.29	0.23	0.30	0.26	nd	nd	nd	ND
1227	CAAN	FT	P	BB	10	? ALL	<979> [5094]	C1AD	79.60	18.67	0.27	1.33	0.13	nd	nd	nd	ND
1228	CAAN	FT	P	BB	15		<719> [1602]	C2AD	67.35	0.20	22.41	9.85	0.00	nd	0.02	nd	ND
1230	CAAN	FT	P	BB	4	NAUHEIM DERIVATIVE	<1012> [5669]	C1AD	89.40	nd	nd	9.98	0.45	nd	0.02	0.15	ND
1231	CACA	TW	H	NEEDLE		EXPANDED HEAD	<138> [567]	C2AD	83.27	9.43	0.42	6.40	0.11	nd	nd	nd	ND
1232	CACA	FT	T	ST JN		DISC	<346> [1232]	C1AD	73.25	15.32	8.57	2.27	0.59	nd	nd	nd	ND
1233	CAAN	FT	M	SUMBO			<1044> [6241]	C1AD	83.90	12.86	0.00	2.94	0.30	nd	nd	nd	ND
1234	CACA	TW	P	BB	10	ACANTHUS HALF	Fig 63, 7 <125> [513]	C2AD	76.64	19.80	2.03	1.39	0.14	nd	nd	nd	ND

XRFID	SITEID	SITETYPE	CLASS	O-TYPE	REF	DESCRIPTION	CATALOGUE, etc	DATE	Cu	Zn	Pb	Sn	Fe	Ni	Mn	As	Co
1235	CAAN	FT	M	SCAR			<1019> [5698]	ROMN	88.89	9.93	nd	1.04	0.14	nd	nd	nd	ND
1236	CACA	TW	?	?		SPLIT PIN CONNECTOR	Cat 75 <117> [397]	ROMN	97.33	nd	0.31	2.18	0.19	nd	nd	nd	ND
1237	CAAN	FT	H	SPOON	1		<958> [4930]	C1AD	86.85	9.32	0.54	2.91	0.13	0.06	nd	nd	ND
1238	CAAN	FT	M	BTSF			<920> [3872]	C1AD	87.43	11.84	0.00	0.49	0.24	nd	nd	nd	ND
1240	DODL	HF	H	U-BIND			Fig 18, <23> [35]	LIA	90.34	nd	0.46	9.14	0.08	nd	0.01	nd	ND
1242	DBSD	SR	P	BB				LIA	85.22	0.15	1.44	12.37	0.12	nd	nd	0.25	ND
1243	HKHO	SR	T	TRT	1		Fig 11, 2	LIA	78.25	19.28	nd	1.70	0.17	0.05	nd	nd	ND
1244 a	DODL	HF	P	BB	?	EARLY HINGED	Fig 18 <20>	LIA	75.84	22.31	0.31	0.88	0.66	nd	nd	nd	ND
1244 b	DODL	HF	P	BB	?	PIN TO 1244a	Fig 18 <20>	LIA	86.77	0.56	0.73	10.90	0.10	nd	nd	0.21	ND
1245	CATB	NS	H	KEY			Cat 59 [2609]	ROMN	84.61	2.89	5.24	7.08	0.18	nd	nd	nd	ND
1246	CATW	TW	M	BTPL	2		Cat 168 <180> [PIII17]	C3AD	82.71	1.65	6.05	9.50	0.09	nd	nd	nd	ND
1247	CATB	NS	H	SNT	9		Cat 54 [54]	ROMN	85.44	11.40	0.37	2.32	0.47	nd	nd	nd	ND
1248	CATW	TW	P/H	PIN	3		Cat 3 <12> [Q I 3]	C4AD	85.61	8.89	0.92	4.02	0.24	nd	nd	nd	ND
1249	CATB	NS	P	PIN	4	INCISED DECORATION	Cat 4 [4501]	ROMN	85.65	8.13	1.56	4.10	0.16	nd	0.01	0.10	ND
1250	CATB	NS	M?	BTSF			Cat 37 [162]	ROMN	79.81	18.41	nd	1.41	0.07	0.12	nd	nd	ND
1252	CATB	NS	P	PLB	5	cf FEACHEM I/III	Cat 11 [3329]	ROMN	88.87	4.37	1.23	5.47	0.06	nd	nd	nd	ND
1253	CATB	NS	P/H	RING	2	CIRCULAR	Cat 11 [1491]	ROMN	41.96	1.07	44.04	11.76	0.21	nd	nd	nd	ND
1254	CATW	TW	P	ARMLET	4		Cat 53 [P I 7]	C3AD	89.59	nd	1.47	7.82	0.06	nd	nd	nd	ND
1255	CATW	TW	P	RING	1	cf HENIG VIII	Cat 82 <182> [PIII17]	C3AD	70.82	0.29	16.53	12.28	0.20	nd	nd	nd	ND
1256	CATB	NS	P/H	RING	2	IRREGULAR	Cat 10 [58]	ROMN	81.84	16.20	0.26	1.42	0.29	nd	nd	nd	ND
1257	CATB	NS	P/H	STYLUS	?		Cat 20 [773]	ROMN	94.54	0.21	0.51	4.51	0.21	nd	nd	nd	ND
1258	CATW	TW	P	PLB	1		Cat 26 <46> [P I 4]	C4AD	85.62	nd	5.27	8.92	nd	nd	nd	0.18	ND
1259	CATB	NS	H	SPOON	1		Cat 31 [2833]	ROMN	64.94	1.11	23.85	9.24	0.34	nd	nd	0.52	ND
1262	CATB	NS	P	BB	9	NO ACANTHUS HALF	Cat 8 [59]	ROMN	86.17	0.63	5.05	7.96	0.19	nd	nd	0.00	ND
1263	CATB	NS	H	SNT	4	CONCENTRIC CIRCLES	Cat 49 [2589]	ROMN	81.39	16.68	nd	1.21	0.38	0.05	nd	0.29	ND
1264	CATB	NS	H	SNT	9		Cat 53 [58]	ROMN	84.02	10.79	0.84	3.36	0.99	nd	nd	0.00	ND
1265	CATB	NS	P	BB	10	ACANTHUS ALL ?	Cat 7 [1992]	ROMN	86.88	0.91	1.56	10.56	0.09	nd	nd	0.00	ND
1266	CATB	NS	P	PLB	1		Cat 13 [75]	ROMN	83.98	8.24	3.15	4.34	0.29	nd	nd	0.00	ND
1269	CATW	TW	P	?		TOILET LOOP	Cat 119 <86> [DXI43]	C2AD	79.73	19.97	nd	nd	0.20	nd	nd	0.10	ND
1270	CATW	TW	P	BB	15		Cat 15 [F XIII 11]	C4AD	80.41	2.26	8.52	8.66	0.15	nd	nd	0.00	ND
1271	CATW	TW	H	SNT	13		Cat 291 <77> [EVI14]	C3AD	80.07	7.61	5.96	5.96	0.39	nd	nd	0.00	ND
1272	CATW	TW	H	?		PLANT-LIKE MOUNT	Cat 364 [J II 12]	C3AD	83.78	4.20	4.40	7.29	0.17	nd	nd	0.16	ND
1273	CATW	TW	H	TLIM	5		Cat 116 <133> [EXIV2]	C4AD	86.99	2.57	1.88	8.47	0.09	nd	nd	0.00	ND
1274	CATW	TW	P	BUTTON		PELTATE	Cat 98 <62> [D XI 32]	C2AD	76.49	3.91	7.67	11.07	0.68	nd	nd	0.18	ND
1275	CATW	TW	M	SCRN			Cat 194 <140> [DXXVII4]	MROM	65.28	3.07	14.67	16.68	0.30	nd	0.01	0.00	ND
1276	CATW	TW	H	SNT	8	TYPE 1	Cat 152 <137> [F VII 7]	C4AD	90.22	0.21	1.33	7.64	0.58	nd	0.03	0.00	ND
1277	CATW	TW	T	PEND	4		Cat 204 <108> [JXIII18]	C1AD	71.62	2.19	16.72	9.13	0.35	nd	nd	nd	ND
1278	CATW	TW	P/H	PIN	1		Cat 125 <80> [E VI 14]	C3AD	83.14	1.02	7.01	8.58	0.10	nd	nd	nd	ND
1280	CATW	TW	P/H	PIN	1		Cat 20 <183> [P III 17]	C3AD	87.38	7.34	0.00	4.98	0.30	nd	nd	nd	ND
1281	CATW	TW	P/H	PIN	1		Cat 124 <18> [GV3]	C4AD	91.51	5.14	0.24	2.82	0.29	nd	nd	nd	ND
1282	CATW	TW	H	DROPHD			Cat 191 <231> [FXXV13]	C4AD	91.75	0.76	0.40	6.89	0.20	nd	nd	nd	ND

XRFID	SITEID	SITETYPE	CLASS	O-TYPE	REF	DESCRIPTION	CATALOGUE, etc	DATE	Cu	Zn	Pb	Sn	Fe	Ni	Mn	As	Co
1283	CATW	TW	M?	LOHG			Cat 171 <101> [JXIII13]	EROM	83.03	13.71	0.31	2.43	0.42	nd	nd	0.10	ND
1285	CATW	TW	P	ARMLET	4		Cat 50 <33> [FXIII5a]	C4AD	83.69	4.33	3.01	8.14	0.20	nd	0.02	nd	ND
1286	CATW	TW	M	BTSF			Cat 164 [J XIII 14]	C3AD	82.50	14.36	nd	2.69	0.23	nd	nd	0.22	ND
1287	CATW	TW	T	LMOUNT		CIRCLE AND BOSS	Cat 209 <11> [LII2]	C4AD	79.35	0.97	10.02	9.35	0.30	nd	nd	nd	ND
1289	CATW	TW	H	SNT	8	TUPE 1	Cat 149 <66> [GVIII5]	C4AD	78.34	6.91	10.37	4.13	0.26	nd	nd	nd	ND
1290	CATW	TW	H	SNT	?		Cat 144 <79> [DXI33]	C2AD	80.42	10.89	2.66	5.48	0.56	nd	nd	nd	ND
1291	CATW	TW	M	BTSF			Cat 162 <90> [EVI15]	C3AD	81.99	15.94	0.90	0.82	0.35	nd	nd	nd	ND
1293	CATW	TW	P	RING	6		Cat 77 <184> [GXXII6]	C4AD	88.46	1.42	4.91	5.00	0.20	nd	nd	nd	ND
1295	VIND	FT	W?	DROPLT			[4655]	C2AD	90.63	0.94	4.13	4.17	0.12	nd	nd	nd	ND
1296	VIND	FT	I?				[4512]	C2AD	76.83	21.27	0.26	1.22	0.35	0.06	nd	nd	ND
1297	VIND	FT	?	SHEET			[4514]	C2AD	96.06	nd	0.31	3.43	0.20	nd	nd	nd	ND
1298	VIND	FT	H	SNT	7		[4658]	C2AD	75.77	22.76	nd	1.15	0.31	nd	0.01	nd	ND
1299	VIND	FT	S?	SHEET			[4655]	C2AD	98.30	nd	0.36	1.22	0.11	nd	nd	nd	ND
1300	VIND	FT	H	SNT	12		[4669]	C2AD	96.38	nd	nd	3.07	0.24	nd	nd	nd	ND
1301	VIND	FT	H?	SNT	12	UNFINISHED	[4669]	C2AD	98.10	nd	0.23	1.46	0.17	nd	0.03	nd	ND
1302	VIND	FT	H	D-CLIP			[4698]	C2AD	95.80	nd	nd	3.93	0.06	nd	nd	nd	ND
1303	VIND	FT	?	SHEET			[4655]	C2AD	96.49	nd	0.20	3.19	0.12	nd	nd	nd	ND
1304	VIND	FT	H?	SNT	12	UNFINISHED	[4698]	C2AD	97.19	nd	0.37	2.08	0.29	nd	0.07	nd	ND
1305	VIND	FT	W?				[4619]	C2AD	83.99	9.38	3.73	2.67	0.23	nd	nd	nd	ND
1306	VIND	FT	?	SHEET			[4572]	C2AD	92.79	nd	nd	6.77	0.20	nd	0.02	nd	ND
1307	VIND	FT	?	SHEET			[4655]	C2AD	97.25	nd	nd	2.64	0.11	nd	nd	nd	ND
1308	VIND	FT	W?	DROPLT			[4699]	C2AD	78.09	7.04	10.42	3.92	0.27	nd	nd	nd	ND
1309	VIND	FT	?	SHEET			[4655]	C2AD	96.59	0.00	0.38	2.72	0.14	nd	nd	0.17	ND
1310	VIND	FT	W?	DROPLT			[4566]	C2AD	85.80	9.37	0.98	3.74	0.11	nd	nd	nd	ND
1311	VIND	FT	?				[4655]	C2AD	88.17	nd	0.17	11.60	0.06	nd	nd	nd	ND
1312	VIND	FT	H?	SNT	12	UNFINISHED	[4589]	C2AD	95.60	nd	0.23	3.67	0.08	nd	0.01	nd	ND
1313	VIND	FT	?	SHEET			[4575]	C2AD	81.43	15.99	nd	2.07	0.27	0.05	nd	nd	ND
1314	VIND	FT	?	STRIP			[4655]	C2AD	89.93	nd	0.37	9.25	0.16	nd	0.01	nd	ND
1315	VIND	FT	?	SHEET			[4669]	C2AD	95.26	nd	1.34	2.95	0.06	nd	nd	0.17	ND
1316	VIND	FT	I?				[5050]	C2AD	82.07	16.24	0.25	1.10	0.34	nd	nd	nd	ND
1317	VIND	FT	W?	DROPLT			[5947]	C2AD	77.95	5.15	10.29	6.29	0.32	nd	nd	nd	ND
1318	VIND	FT	?	STRIP			[3700]	C2AD	83.10	14.22	0.48	1.96	0.25	nd	nd	nd	ND
1319 a	VIND	FT	?	SHEET		REPAIRED	[4260]	C2AD	96.73	nd	nd	3.19	0.08	nd	nd	nd	ND
1319 b	VIND	FT	H	SNT	12		[4260]	C2AD	98.42	nd	nd	1.13	0.28	nd	nd	0.17	ND
1320	VIND	FT	?	SHEET		DOMED	[5265]	C2AD	85.81	nd	0.95	12.92	0.12	nd	0.01	nd	ND
1321	VIND	FT	M	LOLP			[3453]	C2AD	76.97	21.81	nd	1.06	0.16	nd	0.01	nd	ND
1322	VIND	FT	M	SCAR			[5337]	C2AD	79.63	19.53	nd	0.60	0.24	nd	nd	nd	ND
1323	VIND	FT	M	BUCKLE			[5041]	C2AD	78.41	0.11	11.13	10.10	0.10	nd	nd	nd	ND
1324	VIND	FT	T	JNTLP			[5083]	C2AD	83.61	16.03	0.16	nd	0.20	nd	nd	nd	ND
1325	VIND	FT	?	U-BIND			[4175]	C2AD	79.01	18.77	0.38	1.37	0.30	nd	nd	nd	ND
1326	VIND	FT	H	DROPHD			[4639]	C2AD	80.37	17.74	0.25	1.30	0.33	nd	0.01	nd	ND

XRFID	SITEID	SITETYPE	CLASS	O-TYPE	REF	DESCRIPTION	CATALOGUE, etc	DATE	Cu	Zn	Pb	Sn	Fe	Ni	Mn	As	Co
1327	VIND	FT	?	SHEET			[4661]	C2AD	95.69	nd	nd	4.20	0.11	nd	0.01	nd	ND
1328	VIND	FT	M?	SCAR		?	[6100]	C2AD	98.14	nd	nd	1.63	0.24	nd	nd	nd	ND
1329	VIND	FT	M	SCAR			[5392]	C2AD	78.24	19.46	0.34	1.47	0.33	0.05	0.01	nd	ND
1330	VIND	FT	P	PAB	1	A3	[3845]	C2AD	90.39	1.23	1.69	6.61	0.08	nd	nd	nd	ND
1331	VIND	FT	P?	RING	6		[3291]	C2AD	79.43	18.58	nd	1.44	0.29	0.07	nd	nd	ND
1332 a	VIND	FT	H	SNT	3		[5163]	C2AD	81.22	16.72	0.20	1.33	0.36	nd	nd	nd	ND
1332 b	VIND	FT	H	CHAIN			[5163]	C2AD	94.56	1.93	0.87	2.60	0.04	nd	nd	nd	ND
1333	VIND	FT	P	PAB	?	PIN	[4021]	C2AD	90.62	0.12	nd	8.98	0.16	nd	nd	0.11	ND
1334	VIND	FT	H	SNT	3		[5274]	C2AD	79.85	17.66	0.43	1.78	0.28	nd	nd	nd	ND
1335	VIND	FT	H	SNT6			[4015]	C2AD	75.56	22.70	0.18	1.16	0.16	0.05	0.01	nd	ND
1336	VIND	FT	H	KNIFE			[1830]	C2AD	89.68	1.34	2.00	6.79	0.18	nd	0.01	nd	ND
1337	VIND	FT	H	NEEDLE			[5263]	C2AD	81.70	14.60	0.00	3.46	0.23	nd	nd	nd	ND
1338	VIND	FT	H?	PIN	1		[5406]	C2AD	86.00	7.83	0.60	5.18	0.21	nd	nd	nd	ND
1339	VIND	FT	H	TLIM	1		[3850]	C2AD	81.93	15.91	0.51	1.42	0.31	nd	nd	nd	ND
1340	VIND	FT	H	PIN	?		[4455]	C2AD	95.64	0.32	0.77	3.02	0.25	nd	nd	nd	ND
1341	KIRK	BL	T	STJN			Fig 41, 1 <KR/BD>	EIA	88.93	nd	0.45	9.32	0.11	nd	nd	0.22	0.10
1342	KIRK	BL	P/T	B&L	?		Fig 46, 1 <KR/AR>	EIA	86.56	nd	1.08	11.66	0.16	nd	nd	0.30	0.00
1343	KIRK	BL	P/T	TOGGLE			Fig 46, 3 <KR/DD>	EIA	8.34	nd	1.50	14.81	0.51	nd	0.01	0.51	0.05
1344	KIRK	BL	P/T	BUGLE			Fig 46, 2 <KR/AQ>	EIA	89.78	nd	nd	9.37	0.18	nd	nd	0.31	0.02
1345	KIRK	BL	T	TRT	1		Fig 40, 3 <KR/AV>	EIA	87.37	nd	0.59	11.79	0.31	nd	nd	nd	0.00
1346	KIRK	BL	T	TRT	1		Fig 40, 5 <KR/AU>	EIA	85.20	nd	0.43	13.59	0.49	nd	nd	nd	0.00
1347 a	KIRK	BL	T	HSBT			Fig 44, 1 <KR/BF>	EIA	86.07	nd	3.45	10.72	0.12	nd	0.02	nd	0.00
1347 b	KIRK	BL	T	HSBT			Fig 44 <KR/BF>	EIA	86.67	nd	1.51	10.49	1.22	nd	nd	nd	0.02
1348 a	KIRK	BL	T	LINCHP			Fig 37, 1 <KR/AY>	EIA	83.75	nd	nd	15.04	0.41	nd	nd	0.79	0.14
1348 b	KIRK	BL	T	LINCHP			Fig 37, 1 <KR/AY>	EIA	86.07	nd	0.74	11.50	0.31	0.06	nd	0.44	0.11
1349	KIRK	BL	T	TRT	4		Fig 37, 2 <KR /AY>	EIA	85.86	nd	0.77	12.35	0.10	nd	nd	0.43	0.12
1350	BURT	BL	P	BB	3		Fig 117, 1 <FR/BU>	EIA	87.60	nd	nd	11.81	0.09	nd	0.01	0.21	0.00
1351	RUDG	BL	P	BB	1		Fig 104, 2 <FM/BR>	EIA	88.86	nd	nd	10.43	0.15	nd	nd	nd	0.00
1352	RUDG	BL	P	ARMLET	2		Fig 66, 1 <FN/AA>	EIA	89.97	nd	0.80	8.10	0.42	nd	0.01	0.18	0.02
1353	BURT	BL	P	BB	2		Fig 120, 1 <FZ/BH>	EIA	88.02	nd	0.23	10.97	0.06	nd	nd	0.10	0.00
1354	BURT	BL	P	BEAD			Fig 120, 3 <FZ/AY>	EIA	89.64	nd	0.35	8.70	0.49	nd	nd	0.31	0.00
1356	WATC	FT	P	PAB	3		<197> [BCF]	ROMN	86.69	0.76	0.44	11.84	0.08	nd	nd	nd	ND
1357	WATC	FT	W				KM 80/201	ROMN	93.34	nd	0.20	6.05	nd	nd	nd	0.24	ND
1358	WATC	VC	P	B&L	3		Fig 85, 29 <273>	C2AD	88.05	0.32	0.21	11.05	nd	0.09	nd	nd	ND
1359	WATC	FT	H	BRACKT			Fig 86, 66 <149>	ROMN	78.08	11.34	5.16	4.46	0.67	nd	0.01	nd	ND
1361	WATC	FT	S?	FSHEET			Fig 86, 70 <238>	ROMN	96.83	nd	0.29	2.75	0.11	nd	nd	nd	ND
1362	WATC	FT	P	BB	10	ACANTHUS ALL	KM 80/63	ROMN	78.25	11.47	5.42	4.16	0.70	nd	nd	nd	ND
1363	WATC	FT	P	BB	10	ACANTHUS ALL	Fig 84, 8 <275>	ROMN	84.70	11.53	0.26	3.39	0.12	nd	nd	nd	ND
1365	WATC	VC	P	BB	10	? ALL	Fig 84, 5 <340>	C2AD	80.37	15.90	1.72	1.84	0.16	nd	nd	nd	ND
1366	WATC	FT	P/H	ARMLET	1		Fig 85, 45 <225>	C1AD	68.09	nd	27.95	3.49	0.12	0.06	nd	nd	ND
1367	WATC	VC	P	PLB	3	DUCK (3-D)	Fig 84, 17 <252>	C2AD	91.03	0.58	4.54	3.64	0.21	nd	nd	nd	ND

XRFID	SITEID	SITETYPE	CLASS	O-TYPE	REF	DESCRIPTION	CATALOGUE, etc	DATE	Cu	Zn	Pb	Sn	Fe	Ni	Mn	As	Co
1368	WATC	FT	H?	?			Fig 85, 27 <36>	ROMN	78.64	1.97	10.45	8.24	0.39	nd	nd	nd	ND
1369	WATC	FT	H	SNT	8	TYPE 1	Fig 85, 31 <253>	C2AD	75.80	7.05	8.77	8.16	0.22	nd	nd	nd	ND
1370	WATC	FT	T	HARNSS			Fig 84, 19 <159>	C3AD	68.95	8.06	15.44	6.95	0.59	nd	0.01	nd	ND
1371	WATC	VC	P	BB	10	ACANTHUS ALL	Fig 84, 9 <276>	C2AD	79.02	15.72	2.18	2.72	0.37	nd	nd	nd	ND
1372	WATC	FT	H	TONGS			Fig 86, 59 <86>	C2AD	97.23	nd	0.73	1.89	0.14	nd	0.01	nd	ND
1373	WATC	FT	H	SNT	4		Fig 85, 30 <117>	C3AD	70.87	0.96	15.14	12.46	0.25	nd	nd	nd	ND
1374	WATC	VC	T	LINCHP			Fig 85, 24 <154>	C3AD	82.25	8.91	4.34	3.98	0.51	nd	nd	nd	ND
1375	WATC	VC	T	BTRG			Fig 85, 44 <260>	C2AD	85.23	3.48	5.16	6.03	0.11	nd	nd	nd	ND
1376	WATC	VC	H	SLB			Fig 86, 65 <150>	C2AD	81.91	1.91	13.23	3.62	0.05	nd	nd	nd	ND
1377	WATC	FT	T/H	PENDWT			Fig 85, 43 <452>	C4AD	74.39	5.24	11.49	8.41	0.27	nd	nd	nd	ND
1378	WATC	VC	P	BB	10	NO ACANTHUS HALF	Fig 84, 6 <300>	C2AD	84.63	12.89	0.23	1.86	0.13	nd	nd	nd	ND
1379	WATC	FT	H	TLIM	?		Fig 86, 54 <450>	C3AD	80.64	18.17	0.20	0.70	0.30	nd	nd	nd	ND
1381	WATC	VC	H	MIRROR			Fig 86, 61 <207>	C2AD	46.01	nd	25.80	27.60	0.15	nd	nd	nd	ND
1382	WATC	FT	P	PLB	1		Fig 84, 15 <403>	C2AD	76.47	2.15	8.87	11.87	0.64	nd	nd	nd	ND
1383	WATC	VC	P	BB	7	?T-SHAPED CF POLDEN	Fig 84, 3 <279>	C1AD	87.51	2.23	1.17	8.73	0.35	nd	nd	nd	ND
1384	WATC	VC	P	PLB	5	cf BULMER H1	Fig 84, 14 <261>	C2AD	80.20	3.12	4.99	10.96	0.16	nd	nd	nd	ND
1385	WATC	FT	W	DROP			<223> [ACE]	ROMN	88.65	1.11	3.21	6.76	0.08	nd	0.01	nd	ND
1386	WATC	FT	W	DROP			<164> [ARA]	ROMN	84.80	4.69	4.91	5.19	0.08	nd	nd	0.32	ND
1387	WATC	FT	H	VESSEL	BU	LL'S HEAD MOUNT	?	ROMN	77.59	0.15	14.84	6.96	0.07	nd	0.01	0.21	ND
1388	WATC	FT	P	PLB	5	cf BULMER D3	?	ROMN	85.48	11.65	0.32	2.11	0.29	nd	nd	nd	ND
1389	KYTH	SF	H	SCALP			KM ?/105	ROMN	85.07	0.12	2.94	11.45	0.42	nd	nd	nd	ND
1390	WATC	FT	W				KM 79/241	ROMN	77.18	10.46	7.46	4.56	0.35	nd	nd	nd	ND
1391	WATC	FT	?	SHEET		CELTIC SHEET	?	ROMN	81.61	15.54	1.36	1.35	0.14	nd	0.01	nd	ND
1392	MILK	SR	P	PLB	5	BULMER H2	Fig 5	ROMN	89.64	0.12	0.39	9.10	0.37	nd	nd	0.38	ND
1393	MANC	VC	P	PLB	1		Cat 15 <1007> [265]	ROMN	67.54	0.30	25.92	5.78	0.07	nd	nd	0.38	ND
1394	MANC	VC	H	LOOP			Cat 14 <105> [400]	ROMN	84.98	13.13	1.16	nd	0.09	nd	nd	0.63	ND
1395	MANC	VC	H	SLB			Cat 7 <234> [567]	ROMN	83.20	2.15	6.05	7.74	0.44	nd	0.01	0.41	ND
1396	MANC	VC	P	BB	7		Cat 2	ROMN	85.60	8.78	2.26	3.09	0.26	nd	nd	nd	ND
1397	MANC	VC	P	BB	10	NO ACANTHUS ALL	Cat 12 <1079>	ROMN	84.93	11.38	2.10	1.33	0.25	nd	nd	nd	ND
1398	MANC	VC	P?	PAB	?		Cat 20 <239> [567]	ROMN	81.11	18.34	nd	0.29	0.13	nd	nd	0.13	ND
1400	MANC	VC	H	?		FOLDING FOOT RULE	Fig 44, 23 <307>	ROMN	81.73	17.54	0.55	nd	0.17	nd	0.01	nd	ND
1402	MANC	VC	P	PAB	3		MC72 <308> [1 265]	ROMN	83.69	3.03	3.60	8.63	1.01	nd	0.02	nd	ND
1404	MANC	VC	H	V.FIT			Fig 44, 24 <282>	ROMN	80.50	0.50	13.42	5.48	0.09	nd	nd	nd	ND
1405	MANC	VC	T	HMOUNT			Fig 44, 14 <273>	ROMN	73.41	15.74	8.56	1.69	0.61	nd	nd	nd	ND
1406	MANC	VC	W				MC72 <84> [1 510]	ROMN	74.35	10.29	4.12	10.86	0.37	nd	nd	nd	ND
1408	MANC	VC	H	SNT	4	TRISKELE	Fig 44, 20 <90>	ROMN	88.02	0.25	0.40	11.25	0.07	nd	nd	nd	ND
1409	MANC	VC	T	HMOUNT			Fig 44, 13 <325>	ROMN	77.10	15.86	4.38	2.37	0.29	nd	0.01	nd	ND
1410	MANC	VC	P/H	RING	2	CIRCULAR	MC72 <300> [2 252]	ROMN	91.97	nd	0.26	7.58	nd	nd	0.02	0.18	ND
1411	MANC	VC	S	FSHEET			MC 72 <143> [2 108]	ROMN	96.75	nd	0.97	1.50	0.30	nd	0.01	nd	ND
1412	MANC	VC	W				MC72 <208> [4 140]	ROMN	83.06	1.30	6.67	8.29	0.51	nd	0.01	0.17	ND
1413	MANC	VC	H	U-BIND			Cat 8 <80> [324]	ROMN	88.61	0.50	0.38	9.44	0.13	nd	0.01	nd	ND

