Ancient Monuments Laboratory
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THE HISTORICAL IRON RESEARCH PROJECT: RESULTS OF THE FIRST PHASE OF METALLOGRAPHIC AND MICROANALYTICAL EXAMINATION OF IRON FITTINGS FROM HISTORICAL BUILDINGS

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Summary

This report presents the initial findings of the Historical Iron Research Project which investigated 29 iron samples, dated from the thirteenth century to the end of the nineteenth century, largely from English Heritage's Architectural Study Collection. The potential for identifying the technology of production of iron artefacts was investigated through the examination of metallographic and analytical data. Compositional variations were investigated in the metal matrices using SEM based wavelength dispersive analysis, and in the slag inclusions by SEM based energy dispersive detector. This combination of data allowed the partitioning of elements between the two phases to be calculated, providing an insight into furnace conditions. The results were tested against previously suggested models for the composition of alloys for historical production processes. The report includes an archive of the metallographic data and microstructural analyses and forms a catalogue for the metallographic samples now held by the Ancient Monuments Laboratory.

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ANCIENT MONUMENTS LABORATORY REPORT SERIES

The Historical Iron Research Project: Results of the First Phase of Metallographic and Microanalytical Examination of Iron Fittings from Historical Buildings

David Starley

Introduction

The aim of the Historical Iron Project is to gain a greater understanding of the products of the iron industry during the past 600 years. This has been a period of unprecedented technological change for a major industry, yet remarkably little research has been directed at the class of iron alloys widely referred to as wrought irons. This project has two parallel aims. Firstly, it undertakes to examine the relationship between the structure and composition of iron and the technological process, or processes, by which it was produced. Secondly, by concentrating on a range of samples of ironwork from late medieval and post-medieval buildings, it will investigate changes in the availability and use of particular alloys for architectural purposes.

Although research into this project is still ongoing, it was considered appropriate to present the results of the initial phase of work. This first report includes the following topics:

1. The background of the iron industry.
2. Brief summary of previous analytical investigation.
3. Explanation of sampling strategy.
4. Rationale and methodology of the project.
5. Initial results and interpretation of data.
6. Conclusions.

Appendix I. A catalogue of samples / metallographic data.
II. Microanalytical data: Inclusions in iron.
III. Microanalytical data: Iron matrices.

1. European Iron Production

Since the late medieval period, iron and steel production and trade have been of major importance to the economies of both the increasingly specialised iron-producing regions of Europe and the many nations heavily dependent on imports. The continent-wide trade pattern shifted over time, often as a result of technological innovations. The three particularly significant stages were:

1. The transition from direct (bloomery) iron to indirect (blast furnace/finery) alloys.
2. The change from charcoal to coke as fuel for furnaces and hearths.
3. The introduction of bulk steel as a cost-effective alternative to "wrought iron".

The bloomery or "direct"process had developed from, but retained essentially the same principles as used in the earliest furnaces. This was a batch operation in which each smelt was terminated to remove the solid iron bloom. The iron, although containing considerable slag as inclusions, was sufficiently low in carbon that it could be worked without further treatment, apart from bloom smithing to expel slag and consolidate the metal. Documentation records that the first blast furnace was introduced to Britain in 1496 and from the late medieval period the blast furnace became increasingly important economically. The sole product of the blast furnace is cast iron; this has a high carbon content, typically above 2.5%, and is not malleable. A third technique should also be mentioned, the high bloomery (*stückofen*), often considered as an intermediate technological step. This furnace allowed the flexibility to produce either cast iron or malleable alloys, the latter being noted (Percy 1864) for their steely nature. Although there is little firm evidence for the high bloomery process away from its stronghold in central Europe, recent research (Vernon *et al* forthcoming) has suggested that the site of Timberholme in North Yorkshire may be of this type.

Whilst the casting of objects direct from the furnace was often an attractive option, the greater need continued to be for malleable iron, and a series of conversion processes were developed to decarburise cast iron from blast furnaces and so produce a workable alloy. Until the later eighteenth century this was achieved by remelting in a finery, a highly oxidising charcoal-fired hearth. However, in the second half of the century other techniques were developed based on the use of reverberatory furnaces which, by separating the fuel and iron, allowed coal or coke to be used as fuel without excessive transfer of sulphur to the metal (Morton and Mutton 1967). A patent by John Wood in 1761 involved fining of cast iron with coal followed by granulation and heating with flux in crucibles in a reverberatory furnace. The term stamping and potting was applied to this and similar processes operating around this date. In 1783 Cort patented what became known as the dry puddling process. This dispensed with the use of a separate finery hearth and the cast iron was decarburised on a bed of sand in a reverberatory furnace. The originality of his method was the subject of a lawsuit and there is reason to believe aspects of his process were not without precedent (Morton and Mutton 1967). A further development, beyond 1816, was wet puddling, in which the furnace bottom was lined with iron plates protected by furnace cinder. This allowed a slag bath to build up which very effectively oxidised unwanted elements from the cast iron. These developments, together with the use of coke in blast furnaces, were crucial for the continued expansion of the British iron industry, previously hindered by high charcoal costs. From 1720, when more bar iron was imported than produced, the country had become a net exporter by the end of the eighteenth century (Tylecote 1976).

Bessemer's invention of the steel converter in 1856 followed by the Thomas process (Basic Bessemer) and open hearth steel production, led to a rapid drop in the price of steel in the second half of the nineteenth century and allowed low carbon steels to be used economically in a wide range of products. Problems with porosity in steel casting were solved by Mushet's 1856 patent for the addition of speigel (an alloy of manganese and iron) to de-gas the metal before solidification (Dennis 1963, 96-97). The presence of manganese sulphide inclusions is characteristic of bulk steels, which also lack the often considerable volume of slag inclusions found in bloomery, finery and puddled iron. Therefore the identification of bulk steels, as a group, is not difficult.

2. Previous work

A literature survey highlighted the contrast between the large amount of work undertaken on archaeological artefacts and the fewer, less intensive studies of historical materials. A number of studies have aimed to distinguish between direct and indirect iron production. However, the value of many of these is limited because either a very restricted range of artefacts, or material from a single site, were examined without comparative material from the industry as a whole. Attempts to predict or explain compositions which might be expected in iron from specific historical processes are rare. Too frequently data is collected by whatever technique is available, then complex statistical methods are used to discriminate between groups. Additionally, many studies are weakened by a lack of technologically provenanced, or even closely dated, artefacts.

Despite the diversity of production methods, the range of "wrought iron" products have proved remarkably difficult to differentiate. Reasons include the heterogeneity within samples, the very low levels of trace elements which might be co-smelted with the iron, and the great variation in the composition of ores, fluxes and inadvertently added compounds, such as those deriving from furnace linings. A limited number of studies have tackled the problem in a more systematic way with some success. Previous approaches to the subject have compared slag inclusions within the iron to bulk slags recovered from production centres (Rostoker and Dvorak 1990) and against archival iron samples (Gordon 1983).

A recurrent difficulty is that for many of the less well known processes, reliably identified residues, which may be compared with the composition of entrapped slag in "wrought iron" are not available. Morton and Wingrove (1969) do discuss the characteristics of bulk slags from a relatively wide range of iron conversion processes operating through this period. Killick and Gordon (1987) examined dry puddling slags, concluding that it is possible to distinguish these from finery and bloomery slags on the basis of microstructural constituents. Neither of these studies extended to consideration of the evidence for stamping and potting, although the economic importance of these processes was recognised by Killick and Gordon (1987) who note that the process was responsible for half the production of bar iron in Britain by 1780.

3. Sampling strategy

As noted above, a major difficulty with any analytical study of historical ironwork is the scarcity of reference material for which the production process is known with certainty. Without material of known technological provenance, the Historical Iron Project adopted a methodology of examining a range of artefacts, for which the date (but not process) of manufacture was reliably known. This broad spectrum of dated samples could then be compared against historically recorded processes to see if any features of their compositional data might be related to those processes. The microanalysis of the first 27 samples can only be considered as a pilot project, but may provide a sufficiently large data base such that patterns in composition emerge which can be compared with suggestions made by other workers for determining the technology used to produce artefacts.

Before 1490 it can be assumed that all UK produced iron was produced by the traditional bloomery process. Beyond this, known dates for innovative processes in the United Kingdom are as follows:

1496	Charcoal blast furnace / charcoal finery iron
1709	Coke blast furnace / charcoal fined iron
1761	Coke blast furnace / stamping and potting
1780	Coke blast furnace / dry puddling
1816	Coke blast furnace / wet puddling
1856	Bulk steel (Bessemer converter / Thomas process / open hearth process)

This methodology is not without weaknesses. The recycling of old iron, the continued supply of iron from more traditional techniques and the importation of metal from overseas will result in a gradual transition, where material from one source begins to take over from others, rather than a rapid displacement of old by new. Strictly, knowing the date of the sample, it is only possible to say whether it predates a specific technique. However, the choice of architectural ironwork as a source of samples should closely reflect the availability of bulk iron at any particular time. Given the major economic importance of the processes of interest, very extensive sampling should not be necessary to ensure that material from the full range of commonly used techniques will be represented.