XRFID	SITEID	SITETYPE	CLASS	O-TYPE	REF	DESCRIPTION	CATALOGUE, etc	DATE	Cu	Zn	Pb	Sn	Fe	Ni	Mn	As	Co
1415	MANC	VC	P	BB	10	? HALF	Cat 17 <1245> us	ROMN	81.91	16.95	0.49	0.40	0.25	nd	nd	nd	ND
1418	MANC	VC	H	SNT	3		Cat 1 <305> [556]	ROMN	73.58	2.54	12.19	10.97	0.58	nd	0.01	nd	ND
1419	MANC	VC	H	TLIM	6		Cat 11 <126> [421]	ROMN	84.95	3.47	1.44	9.88	0.09	nd	nd	0.18	ND
1420	MANC	VC	?	SNT	?		MC77 <41> [221]	ROMN	90.43	1.35	4.94	3.29	nd	nd	nd	nd	ND
1421	MANC	VC	P	BB	11	HEADSTUD	Cat 7 <54> [237]	ROMN	86.12	0.57	1.11	11.88	0.07	0.07	nd	0.17	ND
1423	MANC	VC	M	SCRN			MC78 <2> [1506]	ROMN	78.29	0.43	9.72	10.65	0.05	0.10	nd	nd	ND
1424	MANC	VC	P	BB	11	HEADSTUD	Cat 9 <508> [222]	ROMN	91.27	0.48	1.85	6.35	0.05	nd	nd	nd	ND
1425	MANC	VC	P	BB	11	HEADSTUD	Cat 6 <145> [490]	ROMN	80.99	17.30	0.90	0.61	0.19	nd	nd	nd	ND
1426	MANC	VC	H	SNT	4		MC78 <65> [260]	ROMN	77.92	1.33	11.11	9.30	0.34	nd	0.02	nd	ND
1427	MANC	VC	P	BB	7		Cat 3	ROMN	77.47	nd	11.05	11.42	0.06	nd	nd	nd	ND
1428	MANC	VC	P	BB	10	NO ACANTHUS ALL	Cat 11 <2> [103]	ROMN	79.61	7.54	7.95	4.77	0.14	nd	nd	nd	ND
1430	MANC	VC	H	RING	2	CIRCULAR	Cat 4 <170> [440]	ROMN	77.58	11.44	6.52	3.89	0.58	nd	nd	nd	ND
1433	MANC	VC	T	PEND	?		MC78 <75>	ROMN	85.43	nd	0.47	13.97	0.12	nd	nd	nd	ND
1434	MANC	VC	P	BB	11	HEADSTUD	Cat 1 <1> [103]	ROMN	82.52	0.41	2.24	14.38	0.16	0.13	0.02	0.15	ND
1436	MANC	VC	P	PAB	1	A3	Cat 19 <219> [585/6]	ROMN	85.58	0.85	4.41	8.97	0.16	nd	0.02	nd	ND
1437	EDCS	HF	P	PAB	1	A3	<366> [522]	ROMN	79.71	1.88	9.49	7.88	0.22	nd	nd	nd	ND
1438	EDCS	HF	H	PIN		?	<357> [493]	ROMN	84.58	2.12	2.37	9.54	0.70	nd	0.01	nd	ND
1439 a	KIRK	BL	T	HSBT			Fig 44, 2 <KR/BH>	EIA	84.31	nd	2.65	12.78	0.24	nd	0.01	nd	0.00
1439 b	KIRK	BL	T	HSBT			Fig 44, 2 <KR/BH>	EIA	85.35	nd	2.53	11.70	0.12	nd	0.02	0.28	0.03
1440 a	KIRK	BL	T	LINCHP			Fig 38 <KR/BM>	EIA	85.62	nd	nd	13.15	0.47	nd	nd	0.77	0.18
1440 b	KIRK	BL	T	LINCHP			Fig 38 <KR/BM>	EIA	83.84	nd	0.64	14.85	0.23	nd	nd	0.44	0.16
1441	KIRK	BL	T	TRT	4		Fig 38 <KR/BM>	EIA	85.71	0.11	1.35	12.57	0.06	nd	nd	0.19	0.10
1442	KIRK	BL	T	TRT	1		Fig 40	EIA	85.03	nd	1.30	12.98	0.69	nd	nd	nd	0.00
1443	KIRK	BL	T	TRT	1		Fig 40	EIA	90.28	nd	0.43	9.03	0.14	nd	nd	0.12	0.00
1444	KIRK	BL	T	TRT	1		Fig 40	EIA	86.01	0.13	0.33	12.74	0.80	nd	nd	nd	0.04
1445	KIRK	BL	T	STJN			Fig 41, 2 <KR/BE>	EIA	87.02	nd	nd	12.55	0.11	nd	nd	0.26	0.05
1446	GLBF	SR	P/H	RING	2	CIRCULAR	<1181> [305]	C3AD	49.80	nd	42.93	6.28	0.00	nd	0.02	nd	ND
1447	GLBF	SR	P	BB	11	? AESICA	<1217> [1 A]	EROM	83.52	13.51	0.89	1.63	0.31	nd	0.01	0.13	ND
1448	GLBF	SR	P/H	ARMLET	4	REUSED AS A STYLUS?	<1237> [115]	C3AD	85.34	nd	2.73	11.93	nd	nd	nd	nd	ND
1449	GLBF	SR	P/T	TOGGLE			<1214> [524]	C3AD	85.35	2.06	5.80	6.71	0.08	nd	nd	nd	ND
1450	GLBF	SR	P	BB	18		<1161> [1 A]	C1AD	80.18	18.71	nd	0.56	0.36	0.07	nd	0.13	ND
1451	GLBF	SR	H	TLIM			<1123> [149]	LROM	87.39	11.32	nd	0.80	0.18	nd	nd	0.31	ND
1453	WEWO	VL	P/M	BTPL	2	TWO TRUMPET MOTIFS	<29> [MA 16a]	C4AD	69.72	3.24	20.00	6.90	0.13	nd	nd	nd	ND
1454	WEWO	VL	P/H	RING	2	SQUARE	<138> [MA 120b]	C4AD	87.08	2.12	0.93	9.65	0.21	nd	nd	nd	ND
1455	WEWO	VL	H	SNT	12		<141> [MA 20/12b]	C2AD	95.77	nd	0.35	3.05	0.29	nd	nd	nd	ND
1456	WEWO	VL	?	FRAG			<267> [MD 25a]	C3AD	82.40	8.73	1.99	5.75	0.37	0.05	0.01	nd	ND
1458	WEWO	VL	?	FSHEET		POSS U-BIND	<528> [MG 115a]	C2AD	84.70	11.89	0.22	2.54	0.25	0.06	0.01	nd	ND
1459	WEWO	VL	?	SHEET			<487> [MF 23a]	C2AD	92.14	nd	0.21	6.74	0.20	nd	nd	nd	ND
1460	WEWO	VL	?	STRIP			<30> [MA 27a]	C4AD	88.83	0.11	2.47	6.90	0.69	nd	0.02	nd	ND
1461	WEWO	VL	?	SHEET		REPOUSSE DOTS & HOLES	<180> [MC 175a]	C3AD	88.45	0.73	2.60	6.06	1.13	0.08	0.04	nd	ND
1462	WEWO	VL	P	PIN	1	BROOCH PIN ?	<344> [MC 222a]	MROM	87.68	5.48	0.60	5.62	0.17	nd	nd	nd	ND

XRFID	SITEID	SITETYPE	CLASS	O-TYPE	REF	DESCRIPTION	CATALOGUE, etc	DATE	Cu	Zn	Pb	Sn	Fe	Ni	Mn	As	Co
1463	WEWO	VL	H	SNT	12		<418> [MF 7a]	C2AD	75.47	22.75	0.70	0.91	0.16	nd	0.01	nd	ND
1464	NCAV	VL	I	INGOT			<1> us	ROMN	81.50	13.31	1.24	3.71	0.23	nd	0.01	nd	ND
1465	WEWO	VL	?	FSHEET			<124> [MA 120b]	C4AD	77.93	20.62	0.47	0.44	0.37	nd	0.01	nd	ND
1466	WEWO	VL	?	SHEET			<136> [MA 20/12b]	C2AD	76.74	22.29	0.46	0.15	0.34	nd	nd	nd	ND
1467	WEWO	VL	H	SNT	12		<52> [MA 20/12b]	C2AD	73.69	25.99	nd	nd	0.16	nd	nd	nd	ND
1468	WEWO	VL	I?	ROD		UNFINISHED OBJECT?	<215> [MC 173a]	C3AD	95.72	1.35	1.50	1.42	nd	nd	nd	nd	ND
1469	WEWO	VL	?	SHEET			<81> [MB 1c]	C4AD	80.43	12.36	2.59	3.31	0.66	0.09	0.01	0.32	ND
1470	WEWO	VL	I?	ROD		UNFINISHED OBJECT?	<340> [MD 1b]	C4AD	93.70	nd	1.89	2.05	0.00	nd	nd	nd	ND
1471	WEWO	VL	P	ARMLET	6	REPAIRED WITH RIVET	<101> [MB 1c]	C4AD	76.45	15.20	4.03	3.48	0.30	0.05	0.01	nd	ND
1472 a	WEWO	VL	P/M	BTPL			<129> [MA 27/2b]	C4AD	94.69	2.18	1.47	1.42	0.11	nd	nd	nd	ND
1472 b	WEWO	VL	?	STRIP			<129> [MA 27/2b]	C4AD	79.06	15.73	1.06	3.52	0.26	0.05	0.01	nd	ND
1473	WEWO	VL	?	SHEET			<41> [MA 31a]	LROM	79.96	18.03	1.84	nd	0.10	0.07	nd	nd	ND
1474	WEWO	VL	W?	DROPLT			<341> [MD 1a]	C4AD	80.26	1.42	9.71	8.51	0.09	nd	nd	nd	ND
1476	WEWO	VL	H	SNT	1	SHEET RIVET SHANK	<35> [MA 20/13a]	C3AD	83.04	10.45	1.92	4.29	0.30	nd	nd	nd	ND
1477	WEWO	VL	H	SNT	11		<47> [MA 20/12a]	C2AD	84.22	14.00	0.45	0.83	0.22	nd	nd	0.28	ND
1478	WEWO	VL	?	?		PLAQUE	<53> [MA 20/12b]	C2AD	73.50	14.59	8.46	3.10	0.34	nd	0.01	nd	ND
1479	WEWO	VL	W?	DROPLT			<328> [MA 20/12b]	C2AD	86.51	1.90	2.40	9.10	0.08	nd	nd	nd	ND
1482	WEWO	VL	?	SHEET			<246> [MD 1a]	C4AD	87.53	6.81	0.48	4.95	0.23	nd	nd	nd	ND
1483	WEWO	VL	H	VESSEL		JUG LID	<536> [MG 132]	C2AD	56.66	nd	42.02	1.35	nd	nd	nd	nd	ND
1484	WEWO	VL	P/H	PIN	1		<476> [ME 25 III a]	C3AD	78.98	12.47	nd	7.46	0.21	nd	0.01	0.17	ND
1485	WEWO	VL	?	SHEET			<9> [MA 5a]	LROM	89.72	1.08	0.60	7.76	0.18	nd	nd	nd	ND
1486 a	WEWO	VL	P	PAB	1	A1/A3	<468> [ME 50]	C3AD	80.13	18.31	nd	1.26	0.25	nd	nd	nd	ND
1486 b	WEWO	VL	P	PAB		PIN TO 1486a	<468> [ME 50]	C3AD	90.86	4.38	1.02	3.65	0.09	nd	nd	nd	ND
1487	WEWO	VL	P	BB	11	HEADSTUD	<507> [MG 18a]	EROM	73.58	1.08	17.66	7.40	0.17	nd	nd	nd	ND
1488	WEWO	VL	?	SHEET		PIERCED	<206> [MC 9b]	C2AD	87.11	nd	nd	12.89	nd	nd	nd	nd	ND
1489	WEWO	VL	T	PEND	2	PARTIALLY MELTED	<116> [MA 120b]	EROM	80.26	17.19	0.71	1.57	0.27	nd	nd	nd	ND
1490	WEWO	VL	?	STRIP			<152> [MC 8e]	C2AD	79.18	20.16	nd	0.13	0.19	0.06	0.01	0.10	ND
1491	WEWO	VL	?	?		LARGE CHAIN LINK ?	<93> [MC 16a]	C4AD	87.15	0.81	1.52	10.39	0.12	nd	nd	nd	ND
1492	WEWO	VL	H	VESSEL		SHEET WITH RIVET RIM	<159> [MA 135a]	C4AD	87.00	nd	1.99	10.95	0.07	nd	nd	nd	ND
1494	WEWO	VL	?	?		HEMISPHERICAL FITTING	<425> [MF 52]	?	88.20	7.97	nd	3.66	0.17	nd	nd	nd	ND
1496	WEWO	VL	?	SHEET			<211> [MA 185a]	C4AD	84.66	nd	1.43	12.78	0.05	nd	nd	nd	ND
1497	NCAV	SR	P	PAB	1	A3	<2> us	ROMN	79.11	18.82	nd	1.54	0.53	nd	nd	nd	ND
1498	WEWO	VL	P	BB	12	HEADSTUD	<205> [MC 8e]	C2AD	88.17	nd	0.75	10.99	nd	nd	nd	nd	ND
1499	WEWO	VL	P	CHAIN			<140> [MA 20/12b]	C2AD	79.92	18.63	0.99	0.27	0.18	nd	nd	nd	ND
1500	WEWO	VL	P	CHAIN			<143> [MC 172k]	C3AD	79.19	20.33	nd	0.17	0.20	nd	nd	0.15	ND
1502	WEWO	VL	P	CHAIN			<229> [MC 173a]	C3AD	81.26	16.86	0.32	1.12	0.15	nd	nd	nd	ND
1503	WEWO	VL	P/H	?		UNFINISHED IMPLEMENT?	<228> [MC 50a]	C3AD	81.03	16.95	0.34	1.58	0.11	nd	nd	nd	ND
1504	WEWO	VL	P	PAB	1	A3	<211> [MC 8c]	C2AD	84.90	9.98	1.60	2.18	1.34	nd	nd	nd	ND
1505	WEWO	VL	P	PAB	1	A2	<34> [MA us]	?	87.27	0.14	3.15	9.35	0.10	nd	nd	nd	ND
1506	SETA	CV	H	VESSEL			Lord 1	ROMN	67.58	nd	24.58	3.14	0.28	0.19	nd	0.83	ND
1509	SETA	CV	P	PLB	5	FEACHEM I	Lord 4	EROM	85.96	0.62	3.75	9.45	0.22	nd	nd	nd	ND

XRFID	SITEID	SITETYPE	CLASS	O-TYPE	REF	DESCRIPTION	CATALOGUE, etc	DATE	Cu	Zn	Pb	Sn	Fe	Ni	Mn	As	Co
1511	SETA	CV	P	PLB	1		Lord 6	ROMN	80.86	5.42	6.16	6.88	0.37	nd	0.03	0.27	ND
1512	SETA	CV	P	BB	10	ACANTHUS HALF	Lord 7	EROM	82.75	10.17	2.18	4.56	0.18	nd	nd	0.15	ND
1513	SETA	CV	P	RING	3		Lord 8	ROMN	80.91	16.06	1.78	1.01	0.23	nd	0.02	nd	ND
1514	SETK	CV	P	PLB	1		Lord 9	ROMN	80.48	7.65	4.02	7.42	0.40	nd	0.02	nd	ND
1515	SETS	CV	P	BB	?	EARLY HINGED	Lord 10	EROM	86.35	1.97	0.23	10.85	0.51	nd	nd	0.10	ND
1516	SETS	CV	P	BB	10	ACANTHUS ALL	Lord 11	EROM	79.79	0.92	11.58	7.67	0.05	nd	nd	nd	ND
1517	SETS	CV	P	BB	9	ACANTHUS ALL	Lord 12	EROM	83.59	9.44	2.96	3.76	0.25	nd	nd	nd	ND
1518	SETS	CV	P	BB	10	NO ACANTHUS HALF	Lord 13	EROM	84.63	11.29	1.73	1.72	0.63	nd	nd	nd	ND
1519	SETS	CV	P	PLB	5	FEACHEM II	Lord 14	EROM	88.05	8.57	0.69	1.71	0.18	nd	nd	0.68	ND
1520	SETS	CV	H?	RING	2	HEXAGONAL	Lord 15	ROMN	82.57	5.01	6.14	5.99	0.30	nd	nd	nd	ND
1521	SETS	CV	?	SHEET			Lord 16	ROMN	83.07	0.51	1.82	13.17	0.07	nd	nd	nd	ND
1522	SETS	CV	?	SHEET			Lord 17	ROMN	86.27	0.52	0.00	11.76	0.05	nd	nd	0.12	ND
1524	SETS	CV	?	SHEET			Lord 19	ROMN	85.94	nd	0.23	12.70	0.05	nd	nd	nd	ND
1525	SETS	CV	?	STRIP		RIVET HOLES?	Lord 20	ROMN	88.68	nd	nd	9.48	0.08	nd	0.04	0.43	ND
1526	SETS	CV	?	SHEET			Lord 21	ROMN	87.94	0.26	nd	9.90	0.11	nd	nd	0.46	ND
1527	SETS	CV	?	SHEET			Lord 22	ROMN	88.57	0.10	1.71	8.35	0.12	nd	nd	nd	ND
1528	SETC	CV	P	PLB	5	FEACHEM 40 BULMER H	Lord 24	EROM	79.57	6.03	3.23	10.93	0.16	nd	nd	nd	ND
1529	SETC	CV	P	PLB	5	HEAD ONLY FEACHEM 38	Lord 23	EROM	82.95	0.60	3.37	12.96	0.00	nd	nd	nd	ND
1530	SETJ	CV	H	SNT	8	TYPE 1	Lord 31	ROMN	73.04	0.62	15.78	9.45	1.11	nd	nd	nd	ND
1531	SETV	CV	H	SNT	4		Lord 30	ROMN	87.73	6.54	3.00	2.44	0.29	nd	nd	nd	ND
1532	SETV	CV	H	SNT	4		Lord 29	ROMN	85.76	6.40	3.21	4.42	0.21	nd	nd	nd	ND
1533	SETV	CV	H	SNT	4		Lord 28	ROMN	87.91	1.72	6.47	3.83	0.08	nd	nd	nd	ND
1534	SETV	CV	H	SNT	8	TYPE 1	Lord 27	ROMN	87.31	2.30	4.76	5.50	0.12	nd	nd	nd	ND
1535	SETV	CV	H	SNT	8	TYPE 1	Lord 26	ROMN	85.01	4.67	5.12	4.98	0.21	nd	nd	nd	ND
1536	SETF	CV	?	?		U-BIND FITTING	Lord 25	ROMN	88.12	0.89	0.75	10.08	0.15	nd	nd	nd	ND
1537	SHIP	NS	H	TLIM			<1228> [692]	C4AD	86.08	0.92	1.98	10.54	0.24	nd	nd	0.24	ND
1539	SHIP	NS	H	HANDLE		WIRE	<1748> [895]	C4AD	97.53	nd	0.31	1.64	0.15	nd	nd	nd	ND
1540	SHIP	NS	?	FRAG			<992> [506]	ROMN	87.83	9.58	1.17	1.08	0.33	nd	nd	nd	ND
1541	SHIP	NS	P	ARMLET	3		<863> [500+]	C4AD	86.44	nd	2.16	10.34	0.15	nd	0.02	nd	ND
1542	SHIP	NS	?	FRAG		RING OR WIRE	<1392> [817]	C4AD	87.34	nd	0.32	10.68	0.17	nd	nd	0.23	ND
1543	SHIP	NS	P	BB	12	HEADSTUD	<844> [501+]	EROM	76.92	14.30	3.34	5.07	0.35	nd	0.01	nd	ND
1544	SHIP	NS	?	SHEET		REPOUSSE DOTS	<1484> [846]	C4AD	86.34	6.45	1.09	5.26	0.26	nd	nd	nd	ND
1545	SHIP	NS	H	SNT		LION-HEAD	<307> [+]	ROMN	79.24	11.28	3.73	5.09	0.66	nd	nd	nd	ND
1546	SHIP	NS	P	BB	15		<772> [303]	MROM	81.09	1.77	8.36	8.67	0.12	nd	nd	nd	ND
1547	SHIP	NS	T	*MOUNT*		*DOUBLE PETAL AND BOSS*	*<789> [330]*	ROMN	77.55	0.40	8.96	12.99	0.11	nd	nd	nd	ND
1548	SHIP	NS	P	BB	10	? ALL	<1876> [845]	EROM	87.95	4.33	4.62	3.04	0.07	nd	nd	nd	ND
1549	SHIP	NS	W?	DROPLT			<1486> [848]	C4AD	86.80	1.70	0.98	9.26	0.19	nd	nd	nd	ND
1550	SHIP	NS	W?	DROPLT			<929> [525]	C4AD	77.80	nd	11.28	10.78	0.14	nd	nd	nd	ND
1551	SHIP	NS	W?	DROPLT			<815> [390]	ROMN	81.33	nd	nd	18.18	0.09	nd	nd	0.40	ND
1552	SHIP	NS	P	PLB	2	SWASH-N	<804> [328]	ROMN	80.48	0.56	5.44	13.04	0.23	nd	nd	0.26	ND
1553	SHIP	NS	P	BB	16	FOOT OF TRUMPET	<777> [323]	EROM	82.64	2.83	5.25	9.07	0.22	nd	nd	nd	ND

XRFID	SITEID	SITETYPE	CLASS	O-TYPE	REF	DESCRIPTION	CATALOGUE, etc	DATE	Cu	Zn	Pb	Sn	Fe	Ni	Mn	As	Co
1554	SHIP	NS	T	TRT	3		<1204> [636]	ROMN	68.54	1.14	17.55	12.69	0.09	nd	nd	nd	ND
1555	SHIP	NS	T	PEND	3		<661> [329]	ROMN	65.02	3.27	22.38	9.17	0.15	nd	0.01	nd	ND
1556	SHIP	NS	H?	VESSEL	?	FOOT OF HANDLE?	<1899> [+]	ROMN	82.95	nd	1.35	15.23	0.13	0.05	nd	0.30	ND
1557	SHIP	NS	P	BB	10	ACANTHUS ALL	<1121> [581]	EROM	83.19	11.70	2.07	2.73	0.21	nd	nd	0.10	ND
1558	SHIP	NS	H	TLIM	9		<881> [502]	C4AD	86.18	nd	0.38	13.29	0.15	nd	nd	nd	ND
1559	SHIP	NS	P	ARMLET	4		<434> [302]	C4AD	76.74	17.90	1.10	3.53	0.50	nd	nd	nd	ND
1560	SHIP	NS	H?	?		LATCH-LIFTER?	<1106> [588]	ROMN	72.86	4.16	15.21	7.62	0.15	nd	nd	nd	ND
1561	CASD	VC	H	TLIM	4		Cat 37	C1AD	88.54	6.81	0.31	3.91	0.41	nd	0.02	nd	ND
1562 a	CASD	FT	M	SHEET		BUCKLE FITTING	Cat 229	C1AD	79.84	18.40	nd	1.35	0.41	nd	nd	nd	ND
1562 b	CASD	FT	M	BKLE		BUCKLE FITTING	Cat 229	C1AD	77.64	19.58	0.85	1.63	0.29	nd	0.01	nd	ND
1564	CASD	FT	T?	LMOUNT		RECTANGULAR	Cat 263	C1AD	88.14	8.68	0.99	2.05	0.14	nd	0.01	nd	ND
1566	CASD	FT	P	PAB	1	A3?	Cat 131	C1AD	81.26	6.04	5.10	7.27	0.32	nd	0.02	nd	ND
1568	CASD	FT	H	SNT	1		Cat 574	C1AD	80.21	19.04	0.19	0.38	0.18	nd	nd	nd	ND
1569 a	CASD	VC	T	JNTRNG			Cat 275	C1AD	74.97	15.07	7.06	2.38	0.52	nd	nd	nd	ND
1571 a	CASD	VC	M	LOHG		SHEET	Cat 220	C1AD	76.79	22.86	nd	0.14	0.18	nd	0.02	nd	ND
1571 b	CASD	VC	M	LOHG		RIVET	Cat 220	C1AD	78.38	21.00	0.23	0.19	0.17	nd	0.02	nd	ND
1571 c	CASD	VC	M	LOHG		HINGE ROD	Cat 220	C1AD	77.78	21.96	nd	nd	0.14	nd	nd	0.12	ND
1572	CASD	VC	?	STRIP		SPATULA?	Cat 386	C1AD	78.08	21.39	nd	0.25	0.38	nd	nd	nd	ND
1573	CASD	VC	H	SNT	2		Cat 527	C2AD	82.70	16.15	nd	0.38	0.46	nd	0.01	0.10	ND
1574 a	CASD	VC	H	CHATEL		CHATELAINE	Cat 364	C2AD	84.59	12.14	0.49	2.42	0.36	nd	nd	nd	ND
1574 b	CASD	VC	H	TLIM	9		Cat 364	C2AD	82.98	15.84	0.19	0.63	0.36	nd	nd	nd	ND
1576	CASD	VC	P	BB	11	FANTAIL	Cat 51	C1AD	94.06	0.62	2.35	2.98	nd	nd	nd	nd	ND
1577	CASD	VC	?	LOHG		MILITARY ?	Cat 692	C1AD	73.50	26.16	nd	0.12	0.09	0.06	nd	nd	ND
1578	CASD	VC	P	PIN	2		Cat 176	C1AD	77.98	21.03	0.49	0.44	0.13	nd	0.03	nd	ND
1579	CASD	VC	T	MOUNT		BOSS&PETAL MOTIF	Cat 281	C1AD	90.33	3.92	2.12	3.40	0.11	0.11	nd	nd	ND
1580	CASD	VC	P	PLB	1		Cat 108	C1AD	81.49	9.55	4.76	3.60	0.60	nd	nd	nd	ND
1581	CASD	VC	W?	DROPLT		OR A WEIGHT ?	Cat 447	C1AD	90.53	2.44	3.84	3.10	0.09	nd	nd	nd	ND
1582 a	CASD	VC	P	PAB	1	A3	Cat 139	C2AD	78.38	21.35	0.15	nd	0.12	nd	nd	nd	ND
1582 b	CASD	VC	P	PAB		PIN	Cat 139	C2AD	84.00	11.30	1.89	1.90	0.45	0.07	nd	nd	ND
1583	CASD	VC	H	PATERA			Cat 340	C1AD	79.71	nd	8.99	11.16	0.14	nd	nd	nd	ND
1584	CASD	VC	M/T	PEND	3		Cat 293	C1AD	76.85	9.23	8.56	4.27	0.48	nd	nd	nd	ND
1586	CASD	VC	M	SCAR	5		Cat 228	C1AD	85.61	11.24	2.40	0.14	0.24	nd	0.01	nd	ND
1587	CASD	VC	P	BB	12	HEADSTUD	Cat 31	C2AD	82.54	15.01	0.37	1.96	0.10	nd	0.01	nd	ND
1588	CASD	VC	P	PLB	6		Cat 107	C2AD	87.67	0.21	5.15	6.88	0.09	nd	nd	nd	ND
1590	CASD	VC	P	BB	12	HEADSTUD	Cat 32	C2AD	86.66	0.12	0.23	12.92	0.07	nd	nd	nd	ND
1592	CASD	VC	P	RING	1	HENIG II/III	Cat 165	C2AD	80.01	0.50	6.33	12.99	0.06	nd	nd	nd	ND
1595	CASD	VC	P	PLB	7	CRUCIFORM	Cat 116	C2AD	80.12	11.89	4.41	3.00	0.58	nd	nd	nd	ND
1596	CASD	VC	M	BTPL	2	LATTICE	Cat 332	C2AD	81.99	7.44	6.18	4.22	0.17	nd	nd	nd	ND
1597	CASD	VC	H	WEIGHT		SPHERICAL W. LOOP	Cat 446	C2AD	90.91	1.43	0.95	6.52	0.20	nd	nd	nd	ND
1598	CASD	VC	H	VESSEL			Cat 468	C2AD	75.45	nd	12.11	12.36	0.08	nd	nd	nd	ND
1599	CASD	VC	P	PLB	8		Cat 110	C2AD	80.56	13.10	3.39	2.52	0.43	nd	0.01	nd	ND

XRFID	SITEID	SITETYPE	CLASS	O-TYPE	REF	DESCRIPTION	CATALOGUE, etc	DATE	Cu	Zn	Pb	Sn	Fe	Ni	Mn	As	Co
1600	CASD	VC	H	SNT	1		Cat 587	C2AD	79.36	17.68	0.66	0.63	1.67	nd	nd	nd	ND
1601	CASD	VC	H	SNT	12		Cat 618	C2AD	98.52	nd	nd	1.22	0.10	nd	0.01	0.15	ND
1602	CASD	VC	H	TLIM	8	HANDLE MISSING	Cat 385	C2AD	90.89	0.68	0.20	6.75	0.51	nd	0.04	nd	ND
1603	CASD	VC	H	SNT	8	TYPE1	Cat 239	C1AD	86.75	0.43	3.50	9.27	0.05	nd	nd	nd	ND
1604	CASD	VC	H	SPOON	1		Cat 451	ROMN	76.44	0.35	11.94	10.87	0.27	nd	nd	nd	ND
1605	OLDW	NS	P	BB	7		Fig 100, 18	EROM	82.70	4.57	0.93	11.55	0.24	0.01	nd	nd	ND
1606	OLDW	NS	H	?		STAPLE	Fig 112, 120	EROM	95.92	nd	nd	3.81	0.26	nd	0.01	nd	ND
1607	OLDW	NS	H	DROPHD			Fig 114, 134	C1AD	79.35	19.82	nd	0.70	0.13	nd	nd	nd	ND
1608	OLDW	NS	H	SNT	3		Fig 112, 119	C2AD	70.50	0.23	20.40	8.74	0.12	nd	nd	nd	ND
1609	OLDW	NS	H	SNT	16		Fig 112, 115	C3AD	80.33	18.19	0.16	0.99	0.33	nd	0.01	nd	ND
1610	OLDW	NS	H	U-BIND			Fig 114, 133	C1AD	79.30	17.90	0.22	2.17	0.12	nd	nd	nd	ND
1611	OLDW	NS	H	U-BIND			Fig 114, 132	C1AD	75.86	23.89	nd	nd	0.17	0.07	0.01	nd	ND
1613	OLDW	NS	H	SNT	2	KNOB	Fig 113, 127	LROM	86.92	0.86	2.24	9.56	0.42	nd	nd	nd	ND
1614	OLDW	NS	?	SHEET		PELTA SHAPE	Fig 114, 135	LROM	72.88	12.06	10.81	3.79	0.46	nd	nd	nd	ND
1615	OLDW	NS	H	SNT	1		Fig 112, 113	LROM	78.49	1.47	10.90	9.01	0.13	nd	nd	nd	ND
1616	OLDW	NS	H	SNT	6		Fig 112, 112	LROM	99.38	nd	0.22	0.28	0.11	nd	nd	nd	ND
1617	OLDW	NS	H	TLIM	5		Fig 110, 99	C1AD	88.37	1.03	0.15	9.79	0.41	nd	nd	0.25	ND
1618	OLDW	NS	H	MIRROR	1		Fig 109, 97	LROM	61.30	nd	15.31	22.44	0.13	nd	nd	0.24	ND
1619	OLDW	NS	H	MIRROR	1		Fig 109, 96	LROM	58.81	nd	18.60	22.54	0.05	nd	nd	nd	ND
1620	OLDW	NS	H	SNT	1		Fig 106, 67	LROM	81.37	18.35	nd	0.10	0.18	nd	nd	nd	ND
1621	OLDW	NS	H	TLIM	5		Fig 110, 102	C1AD	87.23	10.96	0.27	1.02	0.52	nd	nd	nd	ND
1622	OLDW	NS	H	TLIM	5	?	Fig 110, 100	C1AD	92.61	2.95	0.15	4.06	0.23	nd	nd	nd	ND
1623	OLDW	NS	P	PIN	3		Fig 106, 65	C1AD	86.47	9.99	0.42	2.71	0.41	nd	nd	nd	ND
1624	OLDW	NS	P	PIN	3		Fig 106, 64	EROM	91.73	0.18	0.39	6.65	0.05	nd	nd	nd	ND
1625	OLDW	NS	P	RING	1	NO HENIG	Fig 105, 53	LROM	77.11	1.71	11.46	9.45	0.27	nd	nd	nd	ND
1626	OLDW	NS	P	RING	1	NO HENIG	Fig 105, 52	LROM	81.58	17.45	nd	0.69	0.18	nd	nd	nd	ND
1627 a	OLDW	NS	P	ARMLET	5		Fig 103, 39	C3AD	77.71	21.35	nd	0.37	0.40	nd	0.02	0.15	ND
1627 b	OLDW	NS	P	ARMLET	5		Fig 103, 39	C3AD	98.68	0.11	0.27	0.72	0.10	nd	nd	nd	ND
1628	OLDW	NS	P	RING	5		Fig 105, 50	C1AD	77.42	22.10	0.27	nd	0.22	nd	nd	nd	ND
1629	OLDW	NS	P	BB	19		Fig 99, 7	IA	86.70	nd	0.19	12.84	0.09	0.06	nd	0.13	ND
1630	OLDW	NS	P	BB	7		Fig 99, 14	EROM	87.19	0.79	0.29	11.46	0.05	nd	nd	0.22	ND
1631	OLDW	NS	P	BB	12	HEADSTUD	Fig 99, 12	EROM	82.70	14.19	1.63	1.26	0.21	nd	nd	nd	ND
1632	OLDW	NS	P	BB	7		Fig 100, 17	EROM	85.96	0.97	4.62	8.33	0.07	0.05	0.01	nd	ND
1633	OLDW	NS	P	BB	7		Fig 100, 16	C1AD	84.71	2.42	5.35	7.02	0.50	nd	nd	nd	ND
1634 a	OLDW	NS	P	BB	7		Fig 99, 15	C1AD	87.24	nd	0.29	12.41	0.05	nd	nd	nd	ND
1634 b	OLDW	NS	P	BB	7	PIN TO 1634a	Fig 99, 15	C1AD	92.24	nd	0.21	7.40	0.15	nd	nd	nd	ND
1634 c	OLDW	NS	P	BB	7	SPRING TO 1634a	Fig 99, 15	C1AD	78.84	20.48	0.31	0.10	0.35	nd	0.01	nd	ND
1635	OLDW	NS	P	BB	11	FANTAIL	Fig 99, 10	EROM	87.91	0.51	6.68	4.85	nd	nd	nd	nd	ND
1636	OLDW	NS	H	MIRROR	1		Fig 109, 98	MROM	65.69	0.19	8.78	23.53	0.16	nd	nd	nd	ND
1637	OLDW	NS	P	PLB	5	cf BULMER D2	Fig 99, 11	C1AD	87.74	1.82	0.65	9.21	0.14	nd	nd	0.43	ND
1638	OLDW	NS	P	BB	12	HEADSTUD	Fig 99, 13	EROM	84.15	8.58	0.91	6.19	0.17	nd	nd	nd	ND

XRFID	SITEID	SITETYPE	CLASS	O-TYPE	REF	DESCRIPTION	CATALOGUE, etc	DATE	Cu	Zn	Pb	Sn	Fe	Ni	Mn	As	Co
1639	DRAG	NS	H	SNT	10		<DR70 BNT> [2022]	?	75.21	24.07	nd	0.22	0.23	nd	0.04	0.28	ND
1640	DRAG	NS	P	PAB		PAB PIN ?	<DR70 BEX> [1280]	C1AD	77.34	21.50	0.58	0.13	0.27	nd	0.02	nd	ND
1641	DRAG	NS	P	ARMLET	6		<DR67 LJ> [723]	C2AD	79.80	12.72	2.87	3.72	0.32	nd	0.02	nd	ND
1642	DRAG	NS	H	KNIFE			<DR67 SQ> [701]	ROMN	78.49	16.83	2.21	1.02	1.34	nd	nd	0.11	ND
1643	DRAG	NS	?	STRIP		DECORATED	<DR67 TH> [705]	EROM	85.57	2.21	0.25	11.43	0.37	nd	nd	0.17	ND
1644	DRAG	NS	P	BB	8	PIN/HINGE FROM BB 8	<DR67 TY> [700]	C1AD	73.80	25.87	nd	0.00	0.12	0.06	0.01	0.00	ND
1645	DRAG	NS	P	BB		DOLPHIN/FANTAIL	<DR67 TY> [700]	EROM	87.79	0.66	4.00	7.36	0.19	nd	nd	nd	ND
1646	DRAG	NS	P	PAB	3		<DR68 ACY> [701]	LROM	88.62	nd	nd	9.96	0.25	nd	nd	0.33	ND
1647	DRAG	NS	P	BB	8	SIMPLE TYPE	<DR 70 BOR> [402/870]	LIA	80.43	14.82	0.65	3.22	0.88	nd	0.01	nd	ND
1648	DRAG	NS	H	TLIM	2		<DR72 AXQ>	ROMN	87.38	1.06	0.53	10.94	0.09	nd	nd	nd	ND
1649	DRAG	NS	P	BB	2	LA TENE I ?	<DR73 AC> [1175]	EIA	84.16	0.24	nd	14.68	0.06	nd	0.02	0.83	0.03
1650	DRAG	NS	P	BB	19		<DR68 OH> [629]	IA	86.09	nd	0.21	13.39	0.31	nd	nd	nd	0.00
1652	DRAG	NS	S?	FSHEET			<DR69 DA> [1280]	?	88.97	3.69	0.59	6.02	0.11	0.17	nd	nd	ND
1653	DRAG	NS	H	TLIM	6		<DR68 XQ> [941/456]	C1AD	86.93	0.89	0.82	10.11	0.08	0.18	nd	nd	ND
1654	DRAG	NS	P	PAB	2	D	<DR69 DV> [1402]	EROM	90.22	0.55	nd	9.09	0.13	nd	0.01	nd	ND
1656	DRAG	NS	P	PAB		PIN ?	<DR68 OY> [834]	LIA	87.36	nd	1.68	9.63	0.14	0.08	0.01	nd	ND
1657	DRAG	NS	?	STRIP			<DR68 PI> [382]	?	95.45	nd	0.49	3.39	0.06	nd	0.01	nd	ND
1658	DRAG	NS	?	PIN	?		<DR68 OS> [701]	?	89.01	1.04	0.29	8.56	0.25	0.10	0.01	nd	ND
1659	DRAG	NS	P	BB	7	LOOSE HEAD LOOP	<DR63 VK> [478]	EROM	86.94	6.29	2.59	4.03	0.15	nd	nd	nd	ND
1660	DRAG	NS	H	TLIM	6	FRAGMENT	<DR69 GU> [1404]	ROMN	87.18	nd	1.33	10.35	0.30	0.08	nd	nd	ND
1661	DRAG	NS	?	?		U-BIND FITTING	<DR69 GV> [1404]	?	86.18	0.68	0.74	12.23	0.17	nd	nd	nd	ND
1662	DRAG	NS	H	MIRROR	?		<DR69 HI> [1279]	ROMN	62.06	0.15	10.15	25.62	0.10	nd	nd	nd	ND
1664	DRAG	NS	P	ARMLET	1	SPIRAL DECORATION	<DR69 KM> [1400/1403]	ROMN	88.82	nd	1.00	8.69	0.24	nd	0.03	0.16	ND
1665	DRAG	NS	H	TLIM	?		<DR68 AFK> [639/643]	EROM	84.94	0.16	0.88	12.14	0.10	0.05	nd	0.31	ND
1666	DRAG	NS	H	SPOON	1		<DR68 AFG> us	ROMN	96.64	0.32	nd	2.69	0.35	nd	nd	nd	ND
1667	DRAG	NS	T	TOGGLE			<DR68 AIA> [478]	IA	76.07	2.80	15.72	5.12	0.28	nd	nd	nd	.
1668	DRAG	NS	W?	DROPLT			<DR68 AIV> [716]	C2AD	84.55	7.57	0.49	7.08	0.21	nd	nd	0.11	ND
1669	DRAG	NS	?	SHEET			<DR68 APT> [745]	C1AD	77.00	21.51	0.97	0.21	0.13	nd	nd	nd	ND
1670	DRAG	NS	H	NEEDLE			<DR68 ARN> ?	C1AD	81.24	17.49	0.32	0.25	0.36	nd	nd	nd	ND
1671	DRAG	NS	T?	RING	2	CIRCULAR WORN	<DR68 ASF> [229]	?	88.83	nd	1.50	9.84	0.05	0.27	nd	nd	ND
1672	DRAG	NS	?	?		DROPLET ?	<DR68 EO> [730]	?	86.93	0.40	1.27	11.15	0.14	nd	nd	0.11	ND
1673	DRAG	NS	?	STRIP			<DR68 GX> [714]	?	88.35	nd	0.40	9.91	0.14	nd	0.01	nd	ND
1674	DRAG	NS	P	BB	4	? PIN ONLY	<DR68 IC> [725]	EROM	76.55	22.13	1.21	nd	0.11	nd	nd	nd	ND
1676	DRAG	NS	S?	FSHEET			<DR68 OG> [714]	?	85.42	0.22	0.36	12.75	0.08	nd	0.02	nd	ND
1677	DRAG	NS	P	BB	11	SAWFISH WITH DOG	<DR68 CY> [781]	C1AD	88.08	0.31	5.72	5.83	0.05	nd	nd	nd	ND
1678	DRAG	NS	P	BB	11	SAWFISH WITH LION ?	<DR66 DN> [231]	EROM	85.49	5.77	6.69	1.88	0.16	nd	0.01	nd	ND
1679	DRAG	NS	?	SHEET		PIERCED	<DR69 ACT> [1296]	C1AD	84.70	nd	1.77	12.24	0.10	0.05	nd	nd	ND
1680	DRAG	NS	H	TLIM	2		<DR69 AEN> [1666]	LIA	83.13	2.49	0.00	12.78	0.10	nd	nd	0.29	ND
1681	DRAG	NS	P	BB		SPRING FROM IA BB?	<DR69 ALS> [714]	LIA	86.36	nd	0.49	11.53	0.16	0.07	nd	0.16	ND
1682	DRAG	NS	?	?		U-BIND FITTING	<DR69 SB> [1613]	?	85.29	10.40	1.67	2.46	0.17	nd	nd	nd	ND
1683	DRAG	NS	H	PESTLE			<DR67 PA> [800]	?	99.62	nd	0.32	nd	0.06	nd	nd	nd	ND

XRFID	SITEID	SITETYPE	CLASS	O-TYPE	REF	DESCRIPTION	CATALOGUE, etc	DATE	Cu	Zn	Pb	Sn	Fe	Ni	Mn	As	Co
1684	DRAG	NS	H	KEYSLB			<DR69 YM> [1426]	ROMN	80.91	5.57	8.99	4.32	0.21	nd	nd	nd	ND
1685 a	DRAG	NS	H	PESTLE			<DR66 CZ>	?	96.35	nd	2.18	0.87	0.14	nd	nd	0.11	ND
1685 b	DRAG	NS	H	MORTAR			<DR66 CZ>	?	97.59	nd	1.19	0.65	nd	nd	nd	0.12	ND
1686	DRAG	NS	H	U-BIND		DECORATED	<DR67 HW> us	?	91.31	nd	0.79	7.19	nd	nd	nd	nd	ND
1687	DRAG	NS	P	ARMLET	7		<DR69 AMS> [1450]	LROM	87.64	0.84	4.41	5.97	0.27	nd	nd	nd	ND
1688	DRAG	NS	P	ARMLET	3		<DR69 KP> [1404]	ROMN	88.07	nd	1.64	8.86	0.14	nd	nd	0.18	ND
1689	DRAG	NS	H	U-BIND			<DR69 KQ> [1417]	IA	90.56	nd	1.03	6.69	0.54	0.05	nd	0.16	0.02
1690 a	DRAG	NS	P	PAB	2	C DIAMOND SECTION	<DR70 AB> us	?	87.25	4.33	2.85	5.43	0.01	nd	nd	nd	ND
1690 b	DRAG	NS	P	PAB		PIN TO 1690a	<DR70 AB> us	?	80.77	18.88	nd	0.14	0.20	nd	0.01	nd	ND
1691	DRAG	NS	P	BB	19		<DR70 ABI> us	?	85.59	nd	0.41	13.89	0.11	nd	nd	nd	ND
1692	DRAG	NS	P	BB	7		<DR69 LX> [1400/1402]	EROM	87.96	1.54	1.07	9.24	0.20	nd	nd	nd	ND
1693	DRAG	NS	H	TLIM	6		<DR69 PD> [810]	ROMN	89.18	nd	0.57	8.88	0.07	0.06	nd	nd	ND
1694	DRAG	NS	?	WIRE		SQUARE SECTION	<DR69 QI> [810]	?	78.05	21.01	0.53	0.15	0.17	0.10	0.02	nd	ND
1695	DRAG	NS	H	?		HANDLE FROM VESSEL ?	<DR71 NJ>	?	88.87	nd	0.19	9.95	0.08	nd	nd	nd	ND
1696	DRAG	NS	P	PAB	2	C SQUARE SECTION	<DR70 AAX> [1430]	C1AD	91.29	1.64	1.23	5.79	0.05	nd	nd	nd	ND
1697	DRAG	NS	P	PAB	2	D4	<DR70 AD> us	?	77.07	21.83	0.64	0.13	0.32	nd	nd	nd	ND
1698	DRAG	NS	H	TLIM	5		<DR70 AED> [1426]	LROM	83.12	8.36	2.18	5.01	0.33	nd	nd	0.35	ND
1699	DRAG	NS	P	PAB	2	C SQUARE SECTION	<DR70 AC> us	?	89.23	0.74	4.73	5.13	0.16	nd	0.01	nd	ND
1700	DRAG	NS	P	BB	11	FANTAIL/ PLATE ON BOW	<DR70 BEM> [1749]	EROM	80.88	14.39	1.78	2.63	0.31	nd	0.02	nd	ND
1701	DRAG	NS	H	MIRROR	?		<DR70 BBW> [1700]	ROMN	63.49	nd	12.58	23.79	0.12	nd	0.01	nd	ND
1702	DRAG	NS	P	PAB	2	C	<DR70 BBP> [1665]	?	90.95	1.55	nd	6.42	0.42	nd	nd	0.27	ND
1703	DRAG	NS	P	PAB	2	D SQUARE SECTION	<DR70 AGG> [1407]	ROMN	92.06	1.35	nd	5.28	0.30	nd	nd	0.20	ND
1704	DRAG	NS	P	PAB		PIN ?	<DR67 UC> [714]	?	89.75	nd	0.18	9.23	0.12	nd	nd	nd	ND
1705	DRAG	NS	?	SHEET			<DR67 UR> [700]	EROM	84.30	nd	1.68	12.73	0.07	nd	nd	nd	ND
1706	DRAG	NS	W?	DROPLT			<DR67 UW> [442]	C2AD	85.39	12.24	0.83	1.34	0.19	nd	nd	nd	ND
1707	DRAG	NS	H	TLIM	6		<DR67 VC> [485]	ROMN	91.24	nd	0.53	6.41	0.17	nd	nd	nd	ND
1708	DRAG	NS	H	SNT	12		<DR67 VO> [745]	C1AD	83.37	15.29	0.20	0.82	0.32	nd	0.01	nd	ND
1709	DRAG	NS	P	BB	7		<DR67 XL> [819]	EROM	89.28	nd	0.44	10.25	0.04	nd	nd	nd	ND
1710	DRAG	NS	H	U-BIND			<DR67 AEX> [625]	?	92.19	nd	0.88	6.45	0.09	0.14	nd	nd	ND
1711	DRAG	NS	P	BB	5	SIMPLE GALLIC TYPE	<DR67 AFC> [629]	LIA	77.50	21.79	nd	0.40	0.22	0.07	0.01	nd	ND
1712	DRAG	NS	?	SHEET		PIERCED	<DR66 CC> [250]	LROM	82.88	12.94	0.71	3.03	0.16	nd	nd	nd	ND
1713	DRAG	NS	P/H	PIN	1		<DR66 CC> [250]	LROM	82.29	0.28	8.55	7.61	0.44	nd	0.01	nd	ND
1714	DRAG	NS	?	STRIP			<DR66 CF> [231]	?	80.51	15.03	1.89	1.81	0.37	nd	0.03	nd	ND
1715	DRAG	NS	P	ARMLET	1		<DR66 CG> [231]	LROM	83.92	nd	15.37	12.67	nd	nd	nd	nd	ND
1716	DRAG	NS	?	SHEET			<DR66 DL> [231]	?	76.35	nd	0.69	14.46	nd	nd	nd	nd	ND
1717	DRAG	NS	H	?		FOOT ?	<DR68 AA> us	ROMN	76.59	2.02	11.69	9.35	0.34	nd	nd	nd	ND
1718	DRAG	NS	?	WIRE		?	<DR66 DO> [231]	C3AD	83.56	0.32	2.39	12.09	0.16	0.08	nd	0.12	ND
1719	DRAG	NS	?	WIRE			<DR65 BF> [148]	LROM	87.11	0.39	3.29	9.04	0.11	0.07	nd	nd	ND
1720	DRAG	NS	?	STRIP			<DR65 CK> [148]	LROM	89.06	4.24	0.21	6.20	0.16	nd	nd	0.12	ND
1721	DRAG	NS	?	STRIP			<DR66 DO> [231]	C3AD	87.34	nd	0.27	11.13	0.11	nd	0.02	nd	ND
1723	DRAG	NS	P	BB	11	HEADSTUD	<DR65 HG> ?	C1AD	90.17	0.58	3.15	5.92	0.18	nd	nd	nd	ND

XRFID	SITEID	SITETYPE	CLASS	O-TYPE	REF	DESCRIPTION	CATALOGUE, etc	DATE	Cu	Zn	Pb	Sn	Fe	Ni	Mn	As	Co
1724	DRAG	NS	H	NEEDLE			<DR66 HS> [253]	C1AD	78.29	20.92	0.45	0.22	0.12	nd	0.01	nd	ND
1725	DRAG	NS	?	SHEET		PIERCED	<DR65 JI> [59]	LROM	93.60	nd	0.00	5.36	0.24	nd	nd	0.10	ND
1726	DRAG	NS	H	U-BIND			<DR66 KU> [258]	IA	90.31	nd	0.36	8.12	0.31	0.09	nd	nd	0.00
1727	DRAG	NS	?	FRAG			<DR65 JQ> [3]	IA	88.27	nd	nd	10.33	0.09	nd	0.01	0.27	0.02
1728	DRAG	NS	P	BB		BB SPRING AND PIN	<DR65 JR> [3]	IA	72.48	25.52	0.71	0.75	0.39	0.05	nd	nd	ND
1729	DRAG	NS	P	BB		BB SPRING AND PIN ?	<DR65 LP> [3]	IA	87.42	1.29	nd	10.28	0.07	nd	0.01	0.25	0.03
1730 a	DRAG	NS	P	BB		P-BROOCH W. DISC	<DR65 ABV> [114]	C1AD	83.54	nd	0.48	15.52	0.07	nd	nd	0.39	ND
1730 b	DRAG	NS	P	BB		PIN TO 1730a	<DR65 ABV> [114]	C1AD	85.78	nd	0.62	12.06	0.17	0.08	nd	0.32	ND
1731	DRAG	NS	P	BB	11	HEADSTUD	<DR65 MW> [3 ?]	EROM	85.92	1.05	5.21	7.66	0.09	nd	nd	nd	ND
1732	DRAG	NS	P	BB		BB PIN ?	<DR66 LE> [283/284]	IA	90.12	nd	1.90	7.41	0.10	nd	nd	nd	0.00
1733	DRAG	NS	H	NEEDLE			<DR67 ET> [439]	EROM	83.21	1.05	6.63	8.95	0.16	nd	nd	nd	ND
1734	DRAG	NS	?	SHEET		INCISED DECORATION	<DR67 CZ> [470]	C2AD	78.18	21.55	nd	0.15	0.11	nd	0.01	nd	ND
1735	DRAG	NS	P/H	PIN	1	OR NEEDLE ?	<DR67 CJ> [439]	C3AD	88.09	1.68	2.05	6.93	0.22	nd	0.03	nd	ND
1736	DRAG	NS	M	BTPL	3		<DR pre-63 CY> us	MROM	79.35	4.05	8.42	7.78	0.31	nd	nd	nd	ND
1737	DRAG	NS	P	BB		SPRING AND PIN ONLY	<DR66 QP> [289]	IA	88.44	0.30	1.70	8.49	0.25	0.10	0.01	nd	0.00
1738	DRAG	NS	H	SNT	3		<DR65 BE> [146]	LROM	87.79	8.14	0.38	3.37	0.32	nd	nd	nd	ND
1739	DRAG	NS	?	SHEET		PIERCED	<DR64 NF> [3]	IA	86.65	nd	nd	11.40	0.43	nd	nd	nd	0.00
1740	DRAG	NS	H	SNT	2		<DR64 BJ> [3]	IA	88.91	nd	nd	9.70	0.30	0.17	nd	0.10	0.00
1741	DRAG	NS	?	STRIP		PIERCED	<DR64 AD> [59]	LROM	88.23	0.16	0.24	10.23	0.08	0.05	nd	nd	ND
1742	DRAG	NS	T	TRT		1	<DR pre-63 BI> us	?	77.92	nd	15.09	6.35	0.08	0.09	nd	nd	ND
1743 a	ARRS	BL	T	HSBT		LADY'S SIDE LINK 1	Fig 16	EIA	88.63	nd	0.27	10.42	0.26	0.07	nd	0.35	0.00
1743 b	ARRS	BL	T	HSBT		LADY'S SIDE LINK 2	Fig 16	EIA	88.79	nd	0.46	10.36	0.13	0.05	nd	0.21	0.00
1743 c	ARRS	BL	T	HSBT		LADY'S CENTRE LINK	Fig 16	EIA	88.79	nd	4.68	6.47	nd	0.06	nd	nd	0.04
1744 a	RISE	SF	T	HSBT		SIDE LINK 1	Macgregor 10	?	77.10	21.50	nd	0.86	0.54	nd	nd	nd	ND
1744 b	RISE	SF	T	HSBT		SIDE LINK 2	Macgregor 10	?	76.83	22.47	0.25	0.38	0.33	nd	nd	nd	ND
1744 c	RISE	SF	T	HSBT		CENTRE LINK	Macgregor 10	?	90.03	7.63	0.60	0.86	0.87	nd	nd	nd	ND
1745	ARRS	BL	H	?		MIRROR FITTING	Fig 32	EIA	87.98	nd	nd	11.51	0.24	nd	nd	0.27	0.02
1746 a	LOMS	SF	P	TORC		BEADED - BAR	Macgregor 204	?	82.20	11.36	1.93	4.26	0.20	0.05	0.01	nd	ND
1746 b	LOMS	SF	P	TORC		BEADED - BEAD	Macgregor 204	?	87.73	6.29	3.09	2.63	0.16	nd	nd	nd	ND
1746 c	LOMS	SF	P	TORC		BEADED - BEAD	Macgregor 204	?	90.87	5.01	1.85	2.16	0.11	nd	nd	nd	ND
1747 a	STAN	SF	M	SWORD		PIG IV - CHAPE	Macgregor 172	C1AD	87.87	2.09	1.41	8.48	0.15	nd	nd	nd	ND
1747 b	STAN	SF	M	SWORD		PIG IV - SUSPENSION	Macgregor 172	C1AD	86.12	5.14	1.46	6.92	0.30	0.06	nd	nd	ND
1747 c	STAN	SF	M	SWORD		PIG IV - BINDING LOOP	Macgregor 172	C1AD	83.69	0.48	0.35	15.26	0.22	nd	nd	nd	ND
1748 a	SDBG	SF	M	SWORD		PIG IVA - HILT GUARD	Macgregor 156	EROM	80.43	18.81	nd	0.30	0.35	nd	nd	0.12	ND
1748 b	SDBG	SF	M	SWORD		PIG IVA - SUSPENSION	Macgregor 156	EROM	83.68	11.99	0.58	3.20	0.41	nd	nd	0.15	ND
1748 c	SDBG	SF	M	SWORD		PIG IVA - BACK PLATE	Macgregor 156	EROM	82.30	12.41	0.34	4.79	0.15	nd	nd	nd	ND
1749 a	WRTN	SF	M	SWORD		PIG IV - HILT GUARD	Macgregor 158	EROM	81.19	17.47	0.17	0.93	0.23	nd	0.01	nd	ND
1749 b	WRTN	SF	M	SWORD		PIG IV - SUSPENSION	Macgregor 158	EROM	90.68	4.56	1.48	3.16	0.11	nd	nd	nd	ND
1749 c	WRTN	SF	M	SWORD		PIG IV - RIVET FOR b	Macgregor 158	EROM	81.14	17.68	nd	0.70	0.34	nd	nd	0.13	ND
1750	BRGH	SF	M	SWORD		PIG V SCABBARD MOUTH	Macgregor 161	ROMN	81.09	14.51	2.14	2.12	0.14	nd	nd	nd	ND
1751 a	GRMT	BL	M	SWORD		PIG III - CHAPE	Figs 21 & 22	IA	86.81	0.26	0.83	10.45	1.33	nd	nd	0.33	0.04