Generally the ironwork sampled was dated from its architectural context. Most frequently the ironwork was an original fitting in a building where the date of construction was known. Less commonly, dating was based on stylistic detail, where this was considered sufficiently precise and reliable. Choice of material for sampling was guided by the need to cover a broad range of technological processes for the production of iron and the refining of cast iron to wrought iron, as listed above. The eighteenth century was a time of considerable metallurgical innovation, and is fortunately a period for which English Heritage's Architectural Study Collection and London Region archive is particularly strong. A further, more specialised source of late eighteenth century iron was a selection of David Hartley fire plates from various buildings. These have been the subject of a separate report (Finney and Starley 1996). Earlier, post medieval material, was boosted by the inclusion of the wall ties, from the Old Merchant's House, Great Yarmouth, which enumerated the year of construction for a series of buildings between the 1560s (Plate 1) and 1651. Iron fittings sufficiently old to be of undoubted bloomery production are less well represented in the Architectural Study Collection and samples collected during earlier archaeological excavation and structural restoration were included in the study. The latest samples came from ornamental ironwork of the last decade of the nineteenth century.

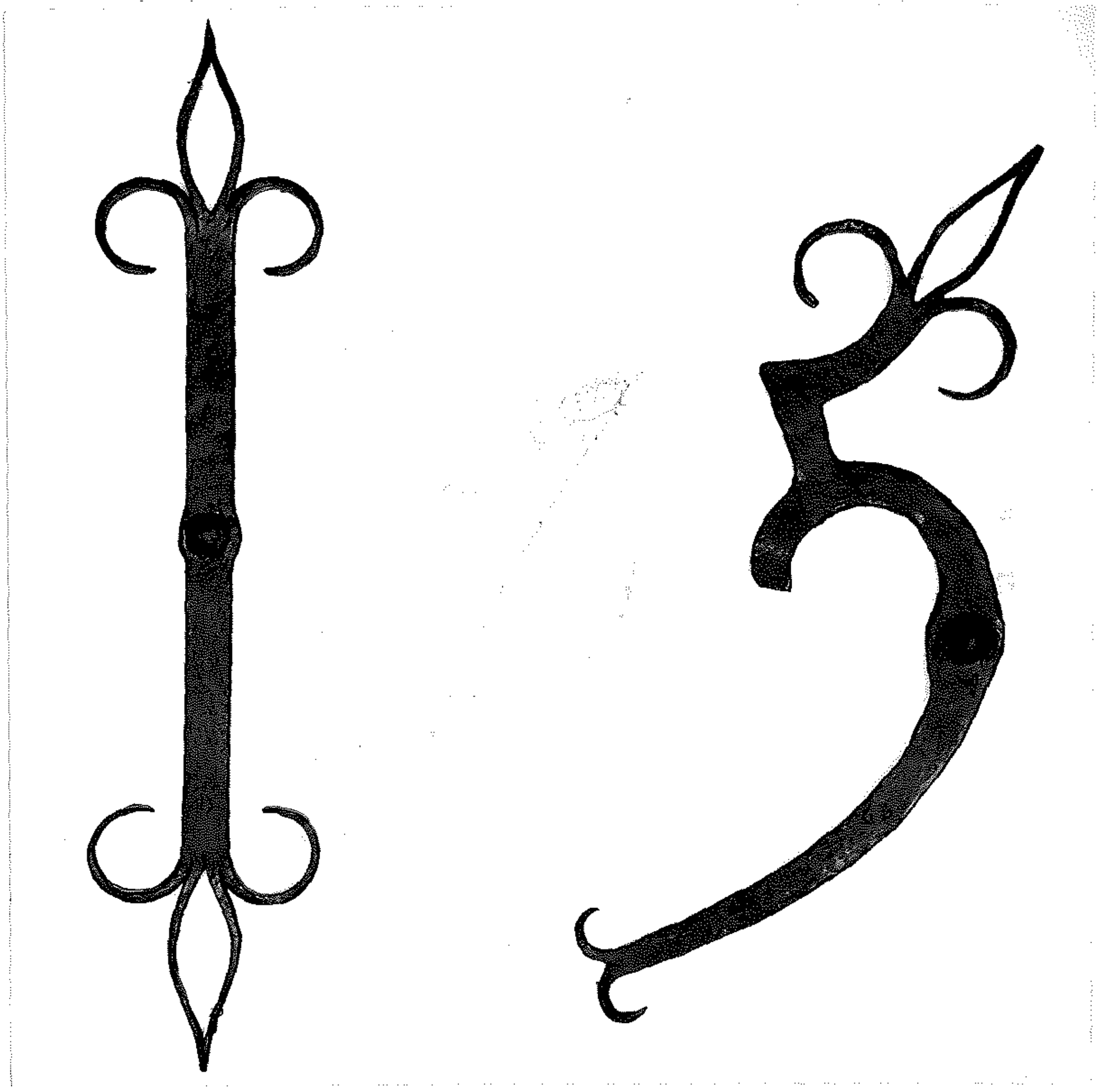


Plate 1. Two "short wall ties", Great Yarmouth, 156.... The final digit was missing from this oldest and largest set of wall anchors known from the town.

4. Project rationale and methodology

The methodology for the project was presented at the *Comité pour la Sidérurgie Ancienne* Ironworking Conference in Norberg, Sweden in April 1995 (Starley 1996), where it received much support from the international specialists present. The event gave an opportunity to air some of the difficulties likely to be encountered, such as high temperature elemental migration between the metal and slag phases, electron beam penetration during slag inclusion analysis and sample heterogeneity. The approach follows closely that previously carried out on high quality steel armours (Starley 1992), but extends over a wider date range. The use of architectural ironwork, has several advantages. Firstly it is generally much more closely dated than archaeological material. Secondly, it is representative of bulk iron production. Finally, architectural ironwork is of specific interest to English Heritage and the project will lead to a better understanding of the use of iron alloys in buildings.

Analysis included the metallographic (optical microscopic) examination of prepared specimens. This was followed by scanning electron microscope (SEM) based microanalysis of the iron and its slag inclusions. As well as analytically characterising the metals, this enabled the partitioning of elements between metallic and nonmetallic phases to be quantified, providing an insight into furnace operating conditions.

Metallography

Samples were cut from the architectural ironwork, using a hacksaw, then divided so that they could be observed in both longitudinal (along the direction of working) and transverse (across the direction of working) sections. The sections were mounted in thermosetting conductive phenolic resin and prepared using standard metallographic techniques; grinding on successively finer abrasive papers then polishing with 1µm grade diamond impregnated cloths. The specimens were examined on a metallurgical microscope in both the "as polished", *ie* unetched, condition and after etching in 2% nital (nitric acid in alcohol). Metallographic examination allowed carbon content, grain size, inclusion content and any heat treatment of samples to be assessed. Plate 2 shows a typical microstructure of wrought iron, with a high slag inclusion content and little if any carbon in the metal.

A Shimadzu microhardness tester with 0.1kg load was used to determine the hardness of different phases within the metallographic structure. Generally, a mean of five values was obtained. These values assist in determining the impurity content of elements such as phosphorus which tend to harden the iron and the heat treatment history of the metal.

Three types of iron can be recognised metallographically when the samples have been etched: ferritic iron, phosphoric iron and steel. All may contain slag inclusions, which may be classified according to numbers of phases present and morphology (spheroidal, sub-round, elongated or stringer). The properties and basic microstructure of these alloys are described below.

Ferritic iron. Pure iron without significant impurities. Relatively soft and easily worked. Recognised in an etched microstructure as plain white crystals. Microhardness values are typically in the range H_v 100-150 (Plate 2).

Phosphoric iron Even trace levels of phosphorus of the order of 0.1 to 0.3% entering the iron during smelting may significantly harden the iron without disadvantageously reducing its toughness. In the etched microstructure phosphoric iron can generally be recognised by a ghosting effect in which ferrite grains have a "watery" appearance with bright areas which may be difficult to bring into sharp focus with the microscope (Plate 3). The microhardness values of phosphoric iron are typically H_v 150-200.