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1751 b	GRMT	BL	M	SWORD		PIG III - GUARD	Figs 21 & 22	IA	87.03	0.17	0.50	11.80	0.16	nd	0.01	0.33	0.08
1752	DNGR	BL	P	BB	1		Fig 26, 4	EIA	89.66	0.10	0.20	9.66	0.10	0.06	nd	0.23	0.03
1753	CWLM	BL	P	ARMLET	8		Fig 27, 6	EIA	85.45	nd	nd	14.08	0.08	nd	nd	0.38	0.02
1754	ARRS	BL	P	ARMLET	8		Fig 27, 8	EIA	87.43	nd	0.64	11.54	0.11	nd	nd	0.29	0.06
1755	ARRS	BL	P	ARMLET	9		Fig 28, 3	EIA	87.04	nd	nd	12.57	0.06	nd	nd	0.32	0.00
1756 a	PLFL	SF	T	HSBT		SIDE LINK 1	Macgregor 8	?	86.16	2.13	0.29	11.31	0.11	nd	nd	nd	ND
1756 b	PLFL	SF	T	HSBT		SIDE LINK 2	Macgregor 8	?	83.25	15.90	0.42	0.16	0.27	nd	nd	nd	ND
1756 c	PLFL	SF	T	HSBT		CENTRE LINK	Macgregor 8	?	88.85	0.93	0.30	9.59	0.07	nd	nd	0.26	ND
1757	ARRS	BL	T	TRT	5		Fig 17, 2	EIA	87.03	nd	0.92	11.71	0.34	nd	nd	nd	0.00
1758	CRHM	SF	M	SWORD		PIG III - CHAPE	Macgregor 136	IA	88.55	nd	3.30	8.07	0.09	nd	nd	nd	0.00
1759 a	EMBL	SF	M	SWORD		PIG IV - CHAPE	Macgregor 145	EROM	86.66	7.12	1.73	3.43	1.06	nd	nd	nd	ND
1759 b	EMBL	SF	M	SWORD		PIG IV - GRIP TUBE	Macgregor 145	EROM	80.03	9.56	6.01	3.88	0.51	nd	nd	nd	ND
1759 c	EMBL	SF	M	SWORD		PIG IV - GRIP STOP	Macgregor 145	EROM	79.33	7.89	6.89	5.35	0.53	nd	0.01	nd	ND
1760 a	BUGT	BL	M	SWORD		PIG III - CHAPE	Figs 21 & 22	IA	89.52	nd	0.46	9.46	0.09	nd	nd	0.47	0.12
1760 b	BUGT	BL	M	SWORD		PIG III SCABB'D MOUTH	Figs 21 & 22	IA	88.04	nd	0.38	10.71	0.33	nd	nd	0.54	0.02
1761	CWLM	BL	P	ARMLET	10		Fig 27, 1	EIA	92.17	nd	0.63	6.90	0.30	nd	nd	nd	0.00
1762	CASD	VC	M	SWORD		POMPEII TYPE MOUNT	Cat 217	C2AD	99.57	nd	nd	nd	0.29	nd	nd	0.14	ND
1763	CASD	VC	M	JNTLP		SPECTACLE TYPE	Cat 277	C2AD	75.32	11.40	7.99	4.79	0.50	nd	nd	nd	ND
1764	CASD	VC	H	SNT	3		Cat 541	C2AD	83.52	13.37	0.29	1.57	0.50	0.14	0.05	0.21	ND
1765	CASD	VC	I	INGOT			Cat 796	C2AD	82.95	14.09	0.82	1.77	0.37	nd	nd	nd	ND
1766	CASD	VC	P	BB	11	HEADSTUD	Cat 35	C2AD	86.28	0.72	6.20	6.71	0.08	nd	nd	nd	ND
1767	CASD	VC	P	PAB	2	C FLAT SECTION	Cat 149	C2AD	77.70	18.81	1.14	1.85	0.41	nd	nd	0.10	ND
1768	CASD	VC	?	PHALER		ATYS	Cat 308	C1AD	74.67	12.94	9.35	2.51	0.53	nd	nd	nd	ND
1769	CASD	VC	H	VESSEL			Cat 487	C1AD	79.37	0.16	10.50	8.86	0.25	nd	nd	nd	ND
1770	CASD	VC	T?	B&L	3		Cat 237	C2AD	96.13	0.78	0.87	2.04	nd	nd	nd	0.18	ND
1771	CASD	VC	P	BB	10	NO ACANTHUS HALF	Cat 79	C2AD	80.17	16.66	2.31	0.49	0.24	nd	0.01	0.13	ND
1772	CASD	VC	?	FRAG		NOT A MIRROR !?	Cat 755	C2AD	91.65	0.35	4.66	3.34	nd	nd	0.01	nd	ND
1773	CASD	VC	T?	B&L	9		Cat 238	C2AD	76.90	8.60	8.56	5.50	0.43	nd	nd	nd	ND
1774	CASD	VC	H	MIRROR	1		Cat 425	C2AD	63.32	nd	12.81	22.53	0.18	nd	nd	nd	ND
1775	CASD	VC	H	SNT	1		Cat 606	C1AD	81.75	17.37	nd	0.69	0.19	nd	nd	nd	ND
1776	CASD	VC	H	SNT	10		Cat 540	C2AD	78.16	0.17	11.99	8.89	0.07	nd	nd	nd	ND
1777	CASD	VC	H	SPOON	1		Cat 460	C2AD	94.38	nd	0.19	3.84	0.60	nd	0.01	0.31	ND
1778	CASD	VC	P	PIN	4	HAND AND ? TYPE	Cat 181	C1AD	85.22	12.20	1.09	1.25	0.24	nd	nd	nd	ND
1779	CASD	VC	H	TLIM	3		Cat 369	C2AD	88.13	6.00	1.53	3.81	0.26	nd	0.01	nd	ND
1781	CASD	VC	H	KEY		?	Cat 651	C1AD	71.92	1.33	17.24	9.39	0.11	nd	0.01	nd	ND
1782	CASD	VC	I?	INGOT?			Cat 794	EROM	79.01	19.40	0.40	0.87	0.32	nd	nd	nd	ND
1783	CASD	VC	T	TRT	3		Cat 302	C2AD	74.88	1.65	15.99	7.21	0.28	nd	nd	nd	ND
1784	CASD	VC	?	SHEET		DECORATED	Cat 269	C2AD	88.19	3.38	0.17	7.45	0.12	0.05	0.01	nd	ND
1785	CASD	VC	P	BB	11	FANTAIL	Cat 57	C2AD	94.32	0.14	1.88	3.55	0.11	nd	nd	nd	ND
1787	CASD	VC	T	TRT	6		Cat 301	C2AD	64.79	17.12	16.14	1.56	0.40	nd	nd	nd	ND
1789	CASD	VC	H	MIRROR	1	?	Cat 572	C2AD	62.55	nd	17.45	18.73	0.40	nd	0.01	nd	ND

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1790	CASD	VC	H	KEY		LEVER	Cat 424	C2AD	68.13	0.15	21.89	9.11	0.26	nd	nd	nd	ND
1791 a	CASD	VC	P	BB	11	HEADSTUD	Cat 647	C1AD	80.52	17.33	0.33	1.65	0.16	nd	nd	nd	ND
1791 b	CASD	VC	P	BB	11	PIN TO 1791a	Cat 34	C1AD	82.30	14.16	nd	3.00	0.19	nd	0.02	0.13	ND
1792	CASD	VC	P	BB	10	NO ACANTHUS HALF	Cat 76	C1AD	88.31	0.26	0.39	10.75	0.08	nd	0.01	0.20	ND
1793	CASD	VC	H	TLIM	6		Cat 358	C1AD	75.54	24.08	nd	0.16	0.21	nd	0.01	nd	ND
1794	CASD	VC	P	PAB	1	A3	Cat 145	C1AD	88.81	8.35	0.56	2.11	0.17	nd	nd	nd	ND
1795	CASD	VC	P	RING	3		Cat 172	C2AD	79.06	20.31	nd	nd	0.27	nd	nd	0.20	ND
1796	CASD	VC	T/H	RING	2	D	Cat 319	C2AD	52.35	nd	38.54	7.92	0.17	nd	nd	nd	ND
1797 a	CASD	VC	H	TLIM	5		Cat 394	C2AD	83.02	13.37	nd	3.11	0.18	nd	0.01	nd	ND
1798	CASD	VC	H	SNT	1		Cat 592	C2AD	72.41	1.42	15.86	10.08	0.23	nd	nd	nd	ND
1799	CASD	VC	H	SNT	6		Cat 546	C2AD	93.29	2.14	0.46	3.96	0.14	nd	0.02	nd	ND
1800	CASD	VC	H	TLIM		?	Cat 376	C2AD	85.36	10.71	0.31	3.33	0.28	nd	nd	nd	ND
1802	CASD	VC	I?	INGOT		FRAG FROM DISC ?	Cat 795	C2AD	75.15	nd	16.95	7.82	0.08	nd	nd	nd	ND
1803	CASD	VC	H	NEEDLE			Cat 440	C2AD	87.23	8.43	0.26	3.57	0.49	nd	nd	nd	ND
1804	CASD	VC	P/H	RING	2	SUB-RECTANGULAR	Cat 725	C2AD	66.51	11.18	17.59	4.32	0.40	nd	nd	nd	ND
1805 a	CASD	VC	M	LOHG			Cat 221	C2AD	78.17	19.47	0.83	1.08	0.28	nd	nd	nd	ND
1805 b	CASD	VC	M	SNT	11	FROM 1805a	Cat 221	C2AD	92.93	5.85	0.47	0.32	0.23	nd	0.01	nd	ND
1806	CASD	VC	H	U-BIND			Cat 199	C2AD	90.17	nd	nd	8.52	0.06	nd	nd	0.12	ND
1808	CASD	VC	?	?		STRAINER OR EYE-GUARD	Cat 781	C2AD	96.94	nd	nd	2.65	0.11	nd	0.01	nd	ND
1809	CASD	VC	H	KEY		LEVER LOCK TYPE	Cat 648	C2AD	76.23	1.91	12.71	8.79	0.35	nd	nd	nd	ND
1810	CASD	VC	P	BB	11	FANTAIL CF 1785	Cat 55	C2AD	83.84	0.76	8.83	6.50	0.07	nd	nd	nd	ND
1811	CASD	VC	P	BB	13	SMALL ?	Cat 85	LROM	91.02	0.71	1.32	6.73	0.20	nd	0.02	nd	ND
1812 a	CASD	VC	P	BB	10	ACANTHUS ALL	Cat 75	C2AD	80.20	0.51	11.66	7.53	0.10	nd	nd	nd	ND
1812 b	CASD	VC	P	BB	10	SPRING/PIN FROM 1812a	Cat 75	C2AD	88.77	2.26	1.90	6.02	0.40	nd	0.02	nd	ND
1814	TPLW	HF	P	RING	4		Cat 77	?	89.87	0.90	0.37	7.40	0.28	nd	0.01	0.11	ND
1815	TPLW	HF	H	U-BIND			Cat 301	LROM	88.38	0.36	0.31	9.90	0.06	nd	0.02	nd	ND
1816	TPLW	HF	H	U-BIND			Cat 301	EROM	90.13	0.70	0.40	7.63	0.27	nd	0.01	nd	ND
1817	TPLW	HF	P/T	B&L	5	C	Cat 236	LROM	85.02	0.89	1.21	12.73	0.15	nd	nd	nd	ND
1818	TPLW	HF	T	LMOUNT		DOUBLE BOSS AND PETAL	Cat 325	EROM	88.29	10.60	nd	0.91	0.20	nd	nd	nd	ND
1819	TPLW	HF	P/T	B&L	3		Cat 228	EROM	87.36	1.89	1.88	8.53	0.20	nd	0.02	0.13	ND
1820	TPLW	HF	P/T	B&L	3		Cat 226	LROM	82.17	4.93	5.02	7.36	0.51	nd	nd	nd	ND
1821	TPLW	HF	P/T	B&L	6	B	Cat 211	EROM	83.87	1.18	0.46	14.32	0.16	nd	nd	nd	ND
1822	TPLW	HF	T	LMOUNT		DOUBLE PETAL AND BOSS	Cat 320	EROM	90.90	0.53	2.57	5.89	0.09	nd	0.01	nd	ND
1823	TPLW	HF	P/T	B&L	6	B	Cat 215	EROM	91.53	0.85	4.00	3.44	0.18	nd	nd	nd	ND
1824	TPLW	HF	H	SNT	3		Cat 287	?	83.79	1.47	3.07	11.19	0.32	nd	nd	0.17	ND
1825	TPLW	HF	H	TLIM	6		Cat 246	LROM	87.44	3.48	0.49	7.46	0.18	nd	0.02	nd	ND
1826	TPLW	HF	H	VESSEL		PATERA RIM / WALL	Acc 1974.13	EROM	76.23	0.11	10.47	13.05	0.14	nd	nd	nd	ND
1827	TPLW	HF	M			SPEAR BUTT ?	Cat 408	EROM	80.28	nd	7.05	12.56	0.11	nd	nd	nd	ND
1828	TPLW	HF	M			SPEAR BUTT ? MELTED	Cat 408	EROM	79.79	2.30	10.02	7.75	0.15	nd	nd	nd	ND
1829	TPLW	HF	P/H	RING	2	CIRCULAR	Cat 174	EROM	83.97	4.04	2.12	7.62	1.18	nd	nd	nd	ND
1830	TPLW	HF	P	RING	1	HENIG II/III	Cat 158	EROM	85.22	4.19	2.64	7.51	0.45	nd	nd	nd	ND

XRFID	SITEID	SITETYPE	CLASS	O-TYPE	REF	DESCRIPTION	CATALOGUE, etc	DATE	Cu	Zn	Pb	Sn	Fe	Ni	Mn	As	Co
1831	TPLW	HF	P	PIN	4	ZOOMORPHIC	Cat 105	EROM	87.61	1.22	1.47	8.44	0.08	nd	0.01	nd	ND
1832	TPLW	HF	P/H	B&L	2		Cat 227	EROM	88.05	5.46	0.87	5.44	0.18	nd	nd	nd	ND
1833	TPLW	HF	P	PIN	4	ROSETTE / BEADED	Cat 117	?	82.87	3.77	2.48	10.54	0.33	nd	nd	nd	ND
1834	TPLW	HF	T	TRT	1		Cat 351	EROM	89.64	5.98	0.54	3.62	0.22	nd	nd	nd	ND
1835	TPLW	HF	T	TRT	7		Cat 352	EROM	89.68	3.96	0.62	5.53	0.21	nd	nd	nd	ND
1836	TPLW	HF	P	PLB	5	FEACHEM19 cf BULMERC1	Cat 33	EROM	87.01	5.67	3.18	3.70	0.28	nd	nd	0.17	ND
1837	TPLW	HF	P	ARMLET	1	BEADED ?	Cat 191	LROM	87.90	3.82	1.23	6.77	0.27	nd	0.01	nd	ND
1838	TPLW	HF	T?	LMOUNT		CIRCULAR WITH RIM	Cat 330	EROM	80.01	14.94	0.73	4.15	0.15	nd	0.01	nd	ND
1839	TPLW	HF	T?	LMOUNT		RECTANGULAR	Cat 333	EROM	86.87	2.51	1.03	9.21	0.24	nd	0.01	0.14	ND
1840	TPLW	HF	M?	MOUNT		OPENWORK TRUMPETS	Cat 316	EROM	82.59	1.94	4.74	10.50	0.23	nd	nd	nd	ND
1841	TPLW	HF	T?	LMOUNT		STAR-SHAPED/BOSS&PETA	Cat 318	EROM	82.69	1.48	6.56	9.00	0.27	nd	nd	nd	ND
1842	TOFT	NS	P	PIN			<1050> [5043]	C1AD	80.40	17.76	0.70	0.60	0.54	nd	nd	nd	ND
1843	TOFT	NS	?	SHEET		KNIFE GUARD ?	<<116> [506]	C1AD	85.21	nd	nd	13.49	0.08	nd	nd	nd	ND
1844	TOFT	NS	P	BB	8	PIN ONLY	<516> [1007]	C1AD	80.21	17.96	nd	0.50	0.31	nd	nd	0.81	ND
1845	TOFT	NS	?	STRIP		PIERCED	<957> [3514]	C1AD	79.89	14.23	2.86	2.24	0.33	nd	0.02	nd	ND
1846 a	TOFT	NS	P	PAB	1	A	<614> [2007]	IA	87.36	nd	0.44	11.64	0.45	nd	nd	nd	ND
1846 b	TOFT	NS	P	PAB		PIN TO 1846a	<124> [509]	IA	94.99	nd	0.22	2.65	1.05	0.05	0.01	0.29	ND
1847	TOFT	NS	P	ARMLET	11	SHEET	<1010> [3066]	C1AD	80.10	19.30	nd	nd	0.16	0.08	0.01	0.12	ND
1849	TOFT	NS	P	BB	?	HINGED STRIP BOW	<521> [1007]	C1AD	90.86	nd	0.46	8.62	0.06	nd	nd	nd	ND
1850	TOFT	NS	P	PLB	1		<529> [1014]	C1AD	80.62	18.27	0.71	nd	0.40	nd	nd	nd	ND
1851	TOFT	NS	P	BB	8	EARLY TYPE ?	<634> [2048]	IA	89.69	0.79	0.36	8.74	0.09	nd	0.01	0.33	ND
1852	TOFT	NS	W			INGATE ?	<981> [4036]	C1AD	84.39	13.53	nd	1.77	0.31	nd	nd	nd	ND
1853	TOFT	NS	I	INGOT		? RECTANGULAR MARKS	<647> [2077]	C1AD	76.79	22.70	nd	0.30	0.21	nd	nd	nd	ND
1854	TOFT	NS	H	SNT	13		<530> [1014]	C1AD	89.60	nd	1.53	8.36	0.23	nd	nd	nd	ND
1855 a	TOFT	NS	H	SHEET			<960> [3514]	C1AD	85.27	nd	1.08	12.19	0.23	0.11	nd	nd	ND
1855 b	TOFT	NS	H	SNT	12		<960> [3514]	C1AD	88.00	0.28	0.43	9.52	0.68	nd	0.01	0.11	ND
1856	TOFT	NS	H	SHEET		KNIFE GUARD ?	<938> [3512]	C1AD	88.21	0.90	nd	10.75	0.13	nd	0.01	nd	ND
1857	TOFT	NS	H	SNT	6		<514> [1005]	C1AD	98.91	nd	0.49	0.00	0.06	0.08	nd	nd	ND
1859	TOFT	NS	?	WIRE			<556> [1121]	C1AD	86.37	nd	0.45	12.11	0.08	nd	nd	nd	ND
1861	TOFT	NS	?	FRAG			<544> [1057]	C1AD	86.68	nd	1.16	10.62	0.08	0.08	nd	0.20	ND
1862	TOFT	NS	?	STRIP			<626> [2043	?	92.32	nd	nd	6.20	0.36	0.13	nd	0.36	ND
1863	TOFT	NS	?	PAB		PIN ?	<636> [2048]	IA	89.50	0.81	0.53	8.25	0.12	nd	nd	0.17	0.00
1867	TOFT	NS	W	DROPLT			<995> [3159]	C1AD	91.19	nd	1.44	6.68	nd	0.17	nd	nd	ND
1868	TOFT	NS	P	BB	16	FOOT OF TRUMPET	<510> [1005]	C1AD	86.55	0.55	1.48	9.88	1.44	0.10	0.01	nd	ND
1869	TOFT	NS	W	DROPLT			<998> [3205]	IA	87.18	nd	0.43	11.00	0.00	nd	nd	nd	0.00
1871	TOFT	NS	W	DROPLT			<615> [2007]	IA	86.32	0.89	0.58	11.57	0.28	0.06	0.01	0.28	0.00
1872	TOFT	NS	W	DROPLT			<632> [2048	LIA	78.51	nd	1.39	19.81	0.13	nd	nd	nd	ND
1873	TOFT	NS	W	DROPLT			<974> [3009]	C1AD	81.66	17.61	nd	0.33	0.21	nd	nd	nd	ND
1874	TOFT	NS	W	DROPLT		ATTACHED TO CRUCIBLE	<966> [3005]	C1AD	92.18	1.80	1.21	4.17	0.27	nd	0.02	nd	ND
1875	CASD	FT	?	STRIP		HELMET PIPING ?	Cat 196	C1AD	80.30	19.35	nd	0.19	0.16	nd	nd	nd	ND
1876	CASD	FT	P	PLB	7		Cat 99	C1AD	76.76	21.14	1.66	0.30	0.14	nd	nd	nd	ND

XRFID	SITEID	SITETYPE	CLASS	O-TYPE	REF	DESCRIPTION	CATALOGUE, etc	DATE	Cu	Zn	Pb	Sn	Fe	Ni	Mn	As	Co
1877	CASD	FT	T	JNTLP		DOUBLE SPECTACLE	Cat 274	C1AD	81.90	15.42	1.03	1.28	0.21	nd	0.01	nd	ND
1878 a	CASD	FT	P	BB	10	NO ACANTHUS HALF	Cat 71	C1AD	82.28	15.42	nd	1.98	0.20	nd	nd	0.11	ND
1878 b	CASD	FT	P	BB	10	PIN TO 1878a	Cat 71	C1AD	86.97	10.60	0.40	1.50	0.32	nd	nd	nd	ND
1879 a	CASD	FT	M	LOHG		LOBATE	Cat 218	C1AD	77.23	22.33	nd	0.16	0.14	nd	nd	0.14	ND
1879 b	CASD	FT	M	SNT	11	TO 1879a	Cat 218	C1AD	78.33	21.09	0.20	0.12	0.16	nd	0.02	nd	ND
1880	CASD	FT	T	TRT	7		Cat 297	C1AD	84.85	13.26	0.23	0.54	1.11	nd	nd	nd	ND
1881	CASD	FT	T	HSBT		RING FROM DERIVATIVE	Cat 278	C1AD	88.70	0.12	0.76	8.12	2.29	nd	0.01	nd	ND
1882	CASD	FT	?	FRAG		CRESCENTIC MOUNT ?	Cat 772	C1AD	76.68	0.10	18.38	4.44	0.17	nd	nd	nd	ND
1884	CASD	FT	H	U-BIND		SHIELD BINDING ?	Cat 472	C1AD	83.78	14.68	nd	1.12	0.12	nd	nd	nd	ND
1885	CASD	FT	M	LOLP			Cat 223	C1AD	79.46	18.99	0.33	0.92	0.29	nd	nd	nd	ND
1886	CASD	FT	P	BB	11	FANTAIL WITH DISC	Cat 49	C1AD	85.84	10.46	0.78	2.44	0.47	nd	0.01	nd	ND
1887	CASD	FT	H	SLB			Cat 646	C1AD	77.56	9.69	7.82	4.62	0.31	nd	nd	nd	ND
1889	CASD	FT	H	MIRROR	2		Cat 426	C1AD	57.61	nd	19.71	22.12	0.29	nd	0.02	nd	ND
1890	CASD	FT	H	MIRROR			Cat 423	C1AD	63.12	nd	14.90	20.47	nd	nd	nd	nd	ND
1891	CASD	FT	M	RSWORD		SUSPENSION STRIP	Cat 213	C1AD	87.28	0.15	0.57	11.01	0.26	nd	0.02	nd	ND
1892	CASD	FT	P	ARMLET	11	SNAKE ?	Cat 189	C1AD	78.41	18.17	2.29	0.81	0.32	nd	nd	nd	ND
1893	CASD	FT	M	BTPL		?	Cat 331	C1AD	84.20	14.09	0.16	1.03	0.38	nd	nd	0.14	ND
1895	CASD	FT	H	MORTAR			Cat 421	C1AD	84.55	0.37	4.79	10.20	0.09	nd	nd	nd	ND
1897	CASD	FT	M	RSWORD		POMPEII TYPE MOUTH	Cat 216	C1AD	75.47	2.25	9.85	11.67	0.77	nd	nd	nd	ND
1898	CASD	FT	T	TRT	6	?	Cat 299	C1AD	64.13	11.74	19.77	3.99	0.36	nd	0.01	nd	ND
1899	CASD	FT	H	KEY		LEVER LOCK TYPE	Cat 645	C1AD	67.13	4.31	20.70	7.37	0.48	nd	nd	nd	ND
1900	CASD	FT	?	FRAG			Cat 776	C1AD	69.61	nd	19.89	10.66	0.07	nd	0.01	nd	ND
1901	CASD	FT	T?	PEND	1		Cat 288	C1AD	87.34	nd	2.02	10.56	0.07	nd	nd	nd	ND
1902	CASD	FT	?	PEND		?	Cat 287	C1AD	75.44	24.17	nd	0.00	0.22	nd	0.01	nd	ND
1903	CASD	FT	P	RING	1	HENIG II/III	Cat 162	C1AD	83.48	0.13	9.84	6.32	0.22	nd	nd	nd	ND
1904	CASD	FT	T	TRT	6		Cat 298	C1AD	84.75	nd	11.25	4.00	nd	nd	nd	nd	ND
1905 a	CASD	FT	P	BB	11	HEADSTUD	Cat 27	C1AD	83.84	13.80	0.22	1.74	0.29	nd	nd	0.12	ND
1905 b	CASD	FT	P	BB	11	PIN TO 1905a	Cat 27	C1AD	80.87	18.26	nd	0.64	0.23	nd	nd	nd	ND
1906	CASD	FT	P	PAB	2	D4?	Cat 151	C1AD	88.07	4.47	1.57	5.69	0.21	nd	nd	nd	ND
1907	CASD	VC	H	SNT	11		Cat 609	C1AD	85.44	11.72	0.96	1.26	0.28	nd	0.01	nd	ND
1908	CASD	FT	P	PAB	1	A3	Cat 143	C1AD	81.31	17.35	nd	1.02	0.26	0.07	nd	nd	ND
1909	CASD	FT	?	FRAG		HALF MADE ?	Cat 775	C1AD	78.30	20.38	0.51	0.55	0.25	nd	nd	nd	ND
1910	CASD	FT	?	STRIP		RIM OF VESSEL ?	Cat 465	C1AD	93.43	nd	0.18	5.40	0.15	nd	0.01	nd	ND
1911	CASD	FT	H	SNT	11		Cat 510	C1AD	75.20	23.93	0.29	0.19	0.38	nd	0.01	nd	ND
1913 a	CASD	FT	P	PLB	5	cF BULMER C	Cat 102	C1AD	84.06	6.30	6.26	3.19	0.19	nd	nd	nd	ND
1913 b	CASD	FT	P	PLB	5	PIN TO 1913a	Cat 102	C1AD	87.69	7.53	2.84	1.55	0.26	nd	nd	nd	ND
1915	BRXM	HF	P	ARMLET	4		Cat 521	LROM	85.43	1.52	4.65	7.60	0.11	nd	0.01	nd	ND
1916	BRXM	HF	T	LMOUNT		HOLLOW PETAL MOTIFS	Cat 516	EROM	89.23	6.26	0.42	3.64	0.38	0.05	0.01	nd	ND
1917	BRXM	HF	H	U-BIND			Cat 528	EROM	92.76	1.97	0.31	4.20	0.15	nd	nd	nd	ND
1918	BRXM	HF	P	PAB	1	A/A3?	Cat 517	EROM	86.88	2.75	2.29	7.99	0.10	nd	nd	nd	ND
1919	BRXM	HF	?	STRIP		D-SECTIONED	Cat 532	EROM	79.88	nd	8.73	11.31	0.09	nd	nd	nd	ND