Steel is iron containing small amounts of carbon, typically 0.2 to 1%. It has advantages in being both tougher and harder than iron and is often used selectively, for instance in the cutting edges of edged tools or in springs, rather than in architectural ironmongery. An important property of steel is that it can be further hardened by appropriate heat treatment. Heating followed by quenching in water gives considerable hardness but may make the artefact brittle. This can be avoided either by subsequently tempering the artefact, *ie* reheating, but to a lower temperature than it was quenched from, which helps relieve stresses within the structure. Alternatively, a less severe "slack" quench can be used, typically by cooling in a less thermally conductive medium, such as oil. The microstructures of steel reflect both the amount of carbon present, the severity of quenching and the effects of reheating. With 0.8% carbon ,"eutectic" composition steel which has not been heat treated consists entirely of a dark etching phase known as pearlite. Occasional steels which exceed this carbon content contain both pearlite and iron carbide. The more common, lower carbon steels contain both pearlite and the carbon-free phase, ferrite. The ratio of these phases directly relates to the composition, thus a 0.4% carbon steel contains 50% pearlite and 50% ferrite, whilst at 0.2% carbon the proportions will be 25% and 75% respectively. In mild steels the amount of carbon present is generally below this level and hence very little pearlite is present. When rapid cooling takes place, a range of other crystalline structures tend to form instead of pearlite, of which the two most common phases are bainite, and (for very rapid cooling) martensite. None of the architectural ironwork examined during the project contained homogeneous steel, which would have been a valuable commodity during all but the latest half century of the period under study. However, in a minority of samples carbon was within a heterogeneous structure which contained both high and low carbon phases (Plate 4).

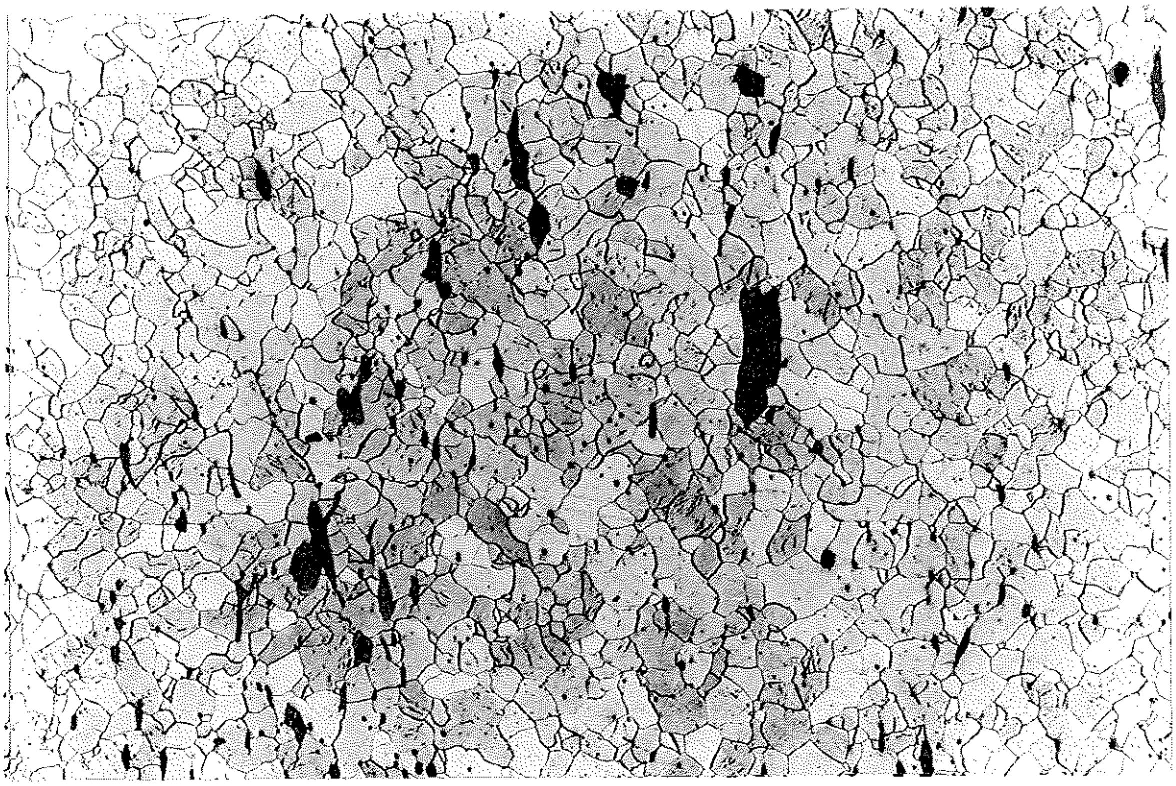


Plate 2. Micrograph of sample 960022. Staircase upright, Coventry Hall, Streatham 1800. Etched in nital x100. Note high proportion of slag inclusions (dark) and the pure iron (ferrite) matrix.

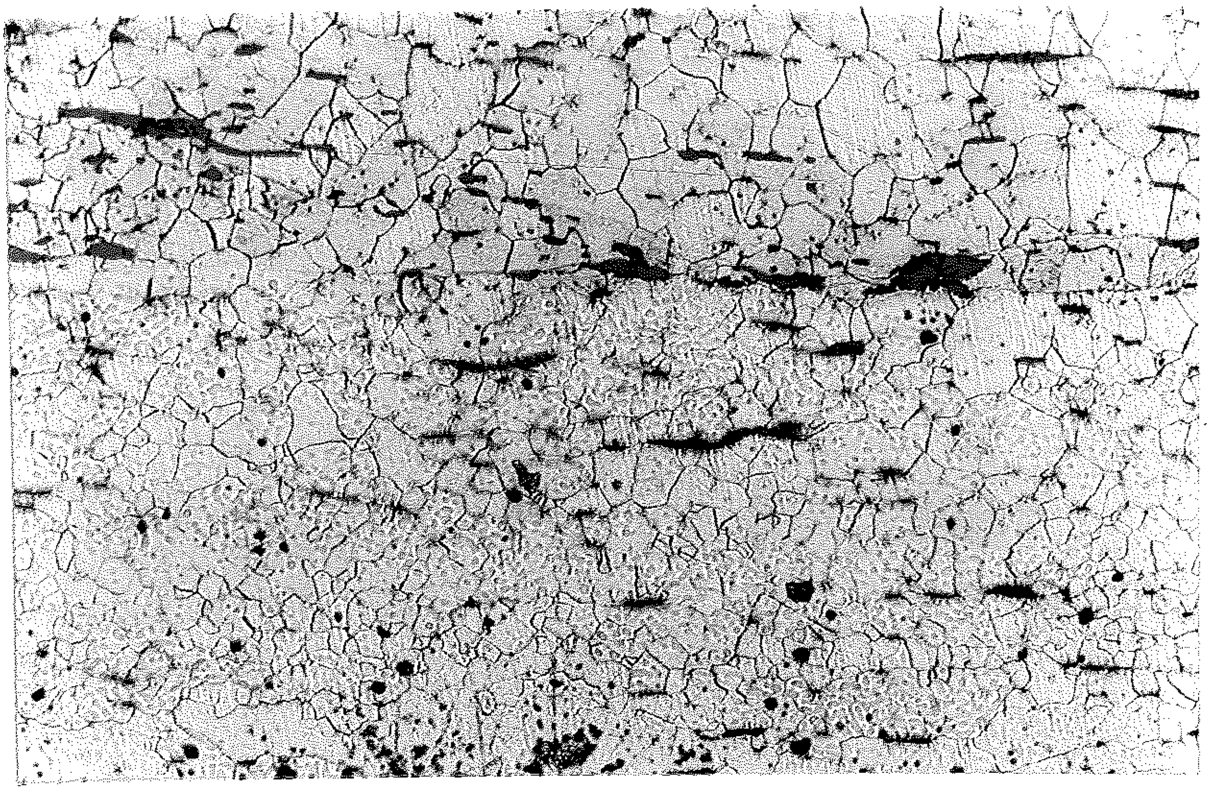


Plate 3. Micrograph of sample 960019. Railing, 5 Knightsbridge c1800. Etched in nital x25. Note ghosting indicative of phosphoric iron.

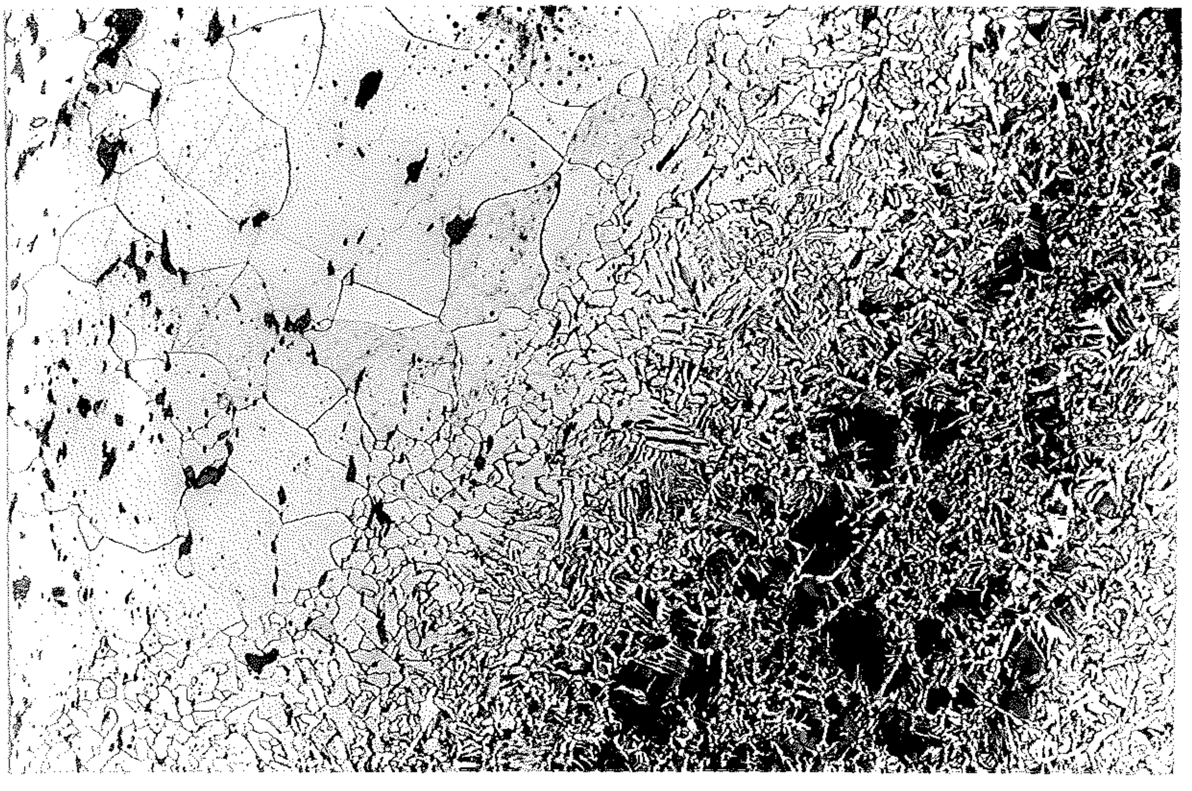


Plate 4. Micrograph of sample 960016. Balcony support, Fournier St. Mosque 1743. Etched in nital x12.5. The light etching phase is ferrite, the dark etching phase is pearlite.

Microanalysis

Microanalysis of the samples was undertaken using two instruments. The AML's own SEM, a LEO 440i fitted with Oxford ISIS, thin window, energy-dispersive X-ray (EDX) analyser, was used to analyse slag inclusions within the iron. This was able to detect all elements above boron in the periodic table. The advantage of SEM based EDX analysis lies in the ability of the technique to undertake analysis at high magnifications on selected small areas, such as the inclusions within the iron matrix. The sample was viewed in back-scattered mode before quantitative analysis was undertaken. This mode enhances atomic number contrast, rather than topography, allowing phases in the flat, polished specimen to be differentiated for analysis. Inclusion size was recorded during analysis to enable a check on one possible source of error; elements such as phosphorus are known to diffuse between inclusions and the metal during hot working and it might be expected that the composition of small inclusions, with a high surface area to volume ratio, would have significantly different compositions as a result. However, no significant link between inclusion size and composition was identified.

It should be noted that the EDX analyser can only be used to detect elements, not compounds. The figures quoted in Appendix II, which refer to the weight percentage of oxide, are derived from assumptions about the stoichiometry (*ie* the combining tendency) of each element. Minimum detectable levels vary from element to element: for oxides of sodium (Na), magnesium (Mg), aluminium (Al), silicon (Si), phosphorus (P), sulphur (S), potassium (K), calcium (Ca) and titanium (Ti) these are approximately 0.1%, whilst manganese (Mn) is a little higher at about 0.15%.

SEM-based wavelength dispersive analysis was commissioned from Oxford University's Research Laboratory for Archaeology and the History of Art, where a Cameca Semprobe with a wavelength dispersive X-ray (WDX) analyser was used to determine the content of impurities dissolved in the iron. Minimum levels of detection are far lower than for an EDX detector: Si; 0.003%, P; 0.004%. S; 0.003%, Ti; 0.008%, V; 0.006%, Cr; 0.005%, Mn; 0.009%, Co; 0.010%, Ni; 0.013%, Cu; 0.03%, Zn; 0.017 and As 0.034%.

Partitioning of elements

A key approach in this study is to consider the behaviour of different elements in the alternative smelting processes, particularly those elements which tend to partition between the metal and slag phases. Many elements pass into the slag: potassium, sodium, calcium and magnesium, whilst some are reduced into the iron: copper, nickel and cobalt. However, for certain elements (phosphorus, manganese, sulphur and silicon) the degree to which they are reduced into the metal during smelting will depend on furnace conditions, especially temperature. The detrimental effect of sulphur on iron is such that high-sulphur raw materials were avoided by smelters. Silicon is only likely to be reduced into the cast iron at high temperatures, certainly when coke is used as fuel, but is removed rapidly during the early stages of fining. Therefore the content of this element was not expected to be significant. Phosphorus is present in many ores and a high proportion of this will be reduced into the iron. Some caution must be exercised because of the tendency for the element to diffuse between metal and inclusions during hot working.

Manganese is potentially the most reliable indicator of smelting conditions. The effect of temperature on the reduction of manganese has been discussed by Bodsworth and Bell (1972). Their calculations, which assume the activity of carbon to be unity and the partial pressure of carbon monoxide to be one atmosphere, suggest that a rise from 1327°C to 1527°C would increase the amount of manganese reduced into the metal elevenfold. Hence, given similar ores, cast iron from the higher temperature blast furnace might be expected to contain levels of manganese an order of magnitude greater than would be expected from a bloomery.

The subsequent effect of the fining processes on the dissolved elements is dramatic. In the conversion processes silicon in the pig iron oxidises most rapidly; followed in succession by manganese, phosphorus and then carbon. Thus, a high proportion of any manganese and phosphorus present will oxidise into the finery/puddling slag. Their final content there will be dependent not only on the amount of the two elements in the cast iron but also on the quantity of slag present and the extent to which other materials were added (particularly hammerscale and haematite ore during wet puddling). However, it would appear likely that slag from the decarburising processes should contain very significantly elevated levels of manganese and phosphorus.

5. Results of first phase of study

The microstructures observed in the samples when examined under an optical microscope are recorded in Appendix I. Despite the broad time span and undoubted range of metalworking processes, the microstructure of the iron alloys show a typical spread of "wrought iron " structures. Most have a matrix composed entirely of ferrite grains and contain inclusions occupying from less than 1% up to 12% of the volume, aligned along the direction of working. High carbon phases are exceptional. Ghosting within grains, together with the evidence from microhardness testing and WDX analysis suggest that many of these alloys contained significant amounts of phosphorus. The levels are similar to those of an earlier study (Goodway and Fisher 1988) which found levels of phosphorus of the order of 0.1 to 0.2 % in nineteenth century drawn music wire. However, in that case it was suggested that such iron had been deliberately selected for drawing, rather than it being a common alloy of the time. The first significant outcome of the Historical Iron Project is that it has demonstrated the widespread use of phosphoric iron in the historic past.

An exceptional metallographic structure was noted in sample 960026. This had a fine uniform grain size, with traces of agglomerated pearlite at grain boundaries and very little sub-round slag. Significantly this sample was the most recent examined, dating between 1889 and 1891, and is undoubtedly the product of one of the bulk steel production techniques.

Complete listings of analytical results are presented in Appendix II (EDX microanalysis of inclusions within the iron) and Appendix III (WDX microanalysis of the metal matrices). Inclusion compositions show considerable variation between samples. Inclusions which are almost exclusively iron oxide are probably entrapped scale. Many inclusions approximate to the composition of fayalite ($2FeO.SiO_2$), but also contain a range of other oxides, similar to bulks slags which result from bloomery smelting, fining and smithing operations. There is a clear tendency for samples with a higher carbon content to contain less iron oxide. Sample 960026 is again shown to be exceptional, containing manganese silicate inclusions.