XRFID	SITEID	SITETYPE	CLASS	O-TYPE	REF	DESCRIPTION	CATALOGUE, etc	DATE	Cu	Zn	Pb	Sn	Fe	Ni	Mn	As	Co
1921	BRXM	HF	P/H	PIN	1	OR NEEDLE	Cat 531	EROM	79.60	17.67	0.92	1.42	0.18	nd	0.01	0.20	ND
1922	BRXM	HF	H	U-BIND			Cat 527	EROM	88.33	0.33	1.03	9.45	0.15	nd	0.01	nd	ND
1923	BRXM	HF	H	NEEDLE			Cat 519	EROM	89.98	5.46	0.76	3.13	0.19	nd	nd	0.20	ND
1924	BRXM	HF	H	SNT	10		Cat 529	IA	83.94	nd	2.51	12.21	0.10	0.07	nd	0.32	0.03
1925	BRXM	HF	?	STRIP			Cat 535	IA	92.57	nd	nd	6.25	0.06	nd	0.01	0.30	0.05
1926	BLML	HD	H	PATERA		HANDLE	Cat B52	C2AD	74.73	0.20	12.32	11.92	0.24	nd	nd	nd	ND
1927	CNGF	HF	T	LINCHP			Macgregor 128	?	81.01	0.88	6.65	11.17	0.18	nd	nd	nd	ND
1928	BLML	HD	T	PHALER		?	Cat B51	EROM	82.77	0.54	7.92	6.68	1.99	nd	nd	nd	ND
1929	BLML	HD	T	LINCHP			Cat B6 Macgregor 132	EROM	81.39	4.67	6.65	7.00	0.23	nd	nd	nd	ND
1930	BLML	HD	H	VESSEL		SHEET W. FE RIM	Cat B14	EROM	81.03	nd	5.41	11.66	0.38	0.08	0.01	nd	ND
1931	BLML	HD	T	LINCHP			Cat B6 Macgregor 133	EROM	81.77	4.80	6.70	6.48	0.19	nd	nd	nd	ND
1932	DNGL	SF	P	TORC			Macgregor 195	?	89.90	0.13	1.70	8.20	0.07	nd	0.01	nd	ND
1933	CLWK	HD	H	VESSEL			Cat C16	EROM	71.88	0.38	14.99	11.96	0.13	0.33	nd	nd	ND
1934	WDEK	HD	T	TRT	1		Cat E2 Macgregor 109	EROM	79.53	0.24	13.62	6.39	0.22	nd	nd	nd	ND
1935	MUCL	HD	T	TRT	1		Macgregor 96	?	77.16	0.21	10.01	12.47	0.14	nd	nd	nd	ND
1936	MUCL	HD	T	TRT	1		Macgregor 97	?	86.71	0.48	1.54	10.52	0.74	nd	nd	nd	ND
1937	MUCL	HD	T	TRT	1		Macgregor 95	?	85.93	3.22	5.57	5.23	0.05	nd	nd	nd	ND
1938	MUCL	HD	T	TRT	1		Macgregor 94	?	88.98	0.83	1.18	8.94	0.07	nd	nd	nd	ND
1939	MUCL	HD	T	TRT	3		Macgregor 59	?	86.95	0.88	4.75	7.43	0.00	nd	nd	nd	ND
1940	CLWK	HD	H	HANDLE		TANKARD HOLDFAST	Cat C2 Macgregor 287	EROM	80.85	0.69	9.46	8.93	0.07	nd	nd	nd	ND
1941	CLWK	HD	H	HOOK			Cat C59	EROM	92.61	nd	2.67	4.63	0.08	nd	0.01	nd	ND
1942	CLWK	HD	H	SHEET		VESSEL REPAIRED	Cat C17	EROM	86.03	0.11	0.46	12.14	0.05	nd	0.01	nd	ND
1943	CLWK	HD	?	SHEET		REUSED PATERA ?	Cat C19	EROM	84.58	8.61	0.61	5.29	0.28	nd	nd	nd	ND
1944	CLWK	HD	H	U-BIND			unnumbered	EROM	81.49	15.98	0.49	1.64	0.31	nd	0.01	nd	ND
1946 a	CLWK	HD	H	VESSEL		SANTON CAULDRON?	Cat C18	EROM	87.24	nd	nd	11.68	0.13	nd	nd	nd	ND
1946 b	CLWK	HD	H	VESSEL		REPAIR TO 1946a	Cat C18	EROM	86.36	nd	nd	12.44	0.09	nd	nd	nd	ND
1946 c	CLWK	HD	H	VESSEL		REPAIR TO 1946a	Cat C18	EROM	87.11	nd	nd	11.83	0.07	nd	0.01	nd	ND
1947 a	CLWK	HD	H	VESSEL		SANTON CAULDRON	Cat C1 Macgregor 309	EROM	87.65	nd	0.26	10.87	0.10	nd	nd	nd	ND
1947 b	CLWK	HD	H	VESSEL		REPAIR TO 1947a	Cat C1 Macgregor 309	EROM	87.45	nd	nd	11.35	0.11	nd	nd	nd	ND
1947 c	CLWK	HD	H	VESSEL		REPAIR TO 1947a	Cat C1 Macgregor 309	EROM	86.13	nd	0.33	12.28	0.08	nd	0.01	nd	ND
1948 a	BLML	HD	H	VESSEL		GLOBULAR CAULDRON	Cat B1 Macgregor 301	EROM	85.62	0.12	0.99	12.21	0.09	nd	0.02	nd	ND
1948 b	BLML	HD	H	VESSEL		REPAIR TO 1948a	Cat B1 Macgregor 301	EROM	86.23	nd	0.53	12.16	0.10	nd	nd	nd	ND
1949	BLML	HD	H	VESSEL		GLOBULAR CAULDRON	Cat B2 Macgregor 302	EROM	86.25	0.27	nd	11.88	0.10	nd	nd	0.25	ND
1950	LCMN	SF	H	VESSEL		GLOBULAR CAULDRON	Acc DU 6	EROM	93.22	1.22	nd	4.31	0.18	nd	nd	0.38	ND
1951	NEWC	FT	M?	MOUNT		OPENWORK ?	<279> [4028]	ROMN	69.72	1.93	21.12	6.34	0.47	nd	nd	nd	ND
1952	NEWC	FT	?	FRAG			[384] ? B262	ROMN	86.34	2.81	0.99	8.91	0.10	nd	nd	nd	ND
1953	NEWC	FT	?	FRAG			[336] ? B247	ROMN	87.42	0.41	1.55	9.26	0.09	nd	nd	nd	ND
1954	NEWC	FT	M	BTPL	2	TRISKELE	B234	MROM	87.39	0.28	5.16	7.04	0.06	nd	0.01	nd	ND
1955	NEWC	FT	W?	FRAG			B258	ROMN	82.05	0.90	7.97	8.87	0.12	nd	nd	nd	ND
1957	NEWC	FT	H?	WEIGHT		?	<298> [2446] B616	ROMN	85.72	nd	1.24	12.73	0.21	nd	nd	nd	ND
1958	NEWC	FT	?	?		DECORATED	[336] B248	ROMN	72.52	0.86	6.65	19.66	0.14	nd	0.01	nd	ND

XRFID	SITEID	SITETYPE	CLASS	O-TYPE	REF	DESCRIPTION	CATALOGUE, etc	DATE	Cu	Zn	Pb	Sn	Fe	Ni	Mn	As	Co
1959	NEWC	FT	?	?			[290] B261	ROMN	84.33	0.80	3.90	9.87	0.09	nd	nd	nd	ND
1960	NEWC	FT	P/M	BUCKLE		?	[298] B246	ROMN	82.23	0.99	2.93	13.62	0.13	nd	nd	nd	ND
1962	NEWC	FT	P/H	BUCKLE		? OR TOILET LOOP	[286] B245	ROMN	88.37	10.97	0.28	nd	0.32	nd	nd	nd	ND
1964	NEWC	FT	H	SNT	8	TYPE 1	<281> [2327] B587	ROMN	74.82	1.96	14.19	8.70	0.21	nd	nd	nd	ND
1965	NEWC	FT	?	FRAG			<19> [147] B271	ROMN	87.42	2.77	1.92	6.97	0.18	nd	nd	nd	ND
1966	NEWC	FT	W	DROPLT			<145> [570] B415	ROMN	84.32	0.57	5.58	9.26	0.18	nd	nd	nd	ND
1967	NEWC	FT	T/H	RING	2	PENTAGONAL	<175> [557] B331	ROMN	83.56	2.28	8.82	5.27	0.08	nd	nd	nd	ND
1968	NEWC	FT	H	HANDLE		SCALPEL ? UNFINISHED	[282] B244	ROMN	78.95	2.10	11.92	6.77	0.27	nd	nd	nd	ND
1969	NEWC	FT	P	PLB	1		B252	ROMN	83.15	2.21	8.36	6.16	0.12	nd	nd	nd	ND
1970	NEWC	FT	P	ARMLET	9		<273> [2222] B592	ROMN	97.47	0.10	nd	1.80	0.10	nd	nd	0.18	ND
1971	NEWC	FT	M	BUCKLE			B243	MROM	72.39	nd	16.65	10.48	0.14	nd	nd	nd	ND
1972	SETJ	CV	P	BB	10	ACANTHUS ALL	Lord 32	EROM	80.95	12.53	3.52	2.73	0.28	nd	nd	nd	ND
1973	SETJ	CV	P	BB	9	NO ACANTHUS ALL	Lord 33	EROM	66.27	9.24	22.42	1.47	0.28	nd	nd	nd	ND
1974	SETJ	CV	P	BB	11	HEADLOOP	Lord 34	EROM	75.18	1.06	15.35	7.33	0.78	nd	nd	nd	ND
1975	SETJ	CV	P	BB	9	? ACANTHUS HALF	Lord 35	EROM	86.43	6.36	2.89	4.08	0.25	nd	nd	nd	ND
1976	SETJ	CV	P	PLB	1	TRISKELE DECORATION	Lord 36	ROMN	87.47	0.56	1.14	10.68	0.15	nd	nd	nd	ND
1977	SETJ	CV	P	PLB	6	BUCKLER ?	Lord 37	ROMN	81.05	0.18	12.08	6.59	0.11	nd	nd	nd	ND
1978	SETJ	CV	P	ARMLET	1	INCISED HATCHING	Lord 38	ROMN	83.81	13.92	0.46	1.61	0.19	nd	0.01	nd	ND
1979	SETJ	CV	P	ARMLET	11	RIBBED/NOTCHED	Lord 39	ROMN	83.39	nd	1.96	12.66	0.48	nd	0.03	nd	ND
1980	SETJ	CV	P	ARMLET	1		Lord 40	ROMN	85.80	1.72	3.51	8.76	0.20	nd	nd	nd	ND
1981	SETJ	CV	?	SHEET			Lord 41	ROMN	86.49	0.12	0.83	12.49	0.07	nd	nd	nd	ND
1982	SETJ	CV	H	SNT	1		Lord 42	ROMN	83.85	0.12	0.71	15.14	0.17	nd	0.01	nd	ND
1983	SETJ	CV	H	SNT	1		Lord 43	ROMN	88.15	2.16	nd	9.27	0.16	nd	nd	0.26	ND
1984	SETJ	CV	?			SPEAR BUTT/LINCH PIN	Lord 44	ROMN	85.85	1.43	3.69	8.36	0.67	nd	nd	nd	ND
1985	SETJ	CV	T/H	RING	2	HEXAGONAL	Lord 45	ROMN	64.08	17.30	15.48	1.07	1.41	nd	nd	0.60	ND
1986	SETJ	CV	P	BB	12	HEADSTUD	Lord 46	EROM	82.52	14.66	1.24	1.40	0.20	nd	nd	nd	ND
1987 a	SETV	CV	P	PLB	5	BULMER D3	Lord 47	EROM	84.86	4.61	6.11	4.26	0.15	nd	0.01	nd	ND
1987 b	SETV	CV	P	PLB		PIN TO 1987a	Lord 47	EROM	94.49	1.35	0.25	3.73	0.19	nd	nd	nd	ND
1988	SETV	CV	P	BB	9	ACANTHUS ?	Lord 48	EROM	88.86	0.42	2.45	8.28	nd	nd	nd	nd	ND
1989	SETV	CV	P	BB	9	ACANTHUS HALF	Lord 49	EROM	85.87	nd	9.95	4.17	nd	nd	nd	nd	ND
1990	SETV	CV	P	BB	12	?HEADSTUD	Lord 50	EROM	78.83	2.72	10.74	7.61	0.10	nd	nd	nd	ND
1991	SETV	CV	P	PLB	1		Lord 51	ROMN	82.64	2.37	5.31	9.49	0.17	nd	0.02	nd	ND
1992	SETV	CV	P	PLB	1		Lord 52	ROMN	85.27	3.89	3.45	7.07	0.33	nd	nd	nd	ND
1993 a	SETV	CV	P	PAB		ANNULAR BROOCH	Lord 53	ROMN	73.48	nd	16.99	9.54	nd	nd	nd	nd	ND
1993 b	SETV	CV	P	PAB	.	PIN TO 1993a	Lord 53	ROMN	86.28	0.86	4.61	8.25	nd	nd	nd	nd	ND
1995	SETV	CV	P	ARMLET	1	INCISED HATCHING	Lord 55	ROMN	82.88	2.79	6.99	7.25	0.09	nd	nd	nd	ND
1996	SETV	CV	T/H	RING	2	CIRCULAR	Lord 56	ROMN	80.46	11.32	4.86	2.96	0.40	nd	nd	nd	ND
1997	SETV	CV	M	MOUNT		PIERCED	Lord 57	MROM	69.81	0.78	21.46	7.59	0.37	nd	nd	nd	ND
1998	SETV	CV	?	SNT	15		Lord 58	ROMN	80.59	18.24	0.25	0.79	0.12	nd	0.01	nd	ND
1999	SETV	CV	W?	LUMP			Lord 59	ROMN	84.54	0.67	1.88	12.76	0.16	nd	nd	nd	ND
2000	SETV	CV	?	FRAG			Lord 60	ROMN	65.20	4.43	23.84	6.22	0.30	nd	nd	nd	ND

XRFID	SITEID	SITETYPE	CLASS	O-TYPE	REF	DESCRIPTION	CATALOGUE, etc	DATE	Cu	Zn	Pb	Sn	Fe	Ni	Mn	As	Co
2001 a	ARRS	BL	T	HSBT		SIDE LINK 1	Fig 16	EIA	88.58	nd	nd	10.92	nd	0.07	0.01	0.41	0.00
2001 b	ARRS	BL	T	HSBT		SIDE LINK 2	Fig 16	EIA	89.25	nd	0.37	9.93	nd	0.06	nd	0.39	0.02
2001 c	ARRS	BL	T	HSBT		CENTRE LINK	Fig 16	EIA	88.92	nd	2.18	8.71	nd	0.06	nd	0.13	0.00
2002 a	STAN	HD	M	SWORD		IV CHAPE	M62 123	C1AD	81.41	17.43	0.29	0.32	0.55	nd	nd	nd	ND
2002 b	STAN	HD	M	SWORD		IV SUSPENSION LOOP	M62 123	C1AD	76.86	22.95	nd	nd	0.18	nd	0.01	nd	ND
2003	STAN	HD	T	B&L	2	? SET ?	M62 25	C1AD	88.82	nd	0.20	10.91	0.07	nd	nd	nd	ND
2004 a	STAN	HD	T	LINCHP		TOP SET ?	M62 79	C1AD	90.23	nd	nd	8.76	1.01	nd	nd	nd	ND
2004 b	STAN	HD	T	LINCHP		BOTTOM SET ?	M62 79	C1AD	89.15	0.35	0.33	9.55	0.63	nd	nd	nd	ND
2005 a	INGL	SF	H	HANDLE		MIRROR RING	Macgregor 269	?	73.92	nd	19.83	6.14	0.12	nd	nd	nd	ND
2005 b	INGL	SF	H	HANDLE		MIRROR HOLDER	Macgregor 269	?	80.12	1.75	12.73	5.30	0.09	nd	nd	nd	ND
2006	STAN	HD	T	LMOUNT		SET C	M62 15	C1AD	80.82	18.79	nd	0.27	0.12	nd	nd	nd	ND
2007	STAN	HD	T	STJN		SET A	M62 5	C1AD	77.06	21.40	nd	1.37	0.17	nd	nd	nd	ND
2008	STAN	HD	T	LMOUNT		SET C	M62 3	C1AD	80.18	18.70	0.28	0.47	0.31	0.05	0.01	nd	ND
2009	STAN	HD	T	B&L	2	? SET C	M62 28	C1AD	80.28	19.13	0.18	0.17	0.24	nd	nd	nd	ND
2010	STAN	HD	T	STJN		SET D	M62 9	C1AD	91.76	0.30	nd	7.72	0.22	nd	nd	nd	ND
2011 a	STAN	HD	?	?		CYLINDER WITH TORUS	M62 92	C1AD	77.68	21.54	0.52	0.13	0.26	nd	nd	nd	ND
2011 b	STAN	HD	?	SHEET		ATTACHED TO 2011a	M62 92	C1AD	81.19	17.35	0.26	0.28	0.75	nd	nd	nd	ND
2012 a	STAN	HD	H	VESSEL		SPUN ?	M62 121	C1AD	87.95	nd	0.19	10.45	0.31	nd	nd	0.19	ND
2013 a	STAN	HD	T	HSBT		SIDE LINK/RING SET D	M62 47	C1AD	88.81	0.54	0.20	10.39	0.06	nd	nd	nd	ND
2013 b	STAN	HD	T	HSBT		CENTRE LINK SET D	M62 47	C1AD	90.33	1.12	0.38	7.98	0.20	nd	nd	nd	ND
2014	STAN	HD	T	HSBT		SIDE LINK/RING SET C	M62 45	C1AD	80.71	18.41	0.23	0.55	0.09	nd	nd	nd	ND
2015	STAN	HD	T	TRT	5	SET D	M62 69	C1AD	92.19	nd	nd	7.73	0.07	nd	nd	nd	ND
2016	STAN	HD	T	TRT	2	DECORATED DOTS SET C	M62 64	C1AD	79.08	20.13	0.24	0.42	0.12	nd	nd	nd	ND
2017	STAN	HD	T	STJN		ATTACHED 2018 SET C	M62 22	C1AD	79.52	20.04	nd	0.20	0.24	nd	nd	nd	ND
2018	STAN	HD	T	STJN		ATTACHED 2017 SET C	M62 22	C1AD	78.39	20.95	nd	0.47	0.18	nd	nd	nd	ND
2019 a	STAN	HD	?	STRIP		REPOUSSE ROSETTES	M62 100	C1AD	88.85	nd	0.27	9.71	0.20	nd	nd	nd	ND
2019 c	STAN	HD	?	STRIP		REPOUSSE ROSETTES	M62 100	C1AD	91.70	nd	0.25	7.18	0.26	nd	0.03	nd	ND
2020	STAN	HD	T	LINCHP		? OR SPEAR BUTT	M62 80	C1AD	85.14	0.96	1.12	11.44	0.89	0.05	nd	0.15	ND
2021 a	STAN	HD	?	STRIP		WITH EDGING	M62 135	C1AD	82.15	17.19	nd	0.17	0.35	0.14	nd	nd	ND
2021 b	STAN	HD	?	STRIP		WITH EDGING	M62 135	C1AD	83.58	15.39	0.27	0.34	0.28	nd	nd	nd	ND
2022	STAN	HD	?	STRIP		REPOUSSE FEATHER	M62 101	C1AD	86.61	nd	0.17	11.27	0.59	nd	nd	nd	ND
2023	STAN	HD	H	SNT	2	CONICAL	M62 116	C1AD	86.18	3.08	4.78	4.24	0.30	0.18	nd	0.79	ND
2024	STAN	HD	M	MAILFS		ROMAN TYPE ?	M62 120	C1AD	74.02	24.68	0.19	0.26	0.80	0.05	nd	nd	ND
2025 a	CATT	SF	M	BUCKLE		HAWKES&DUNNING IVB	Fig 22	C4AD	72.59	9.53	11.79	5.93	0.17	nd	nd	nd	ND
2025 b	CATT	SF	M	BUCKLE		PIN TO 2025a	Fig 22	C4AD	72.94	20.36	4.91	1.43	0.27	0.09	nd	nd	ND
2026	STAN	HD	T	LINCHP		HEAD SET C	M62 77	C1AD	78.99	19.68	0.45	0.48	0.38	nd	0.01	nd	ND
2027	STAN	HD	T	TOGGLE		QUATREFOIL SECTION	M62 21	C1AD	87.00	0.66	0.25	11.87	0.07	0.07	nd	nd	ND
2028	STAN	HD	W			DEBRIS? OR BURNT	M62 124	C1AD	82.80	15.78	nd	1.02	0.24	nd	nd	0.16	ND
2029	STHW	SR	H	RAZOR			Fig 61, 1	LBA	90.93	nd	0.40	8.65	nd	nd	0.01	nd	ND
2030	STHW	SR	H	CHISEL			Fig 61, 5	LBA	90.85	nd	2.00	7.08	nd	0.05	0.01	nd	ND
2031	STHW	SR	H	RAZOR		HALSTATT I TYPE	Fig 61, 2	LBA	85.01	nd	5.12	9.79	nd	0.08	nd	nd	ND

XRFID	SITEID	SITETYPE	CLASS	O-TYPE	REF	DESCRIPTION	CATALOGUE, etc	DATE	Cu	Zn	Pb	Sn	Fe	Ni	Mn	As	Co
2032 a	STAN	HD	?	?		CYLINDER WITH TORUS	M62 92	C1AD	83.08	16.76	nd	nd	0.14	nd	nd	nd	ND
2032 b	STAN	HD	?	SHEET		ATTACHED TO 2032a	M62 92	C1AD	77.17	22.19	0.19	0.19	0.13	0.12	nd	nd	ND
2033	SETJ	CV	?	HANDLE		? UNFINISHED ?	Lord 61	ROMN	88.41	2.15	1.08	8.24	0.11	nd	nd	nd	ND
2034	SETJ	CV	M	BTPL	2	LATTICE	Lord 62	MROM	80.65	2.11	8.84	8.03	0.37	nd	nd	nd	ND
2035	SETV	CV	P	PLB	1		Lord 63	ROMN	86.55	3.19	1.70	8.16	0.25	nd	nd	0.16	ND
2036	SETV	CV	P	PLB	5	FEACHEM42 cf BULMER H	Lord 64	EROM	87.75	0.32	7.64	4.28	nd	nd	0.01	nd	ND
2037	SETV	CV	P	STRIP		NOTCHED	Lord 65	ROMN	87.73	0.35	3.71	8.16	0.05	nd	nd	nd	ND
2038	SETV	CV	H	TLIM	9	MAKER'S STAMP ?	Lord 66	ROMN	88.51	1.43	0.65	9.31	0.08	nd	0.01	nd	ND
2039	SETV	CV	H	TLIM	2	A PAIR WITH 2038	Lord 67	ROMN	87.54	1.32	1.04	10.03	0.07	nd	nd	nd	ND
2040	SETA	CV	P	BB	10	ACANTHUS ALL	Lord 68	EROM	82.47	9.29	3.62	4.39	0.23	nd	nd	nd	ND
2041	SETA	CV	P	PLB	5	FEACHEM 39	Lord 69	EROM	84.62	1.38	5.30	8.53	0.16	nd	nd	nd	ND
2042	SETA	CV	P	BB	15		Lord 70	MROM	85.29	0.23	3.87	10.33	0.27	nd	0.01	nd	ND
2043	SETA	CV	P	PAB	1	A3	Lord 71	ROMN	82.22	0.58	4.45	11.45	0.17	nd	nd	nd	ND
2044	SETA	CV	P	BB	9	NO ACANTHUS ALL	Lord 72	EROM	81.61	0.61	6.01	11.72	0.06	nd	nd	nd	ND
2045	SETA	CV	P	TORC		BEADED	Lord 73	ROMN	90.06	nd	nd	9.64	0.17	nd	nd	0.13	ND
2046	SETA	CV	P	PLB	1	MODERN BOSS ?	Lord 74	ROMN	80.12	1.90	11.78	6.02	0.18	nd	nd	nd	ND
2047	SETA	CV	M	SCRN			Lord 75	MROM	75.19	6.07	12.52	5.84	0.38	nd	nd	nd	ND
2048	SETA	CV	H	U-BIND			Lord 76	ROMN	88.99	0.51	0.28	9.23	0.09	nd	nd	nd	ND
2050	SETC	CV	H	U-BIND			Lord 78	ROMN	86.82	nd	0.41	11.65	0.22	nd	nd	nd	ND
2051	THTW	SR	?	FRAG			<91> [B 274]	LIA	80.86	18.49	nd	0.34	0.25	0.05	0.01	nd	ND
2052	THTW	SR	?	STRIP			<69> [? 160]	LIA	86.94	nd	nd	11.79	0.09	nd	nd	nd	ND
2053	THTW	SR	W	DROPLT			<106> [B 332]	ROMN	80.15	18.58	nd	0.87	0.18	nd	nd	nd	ND
2055	THTW	SR	W	DROPLT			<198> [C 902]	LIA	88.20	nd	0.37	9.86	0.09	0.05	0.01	0.10	ND
2056	THTW	SR	W	DROPLT			<248> [C 938]	LIA	100.00	nd	nd	nd	nd	nd	nd	nd	ND
2057 a	PLMS	SF	M	DAGGER		IV TERMINAL	Macgregor 155	EROM	90.69	0.18	0.56	8.36	0.20	nd	0.01	nd	ND
2057 b	PLMS	SF	M	DAGGER		IV LATERAL BINDING	Macgregor 155	EROM	91.03	nd	0.86	7.91	0.19	nd	nd	nd	ND
2057 c	PLMS	SF	M	DAGGER		IV LONGITUDINL BINDNG	Macgregor 155	EROM	84.65	nd	0.48	14.61	0.14	nd	nd	0.12	ND
2057 d	PLMS	SF	M	DAGGER		IV SUSPENSION LOOP	Macgregor 155	EROM	89.97	0.10	0.83	8.03	0.99	0.06	0.02	nd	ND
2058	PIER	FT	H	D-CLIP			<3118> [431]	LROM	96.83	nd	1.09	1.64	0.07	nd	nd	nd	ND
2059	PIER	FT	?	STRIP		UNFINISHED OBJECT ?	<3010a> [430]	LROM	88.94	nd	1.22	8.77	0.09	nd	nd	nd	ND
2060	PIER	FT	P	BUCKLE		PIN FROM	<3117> [423]	LROM	84.48	nd	1.57	13.89	0.07	nd	nd	nd	ND
2061 a	PIER	FT	?	SHEET		RING AND DOT DECORATE	<2736> [421]	LROM	87.96	nd	1.04	9.70	0.10	nd	0.02	nd	ND
2061 b	PIER	FT	H	SNT	11	?	<2736> [421]	LROM	97.49	nd	1.17	0.92	0.15	nd	nd	nd	ND
2062	PIER	FT	?	FRAG		WASHER ?	<2705> [421]	LROM	87.63	nd	1.95	9.33	0.18	nd	0.02	nd	ND
2064 a	PIER	FT	H	SNT	6		<2518> [414]	LROM	72.44	22.73	1.26	2.55	0.47	nd	0.01	0.10	ND
2065	PIER	FT	P	ARMLET	11		<2602> [414]	LROM	81.42	11.34	2.40	3.94	0.26	nd	nd	nd	ND
2066	PIER	FT	M?	LOHG		? LOBATE HINGE ?	<1564> [322]	EROM	88.01	2.80	1.20	6.93	0.27	nd	nd	nd	ND
2067	PIER	FT	?	FSHEET			<1990> [304]	LROM	90.56	nd	0.90	7.69	0.06	nd	0.01	nd	ND
2068	PIER	FT	H	U-BIND			<1989> [304]	LROM	87.14	1.21	2.34	8.21	0.16	nd	nd	nd	ND
2069	PIER	FT	H	SNT	16	DOMED	<1795> [218]	LROM	87.84	2.86	2.35	6.72	0.16	nd	nd	nd	ND
2070	PIER	FT	M	ARTP			<742> [100]	LROM	67.88	0.92	24.55	5.46	1.09	nd	nd	nd	ND