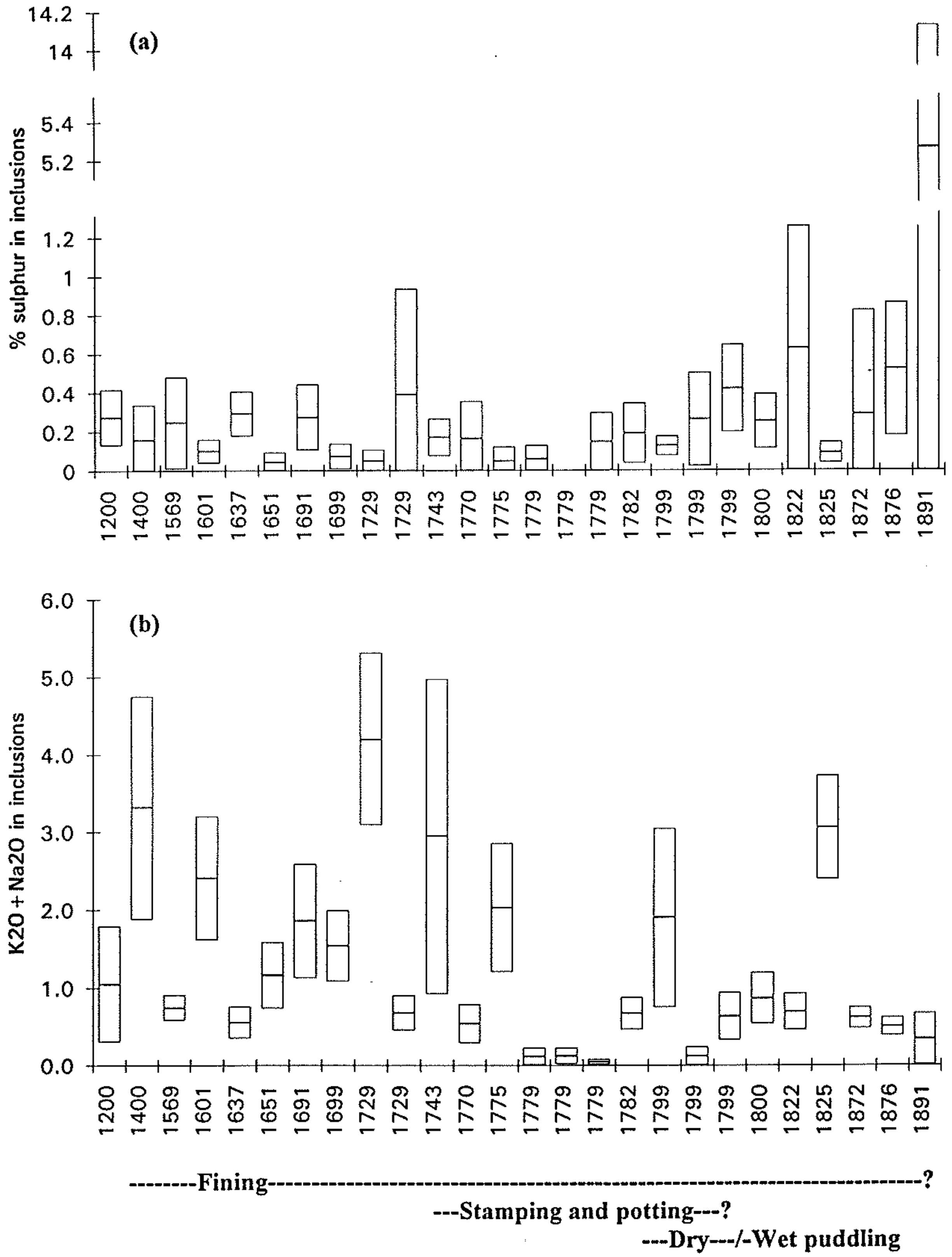
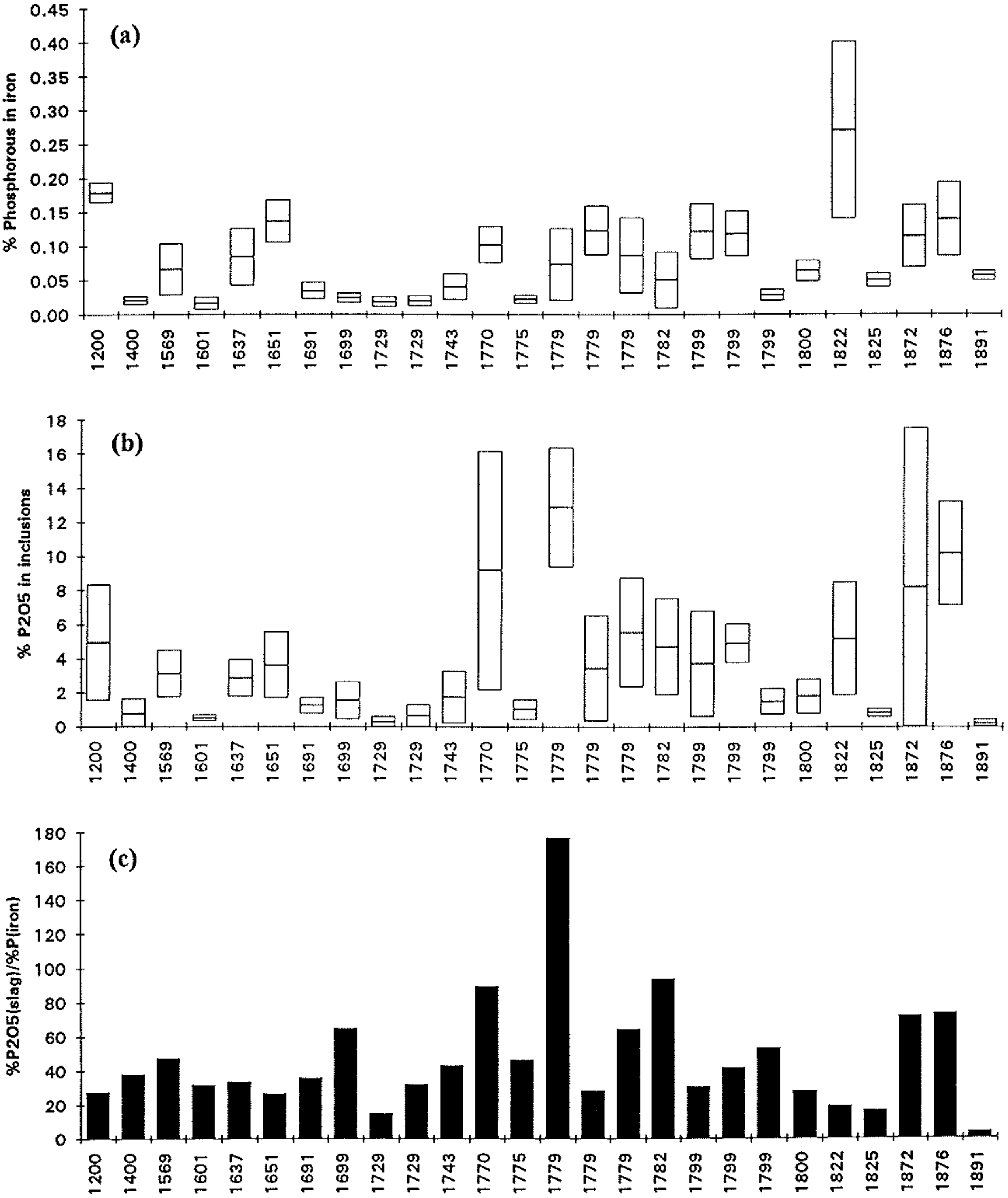


Figure 1. Concentrations of (a) sulphur and (b) oxides of potassium and sodium in inclusions. (mean ±σ)



--------Fining---?

---Stamping and potting---?

---Dry---/-Wet puddling

Figure 2. The distribution of phosphorus in architectural iron samples. (a) Elemental phosphorus in iron matrix (mean ±σ). (b) Phosphorus pentoxide in slag inclusions (mean ±σ). (c) Partitioning of phosphorus between slag inclusions and iron (mean values).

The iron matrix analyses in Appendix III generally show only very low concentrations of impurity elements - one of the characteristics which has led to the products of a wide range of products being labelled "wrought iron". Occasional high values, for example 0.388% copper in 950009 and 0.107% of copper in 960007 may represent either contamination from non-ferrous metalworking or the use of unusually copper-rich ore. Levels of phosphorus vary considerably within individual samples; mean values of 0.1% are common and the greatest concentration is 0.27% in sample 960023.

In order to distinguish trends, data was comparing visually in the form of bar charts showing values for mean and standard deviation composition. In Figures 1 and 2 the data are shown with sample date increasing from left to right. For clarity only the latest possible dates for the samples were used. To allow comparison only samples for which both inclusion and matrix analysis was undertaken were included in the chart. Sample 96012, a window hinge hook supposedly dated to 1694 was also left out because of doubts regarding its authenticity. Data from the two bolts from the Albert memorial (950006 and 950007) were combined into a single value

Figure 1a shows changes in the levels of sulphur in inclusions with time. Low sulphur levels have generally been regarded as indicative of bloomery iron and charcoal fined iron. Generally, values show an upward trend, with mean values above 0.4% all dating to 1799 or later and exceptionally high levels from sample 960026, an iron gate of 1891. Despite this trend, absolute differences over the entire period are narrow and it would appear that little confidence can be placed in sulphur as a discriminator for the fuel used in conversion processes.

The alkalis, potash and soda, originate from either charcoal or coke ash. Killick and Gordon (1987) note that very low levels of Na_2O and K_2O occur in dry puddling slags, where the reverberatory furnace kept the fuel separate from the iron and slag. This contrasts to bloomery and finery slags which form in contact with fuel ash. Rostoker and Dvorak (1990) looked at inclusions and extended this argument to suggest that low alkali content of inclusions could be used as a discriminator of process. In Figure 1b it can be seen that slag inclusions in late eighteenth and nineteenth century samples are generally low in Na_2O and K_2O and so conform to this model (a small staple of 1825 may well be one example of recycled iron). Rostoker and Dvorak suggested that puddled iron should have a "probable upper limit" of 1% for alkali content. Certainly most of the ironwork (7 of 9 samples) used in the period when puddling was at its height conforms to this. However, low alkali contents also appear to be characteristic of iron from the decade before Cort's patent for the puddling process of 1784. These are unlikely to derive from the stamping and potting process which, although it also used reverberatory furnaces, also used highly alkaline fluxes to remove sulphur picked up in an earlier refining stage. Several much earlier samples also contain only low alkali concentrations. Thus, whilst earlier researchers are correct in stating that puddled iron normally contains low alkali inclusions, the presence of low alkali inclusions cannot be cited as proof of this process as a source of the metal.

Reliable figures for manganese partitioning in the architectural samples cannot be accurately determined because of the very low concentrations of the element in the metal and inclusions and so this is not discussed further here. By contrast most of the samples contained levels of phosphorus which are not only numerically significant but also significant to the properties of the alloy (Figure 2a). These provided an opportunity to test the findings of Gordon (1984) who suggested, on the basis of inclusion and bulk metal analyses, that distinctly higher proportions of phosphorus pass into the slag of fined and puddled iron than bloomery iron. Despite the difficulty mentioned above, that some diffusion of phosphorus will occur during subsequent hot working, it is assumed that this effect will be relatively minor in comparison to the changes taking place during the high temperature, highly oxidising conditions of the decarburising processes. Three immediately recognisable features are evident in Figure 2b, which charts the content of phosphorus pentoxide in the inclusions. Firstly, it demonstrates the large quantities of this element that are frequently stored up in the non-metallic phases. Secondly, there is considerable variation of the phosphorus content of inclusions within individual samples. Finally, there is great variation between the mean phosphorus contents of different samples.

As discussed above, it was intended to gain a better understanding of furnace conditions by studying the partitioning of elements, *ie* the relative proportions passing into the slag and metal phases. In Figure 2c values on the Y axis are calculated as mean percentage phosphorus pentoxide in the slag divided by mean percentage phosphorus in the iron. Patterns in the data begin to emerge. Early samples, at least before the late seventeenth century, are relatively consistent and set a baseline for what might be expected from the bloomery process. In fact many later samples show very similar levels. However, a scattering of samples dated as widely as 1699 to 1876 show a technique or techniques which were able to extract greater proportions of phosphorus from the metal into the slag. Wet puddling, from 1816 or slightly later (Mott, 1977-8), had a reputation for the superior removal of phosphorus (and silicon) from cast iron. Five samples date beyond this introduction but none show greater partitioning of phosphorus than several late eighteenth century samples. Whilst initial indications based on so few samples should be treated with some caution, given the apparent rapidity with which wet puddling became the standard technique for the production of wrought iron in Britain, it is unlikely that none of these five samples derived from the process.

6. Conclusions

Architectural ironwork samples provided good coverage of the period of interest, especially the mid to late eighteenth century material. Metallography and microanalysis are powerful techniques for characterising ferrous alloys and determining the later working and heat treatment histories of artefacts. This study extended these techniques to the investigation of iron production technology, particularly with the aim of differentiating specific processes. Microanalysis of both inclusions and metal matrices allowed quantification of elemental partitioning between the two phases which reflects the conditions in the furnace or hearth.

Although the products of later, bulk steel production processes, appeared to be easily identified, hopes of identifying less well documented conversion processes such as stamping and potting were not fulfilled. Whether this is due to methodological weakness or poor choice of samples is unclear and will need to be tested by more specific sampling as the project moves beyond the pilot stage. Meanwhile it would appear that the identification of the production processes of "wrought iron" alloys by quantification of the sulphur or alkali content of their inclusions should be viewed with some caution. Beyond these specific questions the project led to a better understanding of a class of materials commonly encountered in historic buildings and has begun to build up a reference collection with corresponding analytical database. It also provided an unplanned opportunity for constructive collaboration with Frank Kelsall, Inspector of Historic Buildings, North West Region, on the production and use of Hartley's fireplates (Finney and Starley 1996). This suggested that production of this thinly rolled iron sheeting, used to help prevent the spread of fire within buildings, may be related to the rolling of iron for the tin plate industry.

Acknowledgements

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Appendix I

Metallographic recording sheets for samples investigated during the Historical Iron Research Project

A.M. Lab. Metallography Recording Sheet

SAMPLE: 950006

ARTEFACT: ALBERT MEMORIAL BOLT (SQUARE HEAD)

Condition: SURFACE CORROSION

Sample location: END OF BOLT

Permission to sample ☑ After care:

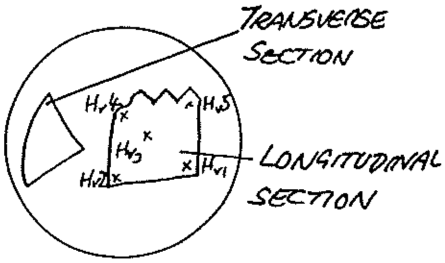
X-radiographs:
Line drawings:
Photos-Colour slide:
135 b/w print:
other:

RECORDING. D. STARLEY

ARCHAEOLOGICAL CONTEXT
Site name: ALBERT MEMORIAL
Specific context:
Dating of context: 1872-6

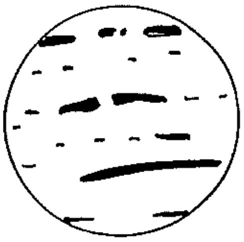
AML Ref:

MACROSTRUCTURE



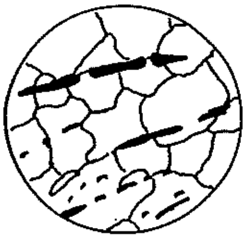
H_v (100g/10sec)
1) 164.3
2) 151.4
3) 125.1
4) 183.4
5) 163.3
MEAN 157.5

MICROSTRUCTURE
unetched LONGITUDINAL x500



SLAG STRINGERS (10% + SPHEROIDAL INCS)
DUAL PHASE
SOME STRINGERS FRAGMENTED

MICROSTRUCTURE
etched: 2% NITAL, LONGITUDINAL x500



LARGE (ASTM 5-2)
IRREGULAR
FERRITE GRAINS
PATCHY PHOSPHORUS GHOSTING

PHOTOS

Film No.	Exp.No.	Mag.	Subject
96002	1	x50	LONGIT.
	2	x12.5	SECTION THRU' THRE
	3	x25	TRANSV.
96003	18A	x12.5	LONGIT.-THREAD
	19A	x12.5	" "
	20A	x25	" "
	21A	x25	TRANS.-PHOS. GHOSTING.
96005	0A	x4	TRANS.
	1A	x4	LONG.

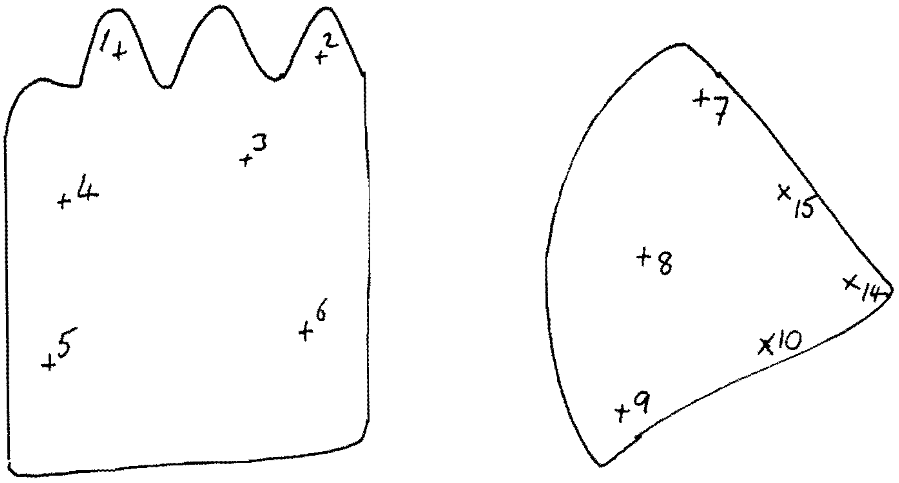
ANALYSES: ✓
SEM/EDX☑ SEM/WDX☑ XRF☐ XRD☐ OTHER☐ see over.