XRFID	SITEID	SITETYPE	CLASS	O-TYPE	REF	DESCRIPTION	CATALOGUE, etc	DATE	Cu	Zn	Pb	Sn	Fe	Ni	Mn	As	Co
2071	PIER	FT	P	ARMLET	7		<1037> [14W]	LROM	88.02	nd	1.92	8.69	0.17	nd	nd	nd	ND
2072	PIER	FT	P	ARMLET	4		<3804> [557]	LROM	85.07	5.73	2.35	6.02	0.24	nd	0.03	nd	ND
2073	DRAG	SF	M	BUCKLE		HAWKES&DUNNING IIA	Philip Maw	C4AD	73.53	0.12	18.25	7.92	0.06	nd	nd	nd	ND
2074	DRAG	SF	M	BUCKLE		HAWKES&DUNNING ?	Philip Maw	C4AD	79.77	0.39	7.69	11.98	0.16	nd	nd	nd	ND
2075	PIER	FT	H	TLIM	2		<1476> [316]	LROM	84.42	11.99	0.79	2.19	0.31	nd	nd	nd	ND
2076	PIER	FT	?	STRIP			<1362> [313]	LROM	86.32	0.10	3.33	9.39	0.09	0.06	nd	nd	ND
2077	PIER	FT	H	?		FITTING PAW	<1227> [300]	LROM	74.34	21.77	2.32	0.55	0.50	0.08	nd	0.44	ND
2078	PIER	FT	P	ARMLET	4		<1217> [300]	LROM	84.19	nd	3.50	10.85	0.07	nd	nd	nd	ND
2079	PIER	FT	H	SNT	3		<1310> [227]	LROM	83.83	11.61	0.80	3.39	0.37	nd	nd	nd	ND
2081	PIER	FT	?	SHEET			<1396> [195]	LROM	86.81	1.24	1.51	9.22	0.11	0.05	0.02	nd	ND
2082	PIER	FT	?	WIRE		HOOK ?	<1237> [195]	LROM	87.36	0.73	0.86	9.57	0.17	nd	nd	nd	ND
2083	PIER	FT	H	SNT	12		<1187> [195]	LROM	87.48	0.44	1.12	9.66	0.11	nd	nd	nd	ND
2084	PIER	FT	H	SNT	3	?	<1022> [190]	LROM	86.94	nd	2.30	9.68	0.05	nd	nd	nd	ND
2085	PIER	FT	P?	TORC		? LIGULA@TWISTED STEM	<1013> [190]	LROM	87.39	6.44	2.46	3.27	0.23	nd	nd	0.21	ND
2087	PIER	FT	P	ARMLET	6		<896> [175]	LROM	83.05	10.01	1.66	4.69	0.15	0.08	nd	nd	ND
2088	PIER	FT	?	STRIP		BUCKLE PIN ?	<843> [175]	LROM	84.83	nd	3.38	10.46	0.05	nd	0.02	nd	ND
2089	PIER	FT	?	SHEET			<1644> [478]	LROM	85.64	1.47	3.72	8.35	0.12	nd	nd	nd	ND
2090	RUDV	VL	H	SNT	11		Cat 58	LROM	86.02	0.28	nd	13.61	0.09	nd	nd	nd	ND
2091	RUDV	VL	P	PAB	2	C	Cat 20	EROM	83.82	0.77	nd	15.11	0.12	0.07	0.02	0.10	ND
2092	RUDV	VL	H	SNT	9		Cat 55	?	83.58	0.12	0.75	13.85	0.16	nd	nd	0.31	ND
2093 a	RUDV	VL	P	BB		EARLY HINGED TYPE	Cat 4	EROM	81.73	16.42	0.39	1.10	0.36	nd	nd	nd	ND
2093 b	RUDV	VL	P	BB		EARLY HINGED TYPE	Cat 5	EROM	81.47	14.75	0.77	2.78	0.21	nd	0.01	nd	ND
2094	RUDV	VL	P/T	B&L		LOOP ONLY	Cat 41A	?	92.49	nd	4.31	3.15	nd	0.05	nd	nd	ND
2095	RUDV	VL	H	SNT	6		Cat 53	LROM	79.39	17.87	0.39	1.72	0.41	nd	0.01	nd	ND
2096	RUDV	VL	H	TLIM	6		Cat 35	EROM	83.71	1.39	0.29	12.11	1.15	0.10	nd	nd	ND
2097	RUDV	VL	P	BB	5		Cat 1	C1AD	80.54	18.95	nd	nd	0.49	nd	0.01	nd	ND
2098	RUDV	VL	H	SNT	11		Cat 56	?	82.83	3.69	6.02	7.27	0.18	nd	nd	nd	ND
2099	RUDV	VL	H	VESSEL		OR LADLE	Cat 50	C3AD	84.95	2.33	1.15	7.86	2.60	nd	nd	nd	ND
2100	RUDV	VL	P	PAB	1	A	Cat 21A	C2AD	85.31	nd	0.29	14.33	0.08	nd	nd	nd	ND
2101	RUDV	VL	H	SNT	1		Cat 61A	C4AD	87.90	0.39	0.74	10.89	0.09	nd	nd	nd	ND
2102	RUDV	VL	?	STRIP			Cat 32	LROM	89.45	0.54	2.09	6.88	0.07	nd	nd	nd	ND
2103	RUDV	VL	H	U-BIND			Cat 49	C2AD	84.64	10.74	nd	4.04	0.17	0.05	nd	nd	ND
2104	RUDV	VL	H	SNT	1		Cat 61	C2AD	84.26	13.39	0.77	1.38	0.18	nd	0.01	nd	ND
2105	RUDV	VL	H	U-BIND			Cat 48	?	87.93	nd	nd	10.64	0.08	0.09	nd	nd	ND
2106	RUDV	VL	H	U-BIND			Cat 48	?	85.99	1.35	1.21	10.34	0.12	0.06	nd	0.16	ND
2107	RUDV	VL	?	STRIP		REPOUSEE DECORATION	Cat 46	C4AD	96.63	nd	0.20	2.51	0.18	nd	nd	nd	ND
2108	RUDV	VL	P	BB	9	ACANTHUS HALF	Cat 11	EROM	80.72	13.96	4.55	0.62	0.15	nd	nd	nd	ND
2109	RUDV	VL	P	BB	10	ACANTHUS HALF	Cat 9	C2AD	78.89	15.87	3.38	1.69	0.17	nd	nd	nd	ND
2110 a	RUDV	VL	P	PAB	1	A/A3	Cat 22	LROM	83.33	0.25	0.30	15.86	0.19	0.07	nd	nd	ND
2110 b	RUDV	VL	P	PAB		PIN TO 2110a	Cat 22	LROM	88.27	0.30	0.72	9.49	0.11	nd	nd	nd	ND
2111	RUDV	VL	W	DROPLT			[RA/JW]	LROM	82.59	13.20	0.43	3.49	0.29	nd	nd	nd	ND

XRFID	SITEID	SITETYPE	CLASS	O-TYPE	REF	DESCRIPTION	CATALOGUE, etc	DATE	Cu	Zn	Pb	Sn	Fe	Ni	Mn	As	Co
2112	RUDV	VL	W	DROPLT			<3> [RB/AG]	MROM	79.72	2.33	10.46	7.26	0.14	nd	nd	nd	ND
2114 a	RUDV	VL	W	DROPLT			[RD/BS]	?	69.77	0.64	3.85	23.84	nd	nd	nd	nd	ND
2114 b	RUDV	VL	W	DROPLT			[RD/BS]	?	83.50	nd	7.70	7.76	0.09	nd	0.01	nd	ND
2115 a	RUDV	VL	W	DROPLT			[RD/AB]	?	81.74	9.80	0.56	7.22	0.11	nd	0.01	nd	ND
2114 b	RUDV	VL	W	DROPLT			[RD/AB]	?	92.86	nd	0.31	5.71	0.09	0.15	nd	nd	ND
2114 c	RUDV	VL	W	DROPLT			[RD/AB]	?	91.91	nd	0.18	6.89	nd	nd	nd	nd	ND
2114 d	RUDV	VL	W	DROPLT			[RD/AB]	?	85.18	1.11	2.98	9.97	0.10	nd	nd	nd	ND
2114 f	RUDV	VL	W	DROPLT			[RD/AB]	?	75.26	0.85	6.34	15.92	0.13	nd	nd	nd	ND
2116	RUDV	VL	P	ARMLET	6		Cat 30	LROM	78.50	11.88	3.00	6.02	0.36	nd	nd	nd	ND
2117	RUDV	VL	W	DROPLT			<39> [RS/GV]	?	88.67	0.11	1.89	9.04	0.13	nd	nd	0.17	ND
2118	RUDV	VL	P	BB	10	ACANTHUS HALF	Cat 10	EROM	78.62	13.80	3.87	3.52	0.18	nd	nd	nd	ND
2119	RUDV	VL	P	RING	3		Cat 29A	LROM	78.99	17.05	1.92	1.42	0.21	0.08	nd	nd	ND
2120	RUDV	VL	H	SNT	6		Cat 52	C2AD	82.42	10.50	0.87	5.25	0.25	nd	nd	nd	ND
2121	SCAR	HF	P	ARMLET	1		Fig 7	LBA	99.72	nd	nd	nd	0.07	nd	nd	0.20	ND
2122	SCAR	HF	T/H	RING	2	CIRCULAR WORN	Fig 6	ROMN	74.74	5.19	9.32	10.58	0.17	nd	nd	nd	ND
2123	SCAR	HF	T/H	RING	2	CIRCULAR WORN	Fig 6	ROMN	74.43	5.09	10.28	10.00	0.21	nd	nd	nd	ND
2124	SCAR	HF	H	GOUGE			Fig 4	LBA	80.47	nd	4.87	13.65	0.48	0.07	nd	0.45	ND
2127	SCAR	HF	M?	AXE		SOCKETED AXE NO RIBS	cf Fig 1	LBA	92.54	nd	2.91	4.45	nd	0.09	nd	nd	ND
2128	SCAR	HF	W	JET			Fig 2	LBA	93.94	nd	3.85	1.96	nd	0.08	nd	0.17	ND
2130	SCAR	HF	M?	AXE		SOCKETED AXE 3 RIBS	Fig 1	LBA	68.58	nd	22.64	8.29	0.05	nd	nd	0.33	ND
2131	PIER	FT	T	SPUR			<3774> [446]	LROM	85.92	2.00	6.50	5.38	0.19	nd	nd	nd	ND
2132	PIER	FT	P	ARMLET	3		<3001> [913]	LROM	99.41	nd	0.23	0.00	0.08	nd	0.02	nd	ND
2134	PIER	FT	H	VESSEL			<3797> [535]	LROM	71.80	nd	16.14	11.68	nd	nd	nd	nd	ND
2135	PIER	FT	M	SCRN			<3936> [465]	C2AD	75.21	7.30	12.25	4.98	0.26	nd	nd	nd	ND
2136	PIER	FT	P	RING	4	?	<3226>	LROM	87.10	nd	2.76	8.88	0.08	nd	nd	nd	ND
2137	PIER	FT	?	FRAG			<1692> [114]	LROM	85.43	4.29	1.90	7.30	0.21	nd	nd	nd	ND
2138	PIER	FT	H	SNT	8	TYPE 1	<2794> [1006]	LROM	79.84	0.42	11.94	7.60	0.20	nd	nd	nd	ND
2139	PIER	FT	?	WIRE			<2941> [927]	LROM	88.85	nd	1.86	8.00	0.17	nd	nd	nd	ND
2140	PIER	FT	?	WIRE		EAR-RING HOOK ?	<2579> [922]	LROM	94.50	nd	1.97	2.87	0.15	nd	nd	nd	ND
2141	PIER	FT	P?	RING	3	?	<1978> [505]	LROM	89.94	nd	1.08	7.65	0.05	nd	nd	0.20	ND
2142	PIER	FT	P	ARMLET	6		<1921> [505]	LROM	77.99	10.03	3.65	7.54	0.21	0.06	nd	nd	ND
2144	PIER	FT	P?	ARMLET	12	?	<2345> [907]	LROM	83.53	0.32	7.37	8.13	0.13	nd	nd	nd	ND
2145	PIER	FT	P/M	BUCKLE		PIN	<2501> [902]	LROM	87.92	0.49	1.82	8.42	0.16	nd	0.02	nd	ND
2146	PIER	FT	?	STRIP			<2445> [902]	LROM	85.68	nd	1.75	11.01	0.10	0.06	nd	nd	ND
2147	PIER	FT	P	ARMLET	12		<3053> [901]	LROM	84.43	nd	2.09	12.06	0.10	0.09	nd	nd	ND
2148	PIER	FT	P?	ARMLET	11	?	<1984> [900	LROM	87.22	nd	2.98	8.74	nd	0.05	nd	nd	ND
2149	PIER	FT	H	SNT	11		<2798> [847]	LROM	82.54	8.16	2.97	5.83	0.24	0.05	nd	0.23	ND
2150	PIER	FT	P	RING	1	NO HENIG	<1873> [806]	LROM	80.19	0.29	12.36	7.17	0.09	nd	nd	nd	ND
2151	PIER	FT	H	NEEDLE			<2387> [538]	LROM	87.28	4.95	1.38	6.06	0.34	nd	nd	nd	ND
2152	PIER	FT	H	?		LEG FROM CANDLESTICK?	<2360> [821]	LROM	86.83	1.72	2.15	9.12	0.19	nd	nd	nd	ND
2153	PIER	FT	P	ARMLET	4		<2344> [536]	LROM	83.38	1.74	4.86	9.19	0.08	nd	nd	nd	ND

XRFID	SITEID	SITETYPE	CLASS	O-TYPE	REF	DESCRIPTION	CATALOGUE, etc	DATE	Cu	Zn	Pb	Sn	Fe	Ni	Mn	As	Co
2154	PIER	FT	P?	ARMLET	11	? SNAKE	<2280> [505]	LROM	86.29	nd	1.52	10.97	0.07	nd	0.01	nd	ND
2155	PIER	FT	H	NEEDLE			<3862> [542]	LROM	85.87	7.14	1.15	5.47	0.34	nd	nd	nd	ND
2156	PIER	FT	P	ARMLET	4		<4472> [1069]	C4AD	79.52	9.47	3.52	6.58	0.27	0.07	nd	nd	ND
2157	PIER	FT	?	STRIP		ARMLET ?	<4473> [1069]	C4AD	80.01	7.65	3.87	7.37	0.19	0.06	nd	nd	ND
2158	PIER	FT	H	SNT	8	TYPE 1	<4479> [1069]	C4AD	78.78	0.94	8.95	10.66	0.55	nd	nd	nd	ND
2161	PIER	FT	P/H	PIN	1	OR UNFINISHED NEEDLE	<4435> [1069]	C4AD	89.92	1.11	2.51	6.29	0.18	nd	nd	nd	ND
2162 a	PIER	FT	M	PTSE		HAWKES&DUNNING V	<4425> [1069]	C4AD	86.63	1.38	1.45	9.64	0.12	nd	nd	nd	ND
2162 b	PIER	FT	M	PTSE		HAWKES&DUNNING V	<4425> [1069]	C4AD	85.81	1.30	1.61	10.35	0.13	nd	nd	nd	ND
2163	PIER	FT	P	ARMLET	4		<4421> [1069]	C4AD	86.05	1.48	1.93	9.40	0.10	nd	nd	nd	ND
2164	PIER	FT	M	PTSE		HAWKES&DUNNING V	<4277> [1048]	C4AD	84.33	nd	2.55	11.64	0.08	nd	nd	nd	ND
2165	PIER	FT	M	PTSE		HAWKES&DUNNING V	<4281> [1048]	C4AD	85.90	3.60	1.82	7.09	0.55	nd	0.02	nd	ND
2166	PIER	FT	?	STRIP		BENT LIKE A HOOK	<4697> [1069]	C4AD	83.08	14.73	0.20	1.65	0.34	nd	nd	nd	ND
2167	PIER	FT	P?	PIN		RATTLE ?	<4692> [1069]	C4AD	78.33	17.99	0.58	2.34	0.40	0.07	nd	nd	ND
2168 a	PIER	FT	P	PAB		PIN	<4662> [1069]	C4AD	89.70	0.14	1.71	7.91	nd	nd	nd	nd	ND
2168 b	PIER	FT	P	ARMLET	6		<4662> [1069]	C4AD	84.41	1.11	4.30	9.24	0.13	nd	nd	nd	ND
2168 c	PIER	FT	?	STRIP			<4662> [1069]	C4AD	76.66	15.79	2.97	3.97	0.29	0.08	nd	nd	ND
2169 a	PIER	FT	M	SCAR			<4661> [1069]	C4AD	87.85	0.00	0.84	9.73	0.10	nd	0.01	0.14	ND
2169 b	PIER	FT	M	PTSE		HAWKES&DUNNING V	<4661> [1069]	C4AD	87.56	3.00	0.51	8.14	0.11	nd	nd	nd	ND
2170	PIER	FT	?	?			<4556> [1069]	C4AD	82.00	1.42	8.87	7.48	0.23	nd	nd	nd	ND
2171	PIER	FT	H	SEALBX			<4550> [1069]	C4AD	80.22	1.77	5.91	11.91	0.19	nd	nd	nd	ND
2172	PIER	FT	P	ARMLET	6		<4529> [1069]	C4AD	85.80	0.82	2.00	10.37	0.12	nd	nd	nd	ND
2173	PIER	FT	P	ARMLET	11	CAST NOTCHES& ZIG-ZAG	<4506> [1069]	C4AD	85.81	0.31	6.40	6.71	0.05	nd	nd	nd	ND
2175	PIER	FT	H	SNT		CF SNT 8	<4796> [1366a]	LROM	5.94	0.61	12.92	10.25	0.27	nd	nd	nd	ND
2176	PIER	FT	T	PEND			<3932> [873]	EROM	81.07	16.74	0.18	1.71	0.30	nd	nd	nd	ND
2177	PIER	FT	H	U-BIND			<3365b> [855]	LROM	84.89	0.86	1.66	11.22	0.13	nd	nd	nd	ND
2178	PIER	FT	H	TLIM	5	W. SUSPENSION LOOP	<4006> [943]	LROM	84.27	10.14	0.87	4.39	0.32	nd	nd	nd	ND
2179	PIER	FT	P/H	PIN	1		<3674> [870]	LROM	87.81	1.66	0.22	9.38	0.13	nd	0.01	0.12	ND
2180	PIER	FT	P?	BEAD			<4016> [1100]	LROM	70.86	2.63	14.57	11.06	0.28	nd	nd	nd	ND
2181	PIER	FT	H	TLIM	2		<4018> [1100]	LROM	85.53	6.67	2.07	5.46	0.27	nd	nd	nd	ND
2182	PIER	FT	H	TLIM		REUSED AS SPIRAL RING	<4007> [1102]	LROM	86.90	6.51	0.24	5.63	0.32	nd	nd	nd	ND
2183	PIER	FT	H	BELL		?	<4104> [1209]	LROM	88.16	0.75	nd	9.97	0.14	nd	nd	0.13	ND
2185 a	PIER	FT	P/M	BUCKLE			<3539> [816]	LROM	87.25	1.24	1.69	9.43	0.38	nd	nd	nd	ND
2186	PIER	FT	P	ARMLET	5	3 STRANDS	<3501> [816]	LROM	86.40	3.10	1.53	7.52	0.52	nd	nd	nd	ND
2187	PIER	FT	P/M	BUCKLE		?TOILET SUSPENSION LP	<3597> [591]	LROM	89.22	2.02	1.79	6.77	0.14	nd	nd	nd	ND
2188	PIER	FT	M	SCRN			<4787> [1344]	C3AD	75.35	6.23	11.16	6.98	0.27	nd	nd	nd	ND
2189	PIER	FT	T	LMOUNT		3 BALLS	<4783> [1327]	LROM	87.68	1.91	4.33	5.78	0.30	nd	nd	nd	ND
2190	PIER	FT	?	SHEET			<4757> [1322]	LROM	84.00	nd	0.35	13.41	0.15	0.10	0.06	0.13	ND
2191	PIER	FT	H	SNT	8	TYPE 2	<4748> [1321]	LROM	79.77	1.33	11.50	7.31	0.10	nd	nd	nd	ND
2192	PIER	FT	H	?		STEELYARD	<4876> [1356]	LROM	92.29	1.37	1.83	4.27	0.23	nd	nd	nd	ND
2194	PIER	FT	?	SHEET			<921> [137]	LROM	85.86	5.75	0.27	7.06	0.31	nd	nd	0.12	ND
2195	PIER	FT	H	TLIM	6		<909> [137]	LROM	78.60	18.32	2.12	0.42	0.38	0.07	nd	nd	ND

XRFID	SITEID	SITETYPE	CLASS	O-TYPE	REF	DESCRIPTION	CATALOGUE, etc	DATE	Cu	Zn	Pb	Sn	Fe	Ni	Mn	As	Co
2196	PIER	FT	?	MOUNT			<785> [127]	LROM	77.33	4.49	9.90	6.67	0.28	nd	nd	nd	ND
2197	PIER	FT	?	SHEET			<676> [127]	LROM	88.05	1.79	0.90	7.48	0.14	nd	0.03	nd	ND
2198	PIER	FT	P	ARMLET	4	?	<656> [127]	LROM	81.82	14.20	1.12	2.21	0.34	0.05	nd	0.00	ND
2199	PIER	FT	P?	BEAD		? PENANNULAR	<689> [114]	LROM	86.04	9.37	0.41	3.49	0.48	nd	nd	0.20	ND
2201	PIER	FT	M/T	PEND		2OPENWORK	<432> [114]	C3AD	79.11	2.66	11.17	6.76	0.23	nd	nd	nd	ND
2202	PIER	FT	H	NEEDLE			<935> [50]	LROM	86.99	7.03	1.88	3.10	0.37	0.10	0.01	0.35	ND
2204	PIER	FT	M	ARTP			<434> [31]	LROM	64.52	0.90	26.49	7.59	0.35	nd	nd	nd	ND
2205	PIER	FT	M?	SCAR		?	<469> [24]	LROM	85.75	nd	1.91	10.86	0.12	nd	0.02	nd	ND
2207	PIER	FT	?	FRAG			<420> [11]	LROM	80.12	nd	19.99	0.32	nd	nd	nd	0.27	ND
2208	PIER	FT	?	STRIP		PIERCED	<308> [100]	LROM	99.74	nd	nd	nd	nd	nd	nd	nd	ND
2209	PIER	FT	H	KEY			<304> [3A]	LROM	78.66	0.15	13.64	7.47	0.07	nd	nd	nd	ND
2210	PIER	FT	?	STRIP			<152> [12]	LROM	76.27	20.18	0.93	1.99	0.41	0.07	nd	nd	ND
2211	PIER	FT	T	STJN		CRUCIFORM	<17> [12B]	LROM	76.60	6.94	8.15	7.79	0.43	nd	nd	nd	ND
2212	PIER	FT	T	TRT	4		<93> [52a]	IA	88.37	nd	0.59	10.39	0.15	0.11	nd	0.38	0.00
2213	ARRS	BL	P	ARMLET	9	W43	Fig 28, 2	EIA	85.21	nd	nd	14.50	0.06	nd	nd	0.23	0.00
2214	ARRS	BL	P	ARMLET	8	W43	Fig 27, 7	EIA	87.35	nd	0.27	11.64	0.52	nd	nd	0.21	0.02
2215	ARRS	BL	P	ARMLET	10	QUEEN'S BARROW	Fig 27, 5	EIA	86.16	nd	0.46	12.84	0.33	nd	nd	0.20	0.02
2216	ARRS	BL	P	ARMLET	10	QUEEN'S BARROW TWISTE	Fig 27, 4	EIA	87.87	nd	0.63	11.09	0.14	nd	0.01	0.26	0.00
2217 a	ARRS	BL	P	BB	2	QUEEN'S BARROW	Fig 23, 3	EIA	87.27	nd	1.34	10.44	0.84	nd	nd	0.11	0.00
2217 b	ARRS	BL	P	BB	2	QUEEN'S BARROW PIN TO	Fig 23, 3	EIA	87.48	nd	1.50	10.72	0.13	nd	nd	0.17	0.00
2218	ARRS	BL	T	POLECP		CHARIOTEER'S	Fig 18, 1	EIA	90.66	nd	0.71	8.09	0.40	nd	nd	0.14	0.03
2220 a	ARRS	BL	T	HSBT		KING'S LÈFT SIDE LINK	Fig 15, 1	EIA	88.27	nd	0.79	10.83	0.11	nd	nd	0.00	0.04
2220 b	ARRS	BL	T	HSBT		KING'S CENTRE LINK	Fig 15, 1	EIA	86.96	nd	0.82	12.15	0.06	nd	nd	0.00	0.02
2220 c	ARRS	BL	T	HSBT		KING'S RIGHT SIDE LIN	Fig 15, 1	EIA	87.54	nd	1.13	11.03	0.15	nd	nd	0.14	0.05
2221	ARRS	BL	T	TRT	5	KING'S	Fig 17, 3	EIA	87.13	nd	0.57	11.04	0.69	nd	nd	0.57	0.09
2222	ARRS	BL	T	TRT	5	KING'S	Fig 17, 4	EIA	87.22	nd	1.32	10.69	0.08	0.14	nd	0.30	0.06
2223 a	ARRS	BL	T	TRT	4	KING'S	Fig 17, 6	EIA	91.95	nd	0.20	7.39	0.18	nd	nd	0.28	0.00
2223 b	ARRS	BL	T	TRT	4	KING'S	Fig 17, 7	EIA	87.88	nd	0.70	11.03	0.26	nd	nd	0.12	0.04
2224 a	ARRS	BL	T	LINCHP		TOP	Fig 14, 1	EIA	87.86	nd	2.09	7.93	1.94	nd	nd	0.18	0.10
2224 b	ARRS	BL	T	LINCHP		BOTTOM	Fig 14, 1	EIA	89.68	nd	0.32	9.20	0.70	nd	nd	0.10	0.03
2225	DNGR	BL	P	BB	1	57	Fig 26, 1	EIA	88.11	nd	nd	11.49	0.17	nd	nd	0.22	0.00
2226	DNGR	BL	P	PIN	4	RING HEADED GRAVE 41	Fig 30, 3	EIA	87.69	nd	nd	11.84	0.11	nd	nd	0.37	0.03
2227	SWDN	BL	P	PIN	4	RING HEADED	Fig 30, 2	EIA	88.22	nd	0.32	11.27	nd	nd	0.01	0.18	0.00
2228	ARRS	BL	P	ARMLET	10		Fig 27, 2	EIA	86.91	0.42	0.22	12.15	0.17	nd	nd	0.11	0.00
2229	SETV	CV	P	BB	12	HEADSTUD	Lord 79	EROM	84.95	12.10	1.75	1.03	0.16	nd	nd	nd	ND
2230	SETV	CV	P	PLB	5	FEACHEM 24 BULMER H	Lord 80	EROM	86.82	1.91	2.01	9.17	0.09	nd	nd	nd	ND
2231	SETV	CV	P	BB	11	HEADSTUD	Lord 81	EROM	81.24	0.31	6.37	11.78	0.09	nd	0.02	0.19	ND
2232	OPEN	VC	H	SNT	8	TYPE 1	Fig 106, 783	ROMN	76.62	1.10	14.58	7.54	0.16	nd	nd	nd	ND
2233	OPEN	VC	H	PATERA		HANDLE	Fig 97, 689	EROM	68.54	nd	23.21	8.09	0.16	nd	nd	nd	ND
2234	OPEN	VC	H	?		MODEL STAND RITUAL !	Fig 97, 695	ROMN	83.70	1.22	8.72	6.27	0.10	nd	nd	nd	ND
2235	OPEN	VC	H	BELL			Fig 101, 735	C2AD	87.45	1.46	1.96	8.80	0.33	nd	nd	nd	ND

XRFID	SITEID	SITETYPE	CLASS	O-TYPE	REF	DESCRIPTION	CATALOGUE, etc	DATE	Cu	Zn	Pb	Sn	Fe	Ni	Mn	As	Co
2236	OPEN	VC	H	TLIM		SPATULA	Fig 98, 696	ROMN	80.59	17.21	0.20	0.25	1.48	0.16	nd	0.11	ND
2237	COVW	HD	H	BELL			Cat 66	ROMN	79.11	0.23	2.90	14.83	2.93	nd	nd	nd	ND
2238	COVW	HD	H	BELL			Cat 67	ROMN	81.96	nd	4.38	13.46	0.20	nd	nd	nd	ND
2239	COVW	HD	?	?		FERRULE	Cat 75	ROMN	72.15	11.93	13.69	1.76	0.43	nd	nd	nd	ND
2240	COVW	HD	P	BB	13	SMALL	Cat 49	LROM	80.11	nd	15.04	4.78	0.06	nd	nd	nd	ND
2242	COVW	HD	M	BUCKLE		MISCASTING	Cat 71	C3AD	76.21	3.87	13.66	5.95	0.31	nd	nd	nd	ND
2243	COVW	HD	H	SNT	8	TYPE 1	Cat 80	ROMN	68.37	5.52	16.64	8.87	0.60	nd	nd	nd	ND
2246	COVW	HD	P	BB	13	LARGE	Cat 48	LROM	79.53	2.87	9.31	8.04	0.25	nd	nd	nd	ND
2247	COVW	HD	H	?		MODEL MASK	Cat 37	ROMN	71.34	8.14	12.85	7.25	0.42	nd	nd	nd	ND
2248	COVW	HD	P	PLB	1		Cat 43	ROMN	83.78	1.96	5.79	8.26	0.21	nd	nd	nd	ND
2250	COVW	HD	P	PLB	1		Cat 42	ROMN	82.57	1.14	3.43	11.97	0.88	nd	0.01	nd	ND
2253	COVW	HD	T?	LMOUNT		TOGGLE SHAPED	Cat 76	ROMN	85.44	0.93	4.11	9.20	0.08	nd	nd	0.24	ND
2254	COVW	HD	H	DROPHD			Cat 69	ROMN	63.41	0.15	27.64	8.54	0.10	nd	nd	nd	ND
2255	COVW	HD	P	RING	2	CIRCULAR	Cat 98	ROMN	87.21	0.35	1.13	10.19	0.09	nd	nd	nd	ND
2256	COVW	HD	H	SNT	8	TYPE 1	Cat 84	ROMN	73.00	1.62	15.99	9.19	0.20	nd	nd	nd	ND
2258	COVW	HD	H	?		MODEL MASK	Cat 36	ROMN	83.38	4.55	7.82	4.03	0.22	nd	nd	nd	ND
2259	COVW	HD	T/H	RING	2	DOVAL	Cat 97	ROMN	71.52	1.54	17.89	8.87	0.18	nd	nd	nd	ND
2260	COVW	HD	H	SNT	8	TYPE 2	Cat 81	ROMN	65.13	1.50	23.51	9.49	0.20	nd	nd	nd	ND
2261	COVW	HD	P	ARMLET	11		Cat 63	LROM	85.67	0.11	2.69	10.25	0.08	0.05	nd	nd	ND
2262	COVW	HD	P	ARMLET	11		Cat 64	LROM	82.68	7.84	1.06	7.24	0.25	nd	0.01	nd	ND
2263	COVW	HD	P/M	BUCKLE			Cat 70	ROMN	74.83	17.73	2.89	3.71	0.84	nd	nd	nd	ND
2265	COVW	HD	H	MOUNT		MODEL HORSE 2-D	Cat 39	ROMN	73.49	3.22	15.18	7.94	0.17	nd	nd	nd	ND
2266	COVW	HD	H	SNT	3		Cat 77	ROMN	78.10	1.67	8.46	11.54	0.23	nd	nd	nd	ND
2268	CORB	SF	T	TRT	8		Macgregor 115	?	89.25	1.06	1.30	8.20	0.18	nd	nd	nd	ND
2269	CORB	SF	T	TRT	2		Macgregor 50	?	86.77	8.33	1.65	3.15	0.09	nd	nd	nd	ND
2270	CORB	SF	T	TRT	1		Macgregor 84	?	82.65	14.20	0.49	2.38	0.28	nd	nd	nd	ND
2271	HSTD	SF	T	TRT	1		Macgregor 85	?	75.42	2.15	10.10	12.17	0.16	nd	nd	nd	ND
2272	CORB	SF	T	LMOUNT		RING WITH PETAL DECOR	Macgregor 15	?	78.95	19.77	0.35	0.62	0.30	nd	nd	nd	ND
2273	CHST	SF	M	SWORD		CHAPE	Macgregor 166	ROMN	88.02	8.23	1.49	1.88	0.38	nd	nd	nd	ND
2274	CHST	SF	M	SWORD		MOUTH	Macgregor 162	ROMN	85.93	11.25	0.67	1.80	0.34	nd	nd	nd	ND
2275	CHST	SF	M	SWORD		CHAPE	Macgregor 169	ROMN	84.02	6.67	5.56	3.63	0.13	nd	nd	nd	ND
2276	OPEN	VC	H	SNT	4	SERATED CIRCUMFERENCE	Fig 95, 680	ROMN	85.03	6.39	4.95	3.44	0.19	nd	nd	nd	ND
2277	OPEN	VC	P	ARMLET	11	RIBBED/TWISTED WIRE ?	[2005]	ROMN	97.49	nd	nd	1.88	0.09	nd	nd	0.18	ND
2279	OPEN	VC	T?	MOUNT		CIRCULAR WITH BOSS	Fig 95, 674	LROM	82.81	4.96	4.82	7.24	0.17	nd	nd	nd	ND
2280	OPEN	VC	H	?		BASE OF CANDLE STICK?	Fig 108, 795	C2AD	81.88	8.01	4.79	5.07	0.26	nd	nd	nd	ND
2281 a	OPEN	VC	T	JNTRNG		HARNESS W. 2281b & c	Fig 96, 684	C2AD	71.78	10.12	12.76	4.89	0.45	nd	nd	nd	ND
2281 b	OPEN	VC	T	SNT	6	HARNESS W. 2281a & c	Fig 96, 684	C2AD	81.65	16.82	0.16	0.67	0.35	nd	nd	nd	ND
2281 c	OPEN	VC	T	JNTLP		HARNESS W. 2281a & b	Fig 96, 684	C2AD	79.89	16.52	0.23	1.49	0.52	nd	nd	nd	ND
2282	OPEN	VC	M	BTPL	2		Fig 94, 664	LROM	76.00	2.18	14.58	7.03	0.20	nd	nd	nd	ND
2283	OPEN	VC	H	SNT	9		Fig 109, 813	C2AD	82.70	16.90	0.22	nd	0.06	0.12	nd	nd	ND
2285	OPEN	VC	H	SLB			Fig 106, 780	ROMN	83.46	3.78	10.14	2.52	0.10	nd	nd	nd	ND