INTERPRETATION:

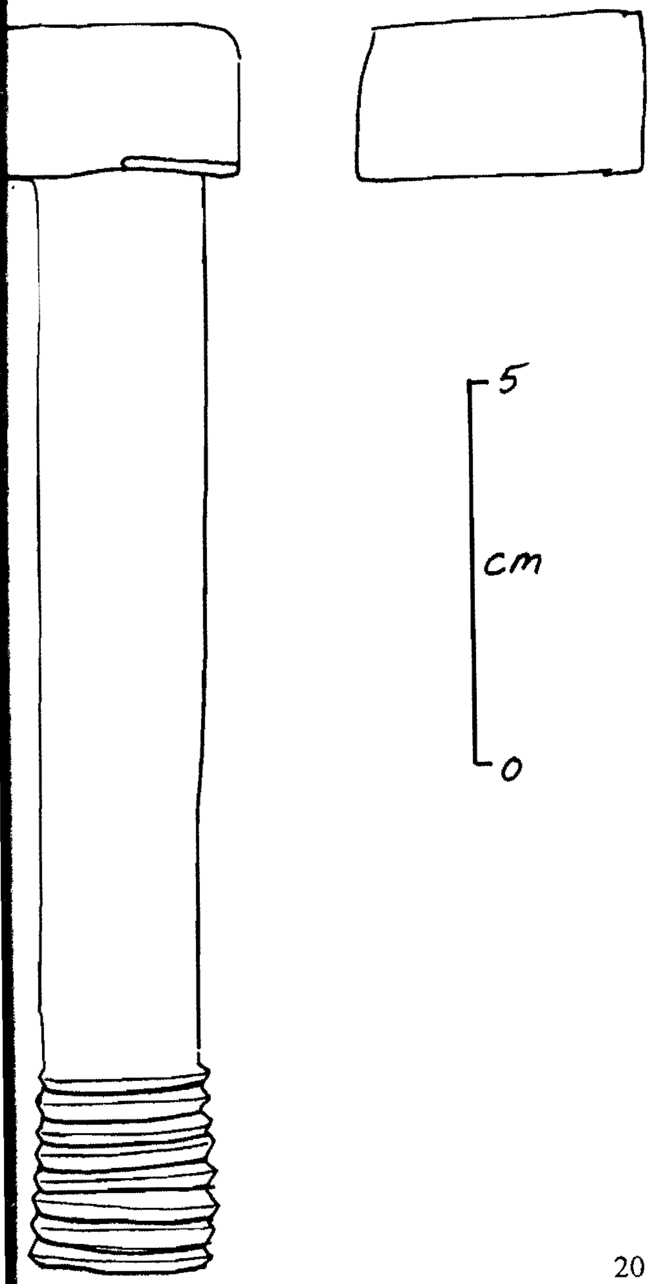
COARSE GRAINED, SLAG-RICH PHOSPHORIC IRON

950006

ALBERT MEMORIAL BOLT



POSITION OF INCLUSION ANALYSES



A.M. Lab. Metallography Recording Sheet

SAMPLE: 950007

ARTEFACT: ALBERT MEMORIAL BOLT (HEXAGONAL HEAD)

Condition: SURFACE CORROSION

Sample location: FROM THREAD AT CUT

Permission to sample ☑ After care:

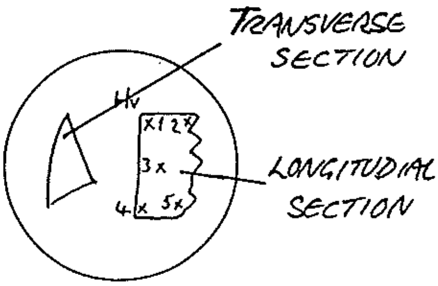
X-radiographs:
Line drawings:
Photos-Colour slide:
135 b/w print:
other:

RECORDING: D. STARLEY

ARCHAEOLOGICAL CONTEXT
Site name: ALBERT MEMORIAL
Specific context:
Dating of context: 1872-6

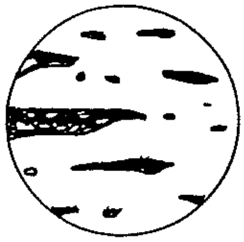
AML Ref:

MACROSTRUCTURE



Hv 1) 153.1
2) 159.5
3) 167.2
4) 181.0
5) 167.2
Mean. 165.6

MICROSTRUCTURE
unetched LONGITUDINAL SECTION x 300



12% SLAG MAINLY DUAL PHASE STRINGERS

MICROSTRUCTURE
etched: 2% NITAL LONGITUDINAL SECTION x500

FERRITE WITH P GHOSTING ASTM 4

SLIGHT ETCH PITTING

PHOTOS

Film No.	Exp.No.	Mag.	Subject
96002	4	x50	LONGIT.
	5	x125	" - THREAD
	6	x50	TRANSV.
	17	x6	LONGIT.
96003	22A	x6	LONGIT.
	23A	x125	"
	24A	x25	"
	25A	x25	TRANSV.
96005	2A	x4	TRANSV.
	3A	x4	LONGIT

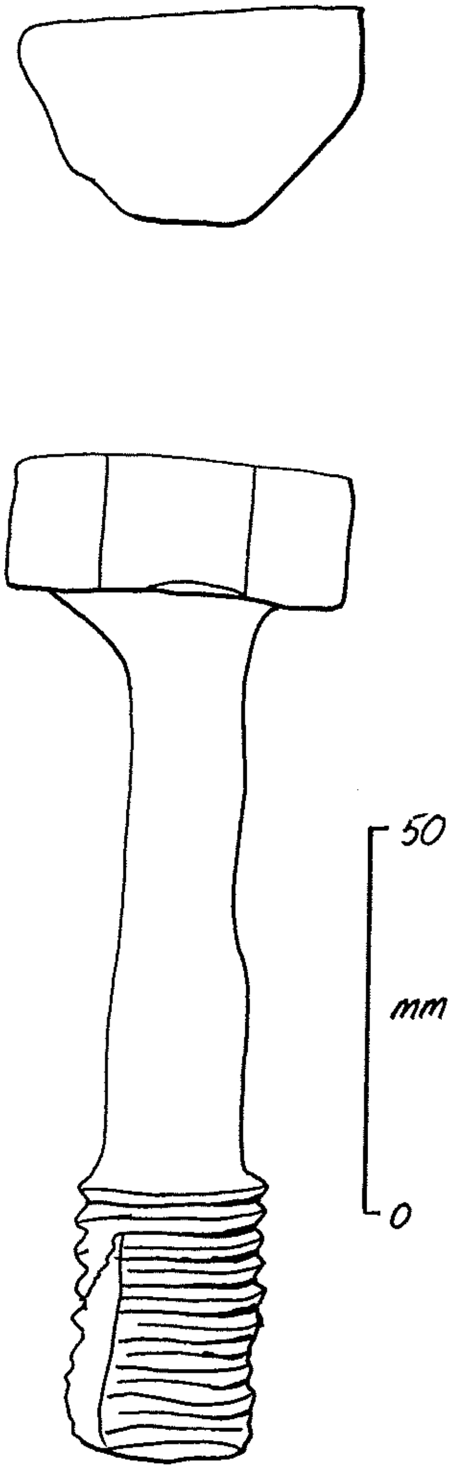
ANALYSES:
SEM/EDX☑ SEM/WDX☐ XRF☐ XRD☐ OTHER☐ see over.

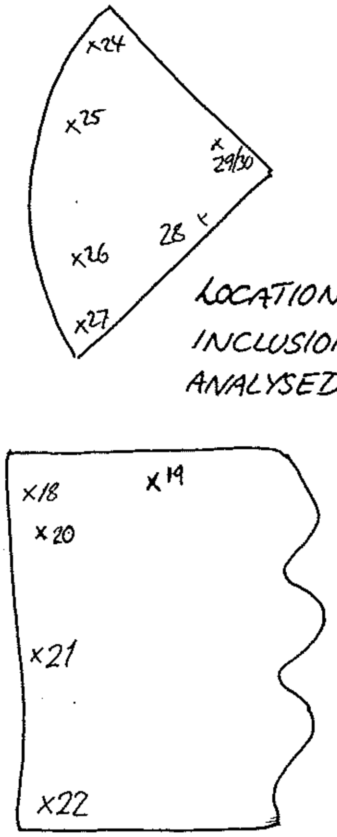
INTERPRETATION:

SLAG-RICH PHOSPHORIC IRON

ALBERT MEMORIAL BOLT

95007





LOCATION OF
INCLUSIONS
ANALYSED

A.M. Lab. Metallography Recording Sheet

SAMPLE: 950009

ARTEFACT: WINDOW GRILL - CASTLE HEDLINGHAM

Condition: SURFACE CORROSION

Sample location: SEE BELOW

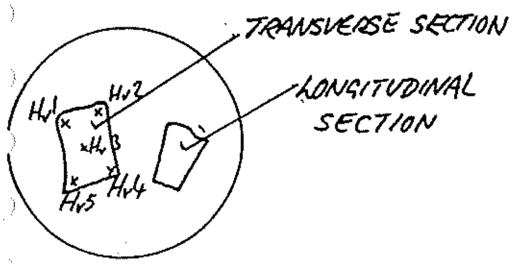
Permission to sample ☑ **After care:**

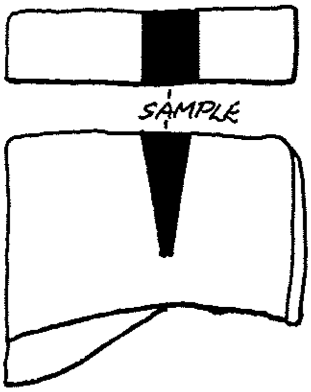
X-radiographs:
Line drawings:
Photos-Colour slide:
135 b/w print:
other:

RECORDING: D. STARLEY

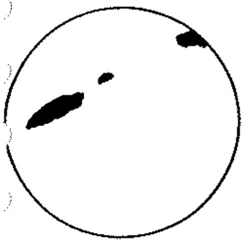
ARCHAEOLOGICAL CONTEXT
Site name: CASTLE HEDLINGHAM
AML Ref:
Specific context: END OF WINDOW BAR. GALLERY LEVEL. NORTH FACE
Dating of context: RIGHT HAND WINDOW - LEFT SIDE
C12th.