XRFID	SITEID	SITETYPE	CLASS	O-TYPE	REF	DESCRIPTION	CATALOGUE, etc	DATE	Cu	Zn	Pb	Sn	Fe	Ni	Mn	As	Co
2286	OPEN	VC	H	U-BIND			[484]	C2AD	83.94	11.90	1.01	2.43	0.52	nd	0.01	nd	ND
2287	OPEN	VC	?	WIRE			[1708]	LROM	94.89	nd	0.70	3.77	nd	nd	nd	nd	ND
2288	OPEN	VC	M	BUCKLE			[1708]	C3AD	82.15	0.60	6.42	10.05	0.08	nd	nd	nd	ND
2290	OPEN	VC	W?	DROPLT			[1705]	C2AD	88.57	0.19	7.76	2.95	0.05	nd	nd	nd	ND
2291	CABL	TW	H	PATERA		HANDLE STAMPED CIA	Fig 119, 98	C2AD	69.86	0.35	19.84	9.69	0.11	nd	nd	nd	ND
2292	CABL	TW	H	PATERA		HANDLE STAMPED ANSIDI	Fig 119, 97	C2AD	73.73	0.17	14.94	10.98	0.18	nd	nd	nd	ND
2293	CABL	TW	M	SCRN			Fig 109, 46	C2AD	74.13	5.18	13.16	7.25	0.29	nd	nd	nd	ND
2294	SHIP	NS	H	KEY		LION	<1583> [547]	ROMN	81.91	0.49	9.45	7.92	0.22	nd	nd	nd	ND
2295 a	DALT	VL	H			CANDLE STICK FOOT 1	Cat 30	LROM	63.96	4.79	20.50	7.76	2.83	nd	nd	nd	ND
2295 b	DALT	VL	H			CANDLE STICK FOOT 2	Cat 30	LROM	67.67	4.81	13.30	12.79	1.42	nd	nd	nd	ND
2295 c	DALT	VL	H			CANDLE STICK FOOT 3	Cat 30	LROM	76.76	2.44	10.12	8.80	1.89	nd	nd	nd	ND
2295 d	DALT	VL	H			CANDLE STICK HOLDER	Cat 30	LROM	77.17	1.75	8.03	11.49	1.52	nd	0.03	nd	ND
2295 e	DALT	VL	H			CANDLE STICK TOP	Cat 30	LROM	76.83	0.50	10.21	11.68	0.64	nd	nd	nd	ND
2296	DALT	VL	?	SHEET		OPENWORK	Cat 33	LROM	75.92	17.87	1.60	3.41	0.64	nd	nd	0.55	ND
2297	DALT	VL	P	PIN	4	NEEDLE ?	Cat 15	LROM	87.39	4.05	1.09	7.31	0.16	nd	nd	nd	ND
2298	DALT	VL	P	ARMLET	7		Cat 10	LROM	76.57	21.34	1.16	0.51	0.40	nd	nd	nd	ND
2299 a	DALT	VL	M?	BTPL		HAWKES&DUNNING	Cat 25	C4AD	86.11	nd	0.76	11.80	0.11	nd	nd	nd	ND
2299 b	DALT	VL	P	PAB	1	A2 REUSED AS BUCKLE	Cat 25	LROM	87.12	0.80	0.93	11.00	0.15	nd	nd	nd	ND
2300	DALT	VL	H	KEY			Cat 31	LROM	70.91	3.23	17.54	7.71	0.62	nd	nd	nd	ND
2301	DALT	VL	P	ARMLET	5		Cat 12	LROM	87.19	nd	1.90	9.55	0.07	nd	nd	nd	ND
2302	DALT	VL	H	D-CLIP			Cat 56	LROM	91.57	0.41	0.32	6.70	0.10	nd	nd	nd	ND
2303	DALT	VL	M	MOUNT		OPENWORK	Cat 26	C3AD	80.33	0.13	11.32	7.27	0.06	0.06	nd	nd	ND
2304	DALT	VL	H	SNT	10		Cat 39	LROM	76.86	nd	15.71	7.27	0.05	nd	nd	nd	ND
2306	DALT	VL	P/H	PIN	4		Cat 20	LROM	84.54	12.45	1.55	0.98	0.19	nd	nd	nd	ND
2307	DALT	VL	P	RING	3		Cat 7	LROM	79.55	19.62	0.00	0.54	0.18	nd	nd	0.11	ND
2308	DALT	VL	P	RING	6	ZIG-ZAG & DOT DECORAT	Cat 14	LROM	72.33	24.05	0.83	2.04	0.32	nd	nd	0.44	ND
2309	DALT	VL	?	SHEET			Cat 88	LROM	90.96	nd	nd	7.83	0.08	nd	nd	nd	ND
2310	DALT	VL	?	?			Cat 34	LROM	90.29	nd	0.32	9.10	0.10	nd	nd	0.19	ND
2311	DALT	VL	H	SNT	2		Cat 37	LROM	86.72	nd	7.92	5.36	nd	nd	nd	nd	ND
2312	DALT	VL	?	ROD			Cat 76	LROM	86.33	nd	1.37	11.14	0.12	nd	0.01	nd	ND
2313	DALT	VL	?	SHEET		PIERCED	Cat 59	LROM	89.82	0.33	0.42	8.50	0.08	nd	nd	nd	ND
2314	DALT	VL	H	VESSEL		RIM	Cat 22	LROM	89.52	nd	nd	8.91	0.13	0.16	nd	nd	ND
2315	DALT	VL	?	SHEET			Cat 86	LROM	87.49	0.27	0.40	10.63	0.10	nd	0.01	nd	ND
2316	DALT	VL	M?	SCAR		?	Cat 29	LROM	82.67	12.68	0.36	3.72	0.32	nd	nd	nd	ND
2317	DALT	VL	?	SHEET			Cat 79	LROM	85.38	nd	0.51	12.55	0.07	0.11	0.01	nd	ND
2318	DALT	VL	P	ARMLET	4	ALTERNATE SIDES	Cat 11	LROM	88.42	1.32	4.75	4.16	0.23	nd	nd	nd	ND
2319	DALT	VL	P	PAB	?	D1/2	Cat 6	LROM	85.78	5.96	0.99	7.10	0.16	nd	0.01	nd	ND
2320	DALT	VL	M	ARTP			Cat 28	LROM	71.79	5.78	12.83	8.87	0.73	nd	nd	nd	ND
2321	DALT	VL	?	SHEET			Cat 78	LROM	75.52	21.51	1.87	0.48	0.51	0.09	0.02	nd	ND
2322	DALT	VL	H	D-CLIP			Cat 54	LROM	86.86	0.00	1.11	10.76	0.08	nd	nd	nd	ND
2323	DALT	VL	M	MOUNT		HEXAGONAL W. BOSS	Cat 27	C3AD	74.09	13.02	3.91	7.96	0.28	nd	0.01	0.74	ND

XRFID	SITEID	SITETYPE	CLASS	O-TYPE	REF	DESCRIPTION	CATALOGUE, etc	DATE	Cu	Zn	Pb	Sn	Fe	Ni	Mn	As	Co
2324	DALT	VL	H	SNT	10		Cat 38	LROM	85.73	nd	5.96	8.22	0.08	nd	nd	nd	ND
2325	DALT	VL	?	?			Cat 63	LROM	78.03	0.45	13.54	7.42	0.08	0.05	0.01	nd	ND
2326	DALT	VL	?	STRIP			Cat 75	LROM	80.91	13.55	2.78	2.14	0.20	nd	nd	nd	ND
2327 a	DALT	VL	H	SNT	6		Cat 44	LROM	80.90	16.82	nd	1.34	0.34	nd	0.03	0.24	ND
2327 b	DALT	VL	H	SNT	7		Cat 44	LROM	79.40	18.26	nd	1.47	0.33	nd	0.03	0.17	ND
2328	DALT	VL	H	SPOON		HANDLE ONLY	Cat 19	LROM	88.79	1.56	2.34	7.12	0.19	nd	nd	nd	ND
2329	DALT	VL	T/H	RING	2	CIRCULAR	Cat 64	LROM	89.83	nd	0.84	8.79	0.25	nd	nd	0.29	ND
2330	DALT	VL	T	TRT	1		Cat 40	LROM	77.18	5.86	6.71	10.13	0.12	nd	nd	nd	ND
2331	DALT	VL	?	ROD			Cat 70	LROM	87.40	4.58	1.10	6.55	0.26	nd	nd	0.11	ND
2332	DALT	VL	H	D-CLIP			Cat 55	LROM	87.10	0.00	0.00	11.73	0.07	nd	nd	0.10	ND
2333	DALT	VL	P	ARMLET	1		Cat 68	LROM	83.46	0.00	7.27	9.15	0.12	nd	nd	nd	ND
2334	DALT	VL	H	SNT	7		Cat 48	LROM	82.72	14.16	0.78	1.37	0.63	nd	0.01	nd	ND
2335	DALT	VL	P	PAB		PIN	Cat 8	LROM	86.19	1.09	3.05	8.59	0.15	nd	nd	nd	ND
2336	NEWC	FT	H	SNT		CLASS 3,6,7 OR 9	[RAI 193] B241	ROMN	83.34	15.51	0.25	0.60	0.29	nd	nd	nd	ND
2337	NEWC	FT	P	ARMLET	2		B2486	ROMN	89.45	nd	1.42	7.69	0.19	nd	nd	0.16	ND
2338	NEWC	FT	?	WIRE			<154> [D 557] B409	ROMN	93.15	nd	0.50	5.45	0.12	nd	nd	nd	ND
2339	NEWC	FT	H	SNT	1		<265> [E 2183] B579	ROMN	89.52	0.45	0.21	8.76	0.08	nd	nd	nd	ND
2340	NEWC	FT	?	STRIP		PIERCED	B249	ROMN	84.39	13.16	1.30	0.78	0.21	nd	nd	nd	ND
2341	NEWC	FT	?	FRAG			[301] B260	ROMN	85.72	nd	1.45	11.52	0.05	nd	nd	nd	ND
2342	NEWC	FT	?	PIN	1	POINT ONLY	[RAI 187] B240	ROMN	88.69	1.58	1.00	7.79	0.11	nd	0.01	nd	ND
2343	HBRN	TR	H	SNT	12		<AW> [2]	C2AD	77.79	20.17	0.30	1.54	0.19	nd	nd	nd	ND
2344	HBRN	TR	H	U-BIND			<AK> us	C2AD	88.21	3.91	0.54	6.44	0.19	nd	0.01	nd	ND
2345	HBRN	TR	?	SHEET			<BE> [2]	C2AD	79.49	18.34	0.45	1.25	0.29	nd	0.01	nd	ND
2346 a	HBRN	TR	H	SNT	6		<BM> [7f]	C2AD	79.75	19.14	0.29	0.60	0.39	nd	0.01	nd	ND
2347 a	HBRN	TR	?	ROD		UNFINISHED OBJECT	<AZ> [4]	C2AD	82.19	16.15	nd	0.68	0.25	0.05	nd	nd	ND
2347 b	HBRN	TR	?	SHEET		CUT ?	<AZ> [4]	C2AD	76.48	21.61	nd	1.22	0.33	0.05	nd	0.12	ND
2347 c	HBRN	TR	?	SHEET			<AZ> [4]	C2AD	85.10	12.30	0.15	1.74	0.33	nd	nd	nd	ND
2348 a	HBRN	TR	?	ROD		UNFINISHED OBJECT	<AZ> [4]	C2AD	82.24	16.48	nd	0.65	0.30	nd	nd	nd	ND
2348 b	HBRN	TR	?	SHEET			<AZ> [4]	C2AD	82.55	16.45	nd	0.68	0.31	nd	0.01	nd	ND
2348 c	HBRN	TR	H	U-BIND			<AZ> [4]	C2AD	92.45	0.79	0.45	5.34	0.14	nd	nd	nd	ND
2349	HBRN	TR	?	SHEET			<AA> [W1]	C2AD	81.73	17.07	0.25	0.58	0.28	0.06	nd	nd	ND
2350	HBRN	TR	?	FRAG		OPENWORK	<AL> us	C2AD	77.80	3.47	9.28	8.27	0.46	nd	nd	nd	ND
2351	SWSH	MC	?	SHEET			<693> [545]	MROM	77.08	7.18	9.07	6.01	0.31	nd	nd	nd	ND
2352	SWSH	MC	H	SNT	6	NO SHANK	Cat 16	MROM	81.01	18.42	nd	0.42	0.24	nd	nd	nd	ND
2353	SWSH	MC	H	SNT	8	TYPE 2?	Fig 12, 13	MROM	63.38	8.01	21.04	7.75	0.27	nd	nd	nd	ND
2354	SWSH	MC	W	DROPLT			<652> [484]	MROM	82.83	15.96	nd	0.95	0.26	nd	nd	nd	ND
2355	SWSH	MC	T/H	RING	2	CIRCULAR WORN	Cat 28	MROM	74.40	7.15	11.75	6.46	0.23	nd	nd	nd	ND
2356	SWSH	MC	P	BB	15		Fig 11, 1	C2AD	74.77	0.11	15.46	9.30	0.23	nd	nd	nd	ND
2357	SWSH	MC	H	SNT	9	PIERCED SHANK	Fig 12, 12	MROM	79.32	4.90	9.45	6.08	0.24	nd	0.02	nd	ND
2358	SWSH	MC	H?	?		KNOB ?	Fig 12, 19	MROM	76.13	12.46	7.53	3.49	0.38	nd	0.01	nd	ND
2359	SWSH	MC	H	SNT	8	TYPE 2 ?	Fig 12, 14	MROM	73.97	10.29	10.20	5.27	0.27	nd	nd	nd	ND

XRFID	SITEID	SITETYPE	CLASS	O-TYPE	REF	DESCRIPTION	CATALOGUE, etc	DATE	Cu	Zn	Pb	Sn	Fe	Ni	Mn	As	Co
2360	SWSH	MC	H	SNT	6	NO SHANK	Fig 12, 15	MROM	87.86	nd	0.57	10.24	0.09	nd	0.01	nd	ND
2361	SWSH	MC	M	RSWORD		CHAPE	Fig 11, 3	MROM	71.16	1.76	18.24	8.40	0.32	nd	nd	nd	ND
2362 a	SWSH	MC	?	SHEET			Fig 11, 9	MROM	88.98	0.32	nd	9.54	0.11	nd	0.01	nd	ND
2362 b	SWSH	MC	?	SHEET			Fig 11, 9	MROM	89.29	0.28	0.28	9.00	0.08	nd	nd	nd	ND
2362 c	SWSH	MC	H	SNT	12	WITH 2362a & b	Fig 11, 9	MROM	89.05	0.77	0.15	8.72	0.10	nd	nd	0.24	ND
2363	SWSH	MC	M	BTPL	3		Fig 11, 5	MROM	63.89	0.25	26.10	9.01	0.19	nd	nd	nd	ND
2364	SWSH	MC	?	?		MODEL WHEEL ?B&L	Fig 11, 8	MROM	83.20	4.28	7.87	4.37	0.23	nd	nd	nd	ND
2365	SWSH	MC	?	RING	2	CIRCULAR	Fig 12, 29	MROM	60.81	0.50	28.73	8.85	0.44	nd	nd	nd	ND
2366	SWSH	MC	P	PLB	1		Fig 11, 2	MROM	78.71	1.24	10.30	9.47	0.16	nd	nd	nd	ND
2368 b	BRHM	BL	H	VESSEL		RIM	<399> Burial 199	C3AD	90.63	nd	0.31	7.82	0.12	nd	nd	nd	ND
2368 c	BRHM	BL	H	VESSEL		BODY	<399> Burial 199	C3AD	87.99	0.17	1.06	9.45	0.06	nd	nd	nd	ND
2369 a	BRHM	BL	H	VESSEL		RIM DECORATED	Cist 4	C3AD	75.31	22.10	0.18	1.75	0.31	nd	nd	0.36	ND
2369 b	BRHM	BL	?	SHEET		DECORATED VESSEL ?	Cist 4	C3AD	76.25	20.62	nd	2.50	0.33	nd	nd	0.30	ND
2370 a	BRHM	BL	H	VESSEL		RIM	<156> Burial 108	C3AD	76.65	18.26	0.78	4.00	0.30	nd	nd	nd	ND
2370 b	BRHM	BL	?	SHEET		VESSEL ?	<156> Burial 108	C3AD	89.81	nd	1.11	8.05	0.13	nd	nd	nd	ND
2371	BRHM	BL	?	?		HANDLE ?	<242> Burial 242	C3AD	81.29	14.08	1.81	2.41	0.16	nd	nd	nd	ND
2372	BRHM	BL	?	SHEET		PIERCED	<412> Burial 275	C3AD	90.57	2.01	0.29	6.10	0.27	nd	nd	nd	ND
2373 a	BRHM	BL	W?	LUMP			<267> Burial 164	C3AD	84.06	1.29	7.28	6.56	0.10	0.08	nd	nd	ND
2373 b	BRHM	BL	H	VESSEL		RIM	<269> Burial 164	C3AD	87.51	nd	0.70	10.52	0.07	0.06	nd	nd	ND
2374	BRHM	BL	?	RING	2	FLAT	<279> Burial 166	C3AD	78.05	5.31	9.87	5.58	0.49	nd	nd	nd	ND
2375	BRHM	BL	H	VESSEL		RIM	<70> Burial 11	C3AD	88.08	nd	1.83	8.93	0.08	nd	0.01	nd	ND
2376 a	BRHM	BL	H	VESSEL		RIM	<36> Burial 26	C3AD	86.24	0.10	0.79	11.28	0.09	nd	nd	nd	ND
2376 b	BRHM	BL	?	SHEET		VESSEL ?	<38> Burial 26	C3AD	89.47	nd	0.34	9.23	0.09	nd	nd	0.10	ND
2378 a	BRHM	BL	H	VESSEL		RIM	<291> Burial 201	C3AD	86.94	nd	1.35	10.58	0.06	nd	0.01	nd	ND
2378 c	BRHM	BL	W?	DROPLT			<291> Burial 201	C3AD	90.73	4.23	0.61	3.90	0.13	nd	nd	nd	ND
2379 a	BRHM	BL	H	U-BIND		WITH RIVET 2379c	<411> Burial 263	C3AD	89.61	nd	nd	8.72	0.14	0.13	nd	0.16	ND
2379 b	BRHM	BL	P/H	RING	2	SQUARE	<423> Burial 263	C3AD	88.01	1.60	5.39	4.08	0.26	nd	0.03	nd	ND
2379 c	BRHM	BL	H	SNT	11	WITH U-BIND 2379a	<411> Burial 263	C3AD	90.42	0.15	0.50	7.56	0.14	0.12	nd	nd	ND
2380 a	BRHM	BL	?	SHEET		VESSEL ?	Burial 27	C3AD	90.11	1.83	0.81	6.10	0.14	nd	nd	0.11	ND
2381 a	BRHM	BL	?	SHEET		VESSEL ?	Burial 27	C3AD	85.63	5.51	0.73	7.26	0.15	0.17	nd	nd	ND
2385	BRHM	BL	W?	DROPLT			<62> Burial 40	C3AD	82.72	0.13	1.85	13.70	0.14	nd	nd	nd	ND
2387 a	BRHM	BL	H	VESSEL			<145> Burial 94	C3AD	89.73	0.44	0.87	8.90	0.08	nd	nd	nd	ND
2388	BRHM	BL	P/H	RING	2	PLAIN	<144> Burial 94	C3AD	94.80	nd	0.38	4.08	0.14	nd	nd	nd	ND
2389 b	BRHM	BL	W?	DROPLT			<170> Burial 123	C3AD	80.00	0.60	5.60	12.61	0.05	nd	nd	nd	ND
2390 a	BRHM	BL	H	VESSEL			<57> Burial 36	C3AD	88.35	0.25	0.87	9.33	0.09	nd	nd	nd	ND
2392	BRHM	BL	M	?		BALDRIC CF OLDENSTEIN	<94> Burial 56	C3AD	73.42	0.51	17.97	7.79	0.19	nd	nd	nd	ND
2393	BRHM	BL	P	BB	13	SMALL	<95> Burial 56	C3AD	91.22	1.38	0.39	5.69	1.31	nd	nd	nd	ND
2395	BRHM	BL	P	BEAD		SPIRAL ?	<105> Burial 58	C3AD	86.46	nd	1.40	10.60	0.14	nd	nd	nd	ND
2396	BRHM	BL	H	VESSEL		RIM	<40?> Cist 3	C3AD	98.31	nd	0.25	1.13	0.16	nd	0.01	nd	ND
2397	BRHM	BL	P	ARMLET	3		<286> Burial 196	C3AD	82.89	14.07	nd	2.18	0.25	nd	0.02	0.44	ND
2398 a	BRHM	BL	H	VESSEL		RIM	<275> Burial 162	C3AD	77.37	17.41	1.42	3.38	0.41	nd	nd	nd	ND

XRFID	SITEID	SITETYPE	CLASS	O-TYPE	REF	DESCRIPTION	CATALOGUE, etc	DATE	Cu	Zn	Pb	Sn	Fe	Ni	Mn	As	Co
2398 b	BRHM	BL	?	?		BENT ROD W. TERMINAL	<275> Burial 162	C3AD	85.25	11.08	0.33	2.48	0.38	nd	0.01	0.14	ND
2399	BRHM	BL	H	SNT	5		<134> Burial 87	C3AD	70.83	9.42	11.36	8.01	0.38	nd	nd	nd	ND
2400	BRHM	BL	H	VESSEL		RIM	<137> Burial 87	C3AD	86.64	6.64	0.76	5.14	0.15	nd	0.01	nd	ND
2401	BRHM	BL	W?	SHEET		VESSEL ?	<161> Burial 129	C3AD	90.35	0.14	1.35	7.21	0.16	nd	nd	nd	ND
2402	BRHM	BL	H	VESSEL		RIM	<380> Burial 244	C3AD	77.15	19.26	0.34	2.72	0.32	nd	nd	0.21	ND
2404	BRHM	BL	?	SHEET		VESSEL ?	<55> Burial 32	C3AD	88.31	nd	0.38	9.21	0.15	nd	nd	0.99	ND
2405	BRHM	BL	H	SNT	11		<288> Burial 159	C3AD	80.10	16.81	0.98	1.37	0.40	0.08	0.02	nd	ND
2406	BRHM	BL	P	BB		P-SHAPED WITH KNOBS	<354> Burial 236	C3AD	85.45	0.34	6.05	8.09	0.07	nd	nd	nd	ND
2407	BRHM	BL	H	SNT	3		<152> Burial 102	C3AD	94.07	0.45	0.79	4.60	0.08	nd	0.01	nd	ND
2408	BRHM	BL	W?	DROPLT			<292> Burial 209	C3AD	85.36	2.51	2.75	9.18	0.19	nd	0.01	nd	ND
2410	BRHM	BL	H	VESSEL		RIM	<190> Burial 125	C3AD	76.89	1.49	11.72	9.80	0.10	nd	nd	nd	ND
2411	BRHM	BL	H	SNT	8	TYPE 1	<109> Burial 59	C3AD	78.82	4.41	9.71	6.86	0.19	nd	nd	nd	ND
2412	BRHM	BL	?	?		SHEET SWASTIKA	<148> Burial 90	C3AD	87.94	0.15	1.01	9.86	0.17	0.05	nd	nd	ND
2413 a	BRHM	BL	H	SNT	16		<150> Burial 90	C3AD	85.36	0.77	4.88	8.93	0.05	nd	nd	nd	ND
2413 b	BRHM	BL	H	SNT	16		<150> Burial 90	C3AD	81.25	2.82	8.01	7.86	0.06	nd	nd	nd	ND
2414	BRHM	BL	W?	DROPLT			<32> Burial 35	C3AD	67.80	1.61	21.14	9.07	0.38	nd	nd	nd	ND
2415	BRHM	BL	W?	DROPLT			<33> Burial 35	C3AD	84.40	1.32	4.11	10.03	0.13	nd	nd	nd	ND
2417 a	BRHM	BL	T?	PEND			<17> Burial 9	C3AD	81.48	7.97	5.12	5.13	0.31	nd	nd	nd	ND
2418 a	BRHM	BL	?	SHEET		DECORATIVE FITTING ?	<60> Burial 39	C3AD	95.27	nd	nd	4.05	0.09	nd	nd	0.17	ND
2418 b	BRHM	BL	H	SNT	12	ATTACHED TO 2418a	<60> Burial 39	C3AD	95.06	nd	0.18	4.16	0.08	nd	nd	0.10	ND
2420	BRHM	BL	H	VESSEL		HANDLE ?	<49> Burial 31	C3AD	89.35	nd	2.93	7.59	0.12	nd	nd	nd	ND
2421 a	BRHM	BL	?	SHEET		VESSEL ?	<1> Burial 1	C3AD	98.63	nd	nd	1.00	0.09	nd	nd	nd	ND
2422	BRHM	BL	H	VESSEL		RIM	<295> Burial 210	C3AD	88.55	0.25	0.40	10.39	0.19	nd	nd	0.21	ND
2423	BRHM	BL	?	STRIP		VESSEL RIM ?	<4> Burial 3	C3AD	88.17	nd	2.48	9.21	0.13	nd	0.01	nd	ND
2424	BRHM	BL	?	MOUNT			<375> Burial 254	C3AD	79.65	0.35	12.02	7.85	0.12	nd	nd	nd	ND
2425	WLDL	VC	?	FSHEET			<437> [671]	C2AD	97.58	nd	nd	1.91	0.21	nd	nd	nd	ND
2426	WLDL	VC	?	SHEET			<266> [830]	C2AD	86.69	3.78	0.83	7.71	0.16	nd	nd	nd	ND
2427	WLDL	VC	?	?		TINY HANDLE ?	<163> [342]	C2AD	79.51	19.10	nd	1.15	0.18	0.05	0.01	nd	ND
2428	WLDL	VC	H	DROPHD		FOR VESSEL ?	<207> [458]	C2AD	71.97	1.80	15.29	10.68	0.25	nd	nd	nd	ND
2429	WLDL	VC	T?	B&L	3		<373(B)> [1057]	C2AD	79.65	0.42	7.52	12.36	0.05	nd	nd	nd	ND
2430	WLDL	VC	H?	TLIM	6	?	<282> [67]	C2AD	78.82	18.13	0.47	2.29	0.17	nd	nd	nd	ND
2431	WLDL	VC	I?	ROD			<126> [43]	C3AD	76.99	22.26	nd	0.41	0.11	0.06	nd	nd	ND
2432	WLDL	VC	T?	B&L	3		<373(C)> [1057]	C2AD	85.35	2.75	5.95	5.04	0.92	nd	nd	nd	ND
2433	WLDL	VC	H	SNT	1		<161> [243]	C2AD	89.90	1.82	3.27	4.26	0.09	nd	nd	nd	ND
2434	WLDL	VC	T?	SNT	3	OLDENSTEIN	<96> [43]	C3AD	75.02	2.97	15.49	6.21	0.30	nd	nd	nd	ND
2435	WLDL	VC	T?	MOUNT		CIRCLE W. BOSS	<115> [114]	C2AD	85.87	9.18	0.86	3.93	0.16	nd	nd	nd	ND
2436	WLDL	VC	H	PESTLE			<252> [38]	C2AD	84.43	1.27	8.29	5.90	0.10	nd	0.02	nd	ND
2437	WLDL	VC	H	SNT	1		<202> [492]	C2AD	83.19	0.59	6.73	9.38	0.11	nd	nd	nd	ND
2438	WLDL	VC	T	TRT	5		<322> [950]	C2AD	90.67	0.99	1.11	6.84	0.19	nd	0.01	0.19	ND
2439	WLDL	VC	?	STRIP			<274> [360]	C2AD	99.77	nd	nd	nd	0.13	nd	nd	nd	ND
2441	WLDL	VC	T	B&L	3		<145> [252]	C2AD	78.67	2.61	10.25	8.33	0.14	nd	nd	nd	ND

XRFID	SITEID	SITETYPE	CLASS	O-TYPE	REF	DESCRIPTION	CATALOGUE, etc	DATE	Cu	Zn	Pb	Sn	Fe	Ni	Mn	As	Co
2442	WLDL	VC	T?	MOUNT		OPENWORK CIRCLE SHANK	<491> [1568]	C2AD	89.98	nd	7.24	2.78	nd	nd	nd	nd	ND
2443	WLDL	VC	T?	LMOUNT		3 SPHERES	<283> [359]	C2AD	85.42	10.10	0.90	3.34	0.24	nd	nd	nd	ND
2444	WLDL	VC	?	STRIP		FOLDED	<374> [355]	C2AD	96.12	0.10	0.33	2.86	0.13	nd	nd	nd	ND
2445	WLDL	VC	?	RING	2	? CIRCULAR	<500> [1521]	C2AD	68.71	nd	24.42	6.99	0.29	nd	nd	nd	ND
2446	WLDL	VC	W?	DROPLT		MELTED SNT 9 ?	<395> [1219]	C2AD	70.46	13.77	11.20	4.15	0.43	nd	nd	nd	ND
2447	WLDL	VC	T?	PEND		PHALLIC	<80> [41]	C3AD	85.63	7.61	1.72	4.00	1.03	nd	nd	nd	ND
2449	WLDL	VC	H	BELL			<114> [148]	C2AD	72.64	0.34	13.64	13.06	0.16	nd	nd	nd	ND
2450	WLDL	VC	H	SLB			<237> [644]	C2AD	77.79	4.16	10.27	7.48	0.30	nd	nd	nd	ND
2451	WLDL	VC	H	KEY			<513> [1521]	C2AD	73.22	7.47	16.77	2.47	0.06	nd	0.01	nd	ND
2452	WLDL	VC	?	STRIP		TLIM 9 ??	<219> [522]	C2AD	87.90	3.19	0.77	6.88	0.41	nd	0.01	0.14	ND
2454	WLDL	VC	H	KEY			<499> [1535]	C2AD	62.86	8.38	23.93	4.40	0.41	nd	0.03	nd	ND
2455	WLDL	VC	H	MORTAR			<101> [41]	C3AD	85.49	2.60	6.99	4.63	0.30	nd	nd	nd	ND
2456	WLDL	VC	P	ARMLET	3		<372> [285]	C2AD	91.55	1.89	2.31	3.62	0.07	nd	nd	nd	ND
2457	PAPC	VC	T	JNTLP			<298> [283]	C3AD	69.92	9.41	14.89	5.10	0.68	nd	nd	nd	ND
2459	PAPC	VC	P	ARMLET	1		<281> [263]	C3AD	71.94	2.44	17.52	7.87	0.23	nd	nd	nd	ND
2460	PAPC	VC	?	STRIP			<475> [330]	C2AD	88.93	5.60	1.30	3.37	0.21	nd	nd	nd	ND
2461	PAPC	VC	W?	DROPLT			<406> [303]	C3AD	83.31	12.48	0.31	3.17	0.27	nd	nd	nd	ND
2462	PAPC	VC	H	VESSEL		BOVINE MOUNT ?	<474> [223]	C3AD	73.55	0.19	18.80	7.27	0.07	nd	nd	nd	ND
2463	PAPC	VC	H?	?		WINDOW GRILL ?	<248> [263]	C3AD	76.77	4.30	11.47	7.29	0.16	nd	nd	nd	ND
2464	PAPC	VC	W?	DROPLT			<463> [285]	C3AD	85.83	2.65	5.49	5.13	0.18	nd	nd	nd	ND
2466	PAPC	VC	T	LMOUNT		DOUBLE BOSS AND PETAL	<412> [314]	C3AD	88.62	1.56	3.83	5.92	0.06	nd	nd	nd	ND
2467	PAPC	VC	?	FSHEET			<244> [263]	C3AD	92.17	nd	nd	6.75	0.19	nd	nd	nd	ND
2468	PAPC	VC	T	TRT	6		<392> [38]	C3AD	69.49	5.67	17.57	6.68	0.49	nd	nd	nd	ND
2469	PAPC	VC	H	U-BIND			<290> [47]	C3AD	88.19	6.85	0.92	3.55	0.21	nd	nd	nd	ND
2470	PAPC	VC	?	STRIP			<378> [262]	C2AD	87.68	0.38	0.79	10.10	0.12	nd	nd	nd	ND
2471	WLDL	VC	?	ROD		OR WIRE	<436> [1361]	C2AD	95.67	nd	0.27	3.31	0.17	nd	nd	nd	ND
2472	PAPC	VC	P/H	PIN	1		<227> [244]	C2AD	80.36	16.43	0.86	1.59	0.36	0.05	nd	nd	ND
2473	PAPC	VC	?	?		SPLIT PIN ?	<127> [6]	C3AD	77.78	20.35	nd	1.21	0.40	nd	0.02	0.25	ND
2474	PAPC	VC	H	SNT	6	NO SHANK	<385> [303]	C3AD	88.47	nd	0.23	9.76	0.14	0.07	0.03	0.15	ND
2475	PAPC	VC	T/H	RING	2	D UNFINISHED	<396> [38]	C3AD	83.20	3.36	4.15	9.13	0.16	nd	nd	nd	ND
2476	PAPC	VC	P	RING	2	SQUARE, PENANNULAR	<356> [294]	C3AD	86.39	2.08	2.10	9.15	0.11	nd	0.01	0.16	ND
2477	PAPC	VC	T	BTSLID		DISC SHAPED	<351> [291]	C3AD	74.67	2.50	9.84	12.63	0.36	nd	nd	nd	ND
2478	PAPC	VC	P/H	ARMLET	9	? OR RING ?	<203> [198]	C2AD	96.59	nd	0.64	2.09	0.27	nd	nd	nd	ND
2479	PAPC	VC	H	U-BIND			<465> [285]	C2AD	81.79	14.96	0.43	2.12	0.64	0.06	nd	nd	ND
2480	PAPC	VC	H	TLIM	6		<254> [266]	C3AD	82.84	8.00	0.49	8.46	0.22	nd	nd	nd	ND
2481 a	PAPC	VC	?	SHEET			<240> [221]	C3AD	96.37	nd	nd	3.00	0.11	nd	nd	0.10	ND
2481 b	PAPC	VC	H?	KEY	?	OR TRT ?	<240> [221]	C3AD	80.60	3.53	11.20	4.57	0.11	nd	nd	nd	ND
2481 c	PAPC	VC	H	DROPHD			<240> [221]	C3AD	83.30	15.07	0.00	0.93	0.54	nd	nd	0.16	ND
2482	PAPC	VC	H	KEY			<347> [30]	C3AD	79.78	2.54	11.64	5.89	0.15	nd	nd	nd	ND
2483	PAPC	VC	H	U-BIND			<418> [262]	C2AD	83.77	12.32	nd	2.91	0.32	nd	0.01	0.17	ND
2484	PAPC	VC	H	TLIM	1		<222> [242]	C2AD	85.42	9.00	0.31	4.42	0.20	nd	nd	nd	ND

XRFID	SITEID	SITETYPE	CLASS	O-TYPE	REF	DESCRIPTION	CATALOGUE, etc	DATE	Cu	Zn	Pb	Sn	Fe	Ni	Mn	As	Co
2485	PAPC	VC	M	BTPL	3		<247> [263]	C3AD	75.66	0.52	14.52	8.35	0.43	nd	nd	nd	ND
2487	EDCS	HF	P	BB	10	NO ACANTHUS HALF	<133> [381]	EROM	79.17	4.97	10.09	5.07	0.45	nd	nd	0.24	ND
2488	EDCS	HF	P	PLB	5	BULMER H cf FEACHEM40	<407> [1486]	EROM	83.30	12.18	0.81	3.22	0.39	nd	nd	0.11	ND
2489	BLML	HD	I	INGOT			Cat B65	EROM	88.06	0.27	1.11	10.34	0.21	nd	nd	nd	ND
2490	TPLW	HF	P	PIN	4	ZOOMORPHIC	Cat 104	?	86.58	1.45	1.52	10.26	0.19	nd	nd	nd	ND
2491	TPLW	HF	P	PIN	4	ZOOMORPHIC	Cat 102	?	92.31	0.90	2.38	4.27	0.09	0.05	nd	nd	ND
2492	TPLW	HF	P	PIN	4	RING HEAD	Cat 96 ?	?	91.69	nd	0.38	7.79	0.13	nd	nd	nd	ND
2493	TPLW	HF	?	SHEET			Q2	?	85.97	nd	nd	13.81	0.08	nd	nd	0.14	ND
2494	TPLW	HF	?	SHEET			?	?	87.39	nd	nd	12.17	nd	nd	nd	0.17	ND
2495	TPLW	HF	?	SHEET			Ma 3	?	85.87	0.38	2.28	11.37	0.10	nd	nd	nd	ND
2496	TPLW	HF	?	SHEET			Q2	?	88.40	0.92	0.99	9.58	0.05	nd	nd	nd	ND
2497	TPLW	HF	?	SHEET			?	?	85.61	5.55	1.75	6.88	0.12	0.07	nd	nd	ND
2498	TPLW	HF	H	U-BIND			?	?	87.42	nd	2.28	10.19	0.10	nd	nd	nd	ND
2499	TPLW	HF	?	SHEET			?	?	86.60	0.13	nd	12.91	0.11	nd	nd	0.24	ND
2501	WLBY	SR	P	BB	4		<ABA> [L2]	IA	89.67	nd	0.56	9.64	0.07	0.05	0.01	nd	0.00
2502	WLBY	SR	?	WIRE		FOR ONE-PIECE BROOCH?	L2 FITR 255	IA	89.41	nd	0.40	10.12	0.07	nd	nd	nd	0.00
2503	WLBY	SR	?	WIRE		PIN ?	<FN 16> [TR6 L2]	IA	88.68	nd	1.07	9.84	0.09	0.05	nd	nd	0.02
2504	WLBY	SR	W	DROPLT			<YON>	IA	88.96	nd	0.87	9.34	0.35	0.05	nd	0.25	0.00
2505	WLBY	SR	W	DROPLT			<EJL>	IA	90.46	nd	0.40	8.82	nd	0.17	nd	0.13	0.30
2506	WLBY	SR	W	DROPLT			<YFU>	IA	89.97	nd	0.56	9.28	nd	0.07	nd	0.11	0.02
2507	WLBY	SR	W	DROPLT			<ENP>	IA	88.63	nd	0.50	10.53	nd	0.14	nd	0.18	0.02
2508	WLBY	SR	W	DROPLT			<OYP>	IA	88.46	nd	1.34	10.04	0.07	0.07	nd	nd	0.02
2509	WLBY	SR	W	DROPLT			<GSO>	IA	86.25	nd	0.71	12.92	0.07	nd	nd	nd	0.04
2510	WLBY	SR	W	DROPLT			<GVC>	IA	85.79	nd	nd	13.80	0.07	0.11	nd	0.23	0.00
2511	WLBY	SR	W	DROPLT			<WIR>	IA	83.17	nd	6.27	10.47	nd	0.10	nd	nd	0.00
2512	WLBY	SR	W	DROPLT			<UBJ>	IA	90.76	nd	nd	9.18	0.05	nd	nd	nd	0.00
2513	WLBY	SR	W	DROPLT			<GRO>	IA	84.76	nd	1.49	13.68	0.07	nd	nd	nd	0.00
2514	WLBY	SR	W	DROPLT			<QCL>	IA	89.73	nd	1.75	8.34	0.00	0.05	0.01	0.13	0.00
2515	WLBY	SR	W	DROPLT			<GZL>	IA	86.80	nd	0.52	12.26	0.15	0.07	nd	0.11	0.09
2516	WLBY	SR	?	STRIP			<WWT>	IA	88.76	nd	0.82	10.22	0.06	0.12	0.01	nd	0.00
2517	WLBY	SR	?	WIRE		SQUARISH SECTION	<WAO>	IA	87.07	nd	nd	11.84	0.50	0.05	0.01	0.20	0.00
2518	WLBY	SR	?	STRIP			<QVC>	IA	88.78	nd	1.16	9.78	0.16	0.07	0.01	nd	0.04
2519	WLBY	SR	?	SHEET			<OLU>	IA	89.20	nd	nd	10.65	0.05	0.09	nd	nd	0.00
2520	WLBY	SR	?	WIRE		SQUARISH SECTION	<CPI>	IA	85.65	nd	0.65	12.41	0.25	0.28	nd	0.43	0.03
2521	YORK	FT	H	TLIM	5	OR STYLUS ?	<405> [4415 IV]	ROMN	85.73	12.17	0.68	1.21	0.22	0.00	nd	nd	ND
2522	YORK	TW	P	PAB	2	C	<1746> [2275 II]	ROMN	86.13	nd	nd	13.72	0.15	nd	nd	nd	ND
2523	YORK	TW	H	SNT	9		<1219> [1360 I]	ROMN	99.72	nd	nd	0.22	0.05	nd	0.01	nd	ND
2524	YORK	FT	P	PAB	1	A3	<1797> [6984 IV]	ROMN	78.76	17.68	0.17	3.02	0.37	nd	nd	nd	ND
2525	YORK	FT	H	KEY		LEVER LOCK TYPE	<1515> [6411 IV]	ROMN	79.54	1.25	12.10	7.00	0.11	nd	nd	nd	ND
2526	YORK	TW	H	SNT	1		<865> [1241]	ROMN	89.47	6.91	0.60	2.72	0.30	nd	nd	nd	ND
2527	YORK	FT	P	RING	7	TWISTED WIRE	<140> [2144 I]	ROMN	87.92	2.75	1.46	7.67	0.19	nd	0.01	nd	ND

XRFID	SITEID	SITETYPE	CLASS	O-TYPE	REF	DESCRIPTION	CATALOGUE, etc	DATE	Cu	Zn	Pb	Sn	Fe	Ni	Mn	As	Co
2528	YORK	FT	P	ARMLET	4	ZIG-ZAG	<229> [1237 I]	LROM	91.64	1.24	3.27	3.71	0.14	nd	0.01	nd	ND
2529	YORK	TW	H	NEEDLE			<1735> [3319 I]	ROMN	90.45	6.72	0.22	2.36	0.24	nd	0.01	nd	ND
2530	YORK	FT	H	SNT	2		<1986> [6842 IV]	ROMN	92.23	0.18	1.70	5.70	0.19	nd	nd	nd	ND
2531	YORK	TW	H	NEEDLE			<1814> [3360 III]	ROMN	77.88	20.59	0.31	0.90	0.27	0.06	nd	nd	ND
2532	YORK	FT	P	ARMLET	4	ZIG-ZAG	<433> [4388 IV]	LROM	88.73	3.53	1.21	6.29	0.25	nd	nd	nd	ND
2533	YORK	TW	H	SNT	6		<1226> [1399]	ROMN	80.21	18.94	nd	0.45	0.40	nd	nd	nd	ND
2534	YORK	FT	H	TLIM	8		<1552> [3538 III]	ROMN	88.03	10.19	nd	1.33	0.40	0.05	nd	nd	ND
2535	YORK	VC	P	PIN	4	HAND & SEED	<5101> [3455]	ROMN	83.45	0.23	4.85	11.21	0.18	0.08	nd	nd	ND
2536	YORK	VC	P	BB	10	ACANTHUS HALF	<2333> [10007]	EROM	79.18	2.40	8.89	9.07	0.45	nd	nd	nd	ND
2537	YORK	VC	P	PAB	1	A2	<5903> [4915 IV]	ROMN	86.33	1.27	5.92	6.40	0.08	nd	nd	nd	ND
2538	YORK	FT	M	SCAR		?	<1171> [3321]	ROMN	83.59	11.22	0.27	4.24	0.52	0.05	nd	0.11	ND
2539	YORK	FT	H	STYLUS			<1281> [3296 III]	ROMN	82.20	15.15	0.21	1.99	0.45	nd	nd	nd	ND
2540	YORK	FT	M	STEND			<1697> [6743 IV]	MROM	70.99	2.46	21.28	5.06	0.22	nd	nd	nd	ND
2541	YORK	TW	H	TLIM	9	?	<224> [1050]	ROMN	80.25	14.43	4.88	0.14	0.31	nd	nd	nd	ND
2542	STAN	HD	T	LMOUNT		SET A	M62 1	C1AD	79.68	18.53	0.22	1.14	0.43	nd	nd	nd	ND
2543	STAN	HD	T	STJN		SET A	M62 6	C1AD	77.85	20.62	nd	1.35	0.18	nd	nd	nd	ND
2544	STAN	HD	T	LMOUNT		SET A	M62 11	C1AD	77.24	21.18	0.35	0.98	0.18	0.06	nd	nd	ND
2545 a	STAN	HD	T	HSBT		RING SET A	M62 37	C1AD	76.47	22.00	nd	1.26	0.19	0.05	nd	nd	ND
2545 b	STAN	HD	T	HSBT		CENTRE LINK SET A	M62 37	C1AD	84.29	1.38	nd	14.34	nd	nd	nd	nd	ND
2546	STAN	HD	T	TRT	5	SET A	M62 51?	C1AD	77.28	19.61	0.21	2.65	0.24	nd	nd	nd	ND
2547	STAN	HD	T	TRT	5	SET A	M62 53	C1AD	81.60	16.69	0.00	1.45	0.26	nd	nd	nd	ND
2548	YORK	TW	M	STEND			<2911> [1391 I]	MROM	76.81	5.60	11.27	5.63	0.67	nd	nd	nd	ND
2549	STAN	HD	T	TRT	5	SET A	M62 58	C1AD	81.14	16.56	0.15	1.84	0.32	nd	nd	nd	ND
2550	STAN	HD	T	LINCHP		TOP SET A?	M62 70	C1AD	83.04	16.17	nd	0.43	0.37	nd	nd	nd	ND
2551	STAN	HD	T	LINCHP		BOTTOM SET A?	M62 70	C1AD	79.49	18.93	0.22	0.93	0.42	nd	nd	nd	ND
2552	STAN	HD	T	B&L	2	SET A?/B?	M62 32	C1AD	78.58	20.58	0.33	0.37	0.14	nd	nd	nd	ND
2553	STAN	HD	T	LMOUNT		SET B	M62 2	C1AD	77.78	19.88	0.30	1.90	0.14	nd	0.01	nd	ND
2554	STAN	HD	T	STJN		TWO RINGS SET B	M62 7	C1AD	78.32	20.18	nd	1.23	0.26	nd	nd	nd	ND
2555	STAN	HD	T	LMOUNT		SET B	M62 12	C1AD	77.68	21.01	0.26	0.97	0.08	nd	nd	nd	ND
2556	STAN	HD	T	STJN		? SET B	M62 17	C1AD	80.65	18.52	0.16	0.53	0.14	nd	nd	nd	ND
2557	STAN	HD	T	HSBT		RING ONLY SET B	M62 40	C1AD	80.41	18.62	nd	0.75	0.27	nd	nd	nd	ND
2558	STAN	HD	T	HSBT		RING ONLY SET B	M62 41	C1AD	83.69	13.87	0.23	1.81	0.40	nd	nd	nd	ND
2559	STAN	HD	T	TRT	5	SET B	M62 57	C1AD	80.47	18.33	0.54	0.46	0.19	nd	0.01	nd	ND
2561	STAN	HD	T	LINCHP		SET B TOP	M62 75	C1AD	81.19	17.83	nd	0.71	0.26	nd	nd	nd	ND
2562	STAN	HD	T	HSBT		RING ?? SET B/D	M62 43	C1AD	88.12	nd	0.27	11.24	0.36	nd	0.01	nd	ND
2563	STAN	HD	T	HSBT		RING ?? SET B/D	M62 44	C1AD	77.29	21.30	0.80	0.16	0.45	nd	nd	nd	ND
2564	STAN	HD	T	LMOUNT		? SET B?	M62 14	C1AD	81.22	13.89	nd	4.79	0.10	nd	0.01	nd	ND
2565	STAN	HD	T	B&L	2	SET B?	M62 30	C1AD	85.15	10.99	0.19	3.35	0.32	nd	nd	nd	ND
2566	STAN	HD	T	B&L	?	SET B?/C?	M62 34	C1AD	81.64	17.62	nd	0.56	0.18	nd	nd	nd	ND
2567	STAN	HD	T	LMOUNT		SET C?	M62 13	C1AD	77.64	21.57	0.20	0.36	0.24	nd	nd	nd	ND
2568	STAN	HD	T	LINCHP		BASE ONLY SET C?	M62 74	C1AD	81.62	12.89	0.39	4.90	0.20	nd	nd	nd	ND

XRFID	SITEID	SITETYPE	CLASS	O-TYPE	REF	DESCRIPTION	CATALOGUE, etc	DATE	Cu	Zn	Pb	Sn	Fe	Ni	Mn	As	Co
2569	STAN	HD	T	LINCHP		BASE ONLY SET C?	M62 73	C1AD	80.50	14.46	nd	4.83	0.20	nd	nd	nd	ND
2570	STAN	HD	T	B&L	2	SET D?	M62 24	C1AD	78.91	18.23	0.37	2.37	0.12	nd	nd	nd	ND
2572 a	STAN	HD	T?	FRAG		LIPPED SET D?	M62 83	C1AD	80.70	15.71	0.31	3.09	0.14	0.06	nd	nd	ND
2572 b	STAN	HD	?	STRIP		ATTACHED TO 2572a	M62 83	C1AD	89.96	2.71	0.63	6.21	0.08	0.14	0.01	nd	ND
2573	STAN	HD	T	STJN		TWO RINGS SET ?	M62 10	C1AD	84.75	13.83	0.36	0.94	0.12	nd	nd	nd	ND
2574	STAN	HD	T?	HOOK		SET ?	M62 18	C1AD	76.67	22.56	0.41	0.11	0.20	0.06	nd	nd	ND
2575	STAN	HD	T	LMOUNT		SET ?	M62 88	C1AD	83.56	0.47	2.42	12.82	0.05	0.06	nd	nd	ND
2576	STAN	HD	?	SHEET		DECORATED	M62 98	C1AD	86.27	12.72	0.20	0.49	0.32	nd	nd	nd	ND
2578	WTWG	SR	T/H	RING	2	D	<WE.AY> [7:67]	ROMN	64.32	2.99	25.64	6.83	0.22	nd	nd	nd	ND
2579 a	SKRN	SF	P	TORC		BEADED	Macgregor 207	?	80.98	18.76	0.00	0.10	0.15	nd	nd	nd	ND
2579 b	SKRN	SF	P	TORC		WIRE LOOP	Macgregor 207	?	76.27	21.79	1.14	0.68	0.13	nd	nd	nd	ND
2580	WTWG	SR	?	STRIP			<WE.DV> [7:6]	ROMN	95.30	nd	nd	4.44	0.13	nd	0.01	0.11	ND
2581	WTWG	SR	?	WIRE			<WE.IN> [7:249]	ROMN	88.38	0.11	3.03	8.31	0.08	0.08	0.01	nd	ND
2582	WTWG	SR	P	RING	1	HENIG X ?	<WE.PJ> [7:297]	ROMN	87.82	0.88	3.37	7.81	0.07	0.05	nd	nd	ND
2583	WTWG	SR	?	SHEET			<WE.PK> [7:297]	ROMN	90.36	nd	1.54	7.14	0.81	nd	0.01	0.13	ND
2585 a	WTWG	SR	P	BB	5		<WE.RA> [7:335]	EROM	78.47	20.69	0.16	0.22	0.46	nd	nd	nd	ND
2585 b	WTWG	SR	P	BB		NEW HINGED PIN FOR a	<WE.RA> [7:335]	EROM	90.65	0.42	1.44	7.27	nd	0.08	0.01	0.13	ND
2586	WTWG	SR	?	SHEET			<WE.YR> [7:280]	ROMN	78.08	21.52	0.28	nd	0.12	nd	nd	nd	ND
2587	WTWG	SR	?	WIRE			<WE.AE2> [7:528]	ROMN	83.39	15.75	0.38	0.24	0.21	nd	0.01	nd	ND
2588	WTWG	SR	?	FRAG			<WN.BO> [11:05]	ROMN	89.02	nd	2.40	8.42	0.06	0.10	nd	nd	ND
2589	WTWG	SR	P	BB	12	HEADSTUD cf B&L	<WN.CX> [11:11]	EROM	78.28	20.35	0.41	0.46	0.50	nd	nd	nd	ND
2590	WTWG	SR	?	SHEET		FOR IA BEAD ?	<WN.OI> [11:514]	IA	91.32	nd	0.57	7.84	0.10	0.14	nd	nd	0.03
2591	WTWG	SR	H	SNT	3		<WN.KY> [9:210]	ROMN	81.28	17.29	0.22	0.79	0.41	nd	0.01	nd	ND
2592	WTWG	SR	P	CHAIN		FOR BROOCH ?	<WN.VO> [11:547	EROM	78.89	20.22	0.55	0.14	0.21	nd	nd	nd	ND
2593	WTWG	SR	?	SHEET			<WE.QI> [7:275]	ROMN	88.16	nd	0.59	11.03	0.10	0.08	0.02	nd	ND
2594	WTWG	SR	?	FSHEET			<WS.FI> [6:206]	IA	92.15	nd	nd	7.25	0.10	nd	0.01	0.46	0.02
2595	WTWG	SR	?	SHEET		HALF PIERCED DISC	<WW.KO> [9:149]	ROMN	89.89	nd	1.56	8.38	0.12	nd	0.01	nd	ND
2596	RDCL	SF	P	PIN	4	RING HEADED	KINCM1993.4.3	IA	86.69	nd	0.25	12.87	nd	nd	0.01	0.18	0.00
2597	WTWG	SR	W?	LUMP			<WN.AB> [11:+]	?	88.61	9.67	0.30	1.25	0.16	nd	0.01	nd	ND
2598	WTWG	SR	?	WIRE			<WE.JD> [7:+]	?	81.74	17.49	0.60	nd	0.11	nd	nd	nd	ND
2600	WTWG	BL	T/H	RING	2	FLAT WORN	<WW.DV> Burial 312	IA	91.53	nd	nd	8.30	0.17	nd	nd	nd	0.00
2601	WTWG	BL	P	RING	?	TUBULAR CAST	<WW.EO> Burial 317	IA	83.73	nd	4.05	11.18	nd	nd	nd	0.20	0.02
2602	WTWG	BL	T/H	RING	2	FLAT WORN	<WT.DQ> Burial 245	IA	85.54	nd	0.78	13.54	0.13	nd	nd	nd	0.02
2603	WTWG	BL	?	ROD		UNFINISHED OBJECT ?	<WS.PN> Burial 146	IA	89.78	nd	0.22	8.13	1.72	nd	nd	0.15	0.00
2604 a	WTWG	BL	P?	BEAD		PIERCED FLAT SHEET	<WW.KL> Burial 363	IA	96.90	nd	0.15	2.15	0.80	nd	nd	nd	0.00
2604 b	WTWG	BL	P?	BEAD		PIERCED FLAT SHEET	<WW.KM> Burial 363	IA	96.97	nd	nd	2.22	0.80	nd	0.01	nd	0.00
2604 c	WTWG	BL	P	BEAD		ROLLED SHEET	<WW.KN> Burial 363	IA	91.59	nd	0.15	8.00	0.06	0.07	nd	0.11	0.02