MACROSTRUCTURE





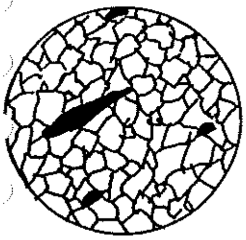
MICROSTRUCTURE
unetched x500 LONGITUDINAL



1% ELONGATED INCLUSIONS
GENERALLY SINGLE PHASE, SOME DUAL

(TRANSVERSE INCLUSIONS IRREGULAR, 2%)

MICROSTRUCTURE
etched: 2% NITAL x500 LONGITUDINAL



ASTM 3-6
EQIAXED FERRITE GRAINS
AREAS OF VERY DISTINCT
PHOSPHORUS GHOSTING.

Hv
1) 166.2
2) 161.4
3) 165.2
4) 200.7
5) 170.3
MEAN 172.8

PHOTOS

Film No.	Exp.No.	Mag.	Subject
96002	7	x25	LONGIT.
	8	x25	TRANSV.
96003	26A	x12.5	LONGIT
	27A	x25	"
	28A	x12.5	TRANSV.
	29A	x25	" (P. GHOSTING
	30A	x100	" " "
96005	4A	x4	LONGIT.
	5A	x4	TRANSV.
96008 (SLIDE)	1,2,3	x25	LONGIT.

ANALYSES: ✓
SEM/EDX☑ SEM/WDX☐ XRF☐ XRD☐ OTHER☐ see over.

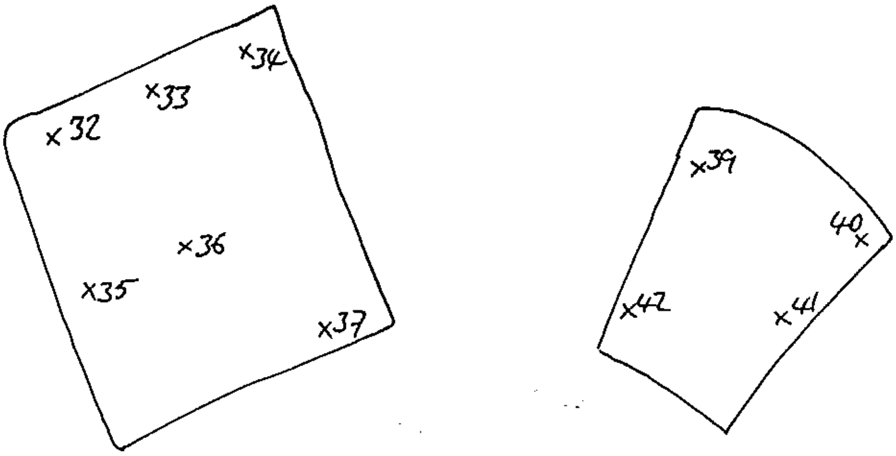
INTERPRETATION:

PHOSPHORIC IRON

950009

CASTLE HEDINGHAM WINDOW GRILL

POSITION OF INCLUSION ANALYSES



A.M. Lab. Metallography Recording Sheet

SAMPLE: 950012a

ARTEFACT: DAVID HARTLEY FIREPLATE

Condition: SURFACE CORROSION

Sample location: TURNED OVER END OF PLATE

Permission to sample ☑ After care:

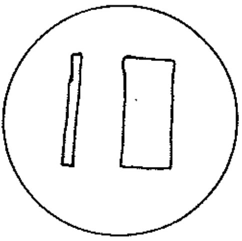
X-radiographs:
Line drawings:
Photos-Colour slide:
135 b/w print:
other:

RECORDING: T. FINNEY

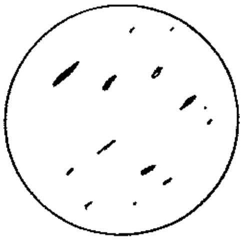
ARCHAEOLOGICAL CONTEXT
Site name: NORBURY PARK
Specific context:
Dating of context: c1770s

AML Ref:

MACROSTRUCTURE

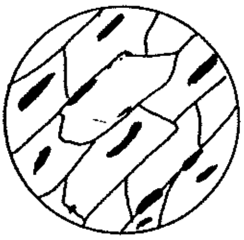


MICROSTRUCTURE
unetched



BROKEN-UP SLAG INCLUSIONS
2%

MICROSTRUCTURE
etched:



ELONGATED GRAINS
ASTM 5

PHOTOS

Film No.	Exp.No.	Mag.	Subject
96001	13	×50	
	14	×50	
96001	22	×50	
	23	×100	
	24	×100	
	25		

ANALYSES:
SEM/EDX☑ SEM/WDX☑ XRF☐ XRD☐ OTHER☐ see over.

INTERPRETATION:

FERRITIC IRON

A.M. Lab. Metallography Recording Sheet

SAMPLE: 960002

ARTEFACT: DAVID HARTLEY FIREPLATE

Condition: SURFACE CORROSION

Sample location: EDGE OF PLATE, BY NAILHOLE

Permission to sample ☐ After care:

X-radiographs:
Line drawings:
Photos-Colour slide:
135 b/w print:
other:

RECORDING: T. FINNEY

ARCHAEOLOGICAL CONTEXT

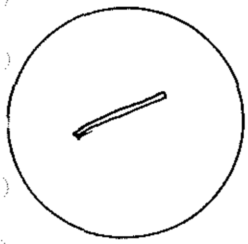
Site name: BEDFORD GARDENS

Specific context:

Dating of context:

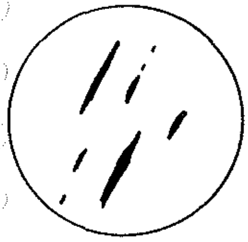
AML Ref:

MACROSTRUCTURE



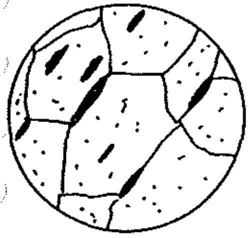
TRANSVERSE SECTION

MICROSTRUCTURE
unetched



GREY SLAG STRINGERS ≈5% MOSTLY ALONG CENTRE OF PLATE

MICROSTRUCTURE
etched:



FERRITE ASTM 6

SOME SLAG WITHIN GRAINS

PHOTOS

Film No.	Exp.No.	Mag.	Subject

ANALYSES:
SEM/EDX☐ SEM/WDX☐ XRF☐ XRD☐ OTHER☐ see over.

INTERPRETATION:

FERRITIC IRON, HOT ROLLED, TINNED

A.M. Lab. Metallography Recording Sheet

SAMPLE: 960003

ARTEFACT: FIRE PLATE

Condition: SOME SURFACE CORROSION

Sample location: NOT KNOWN

Permission to sample ☐ After care:

X-radiographs:
Line drawings:
Photos-Colour slide:
135 b/w print:
other:

RECORDING: T. FINNEY

ARCHAEOLOGICAL CONTEXT

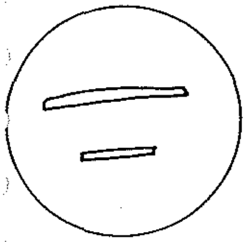
Site name: QUARRY BANK MILL, STYAL

Specific context: WEAVING SHED

Dating of context: BUILDING 1796 - CONTEMPORARY?

AML Ref:

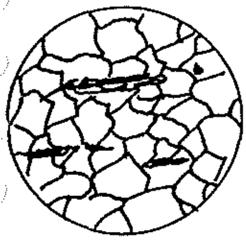
MACROSTRUCTURE



MICROSTRUCTURE
unetched

3% SLAG/CORROSION

MICROSTRUCTURE
etched: x100



GRAIN SIZE ASTM5
EQUIAXED FERRITE GRAINS

PHOTOS

Film No.	Exp.No.	Mag.	Subject
96001	11	x50	
	12	x100	
96001	25	50	
	26	50	
	27	100	
	28	100	
	29	250	SLAG.

ANALYSES:
SEM/EDX☑ SEM/WDX☑ XRF☐ XRD☐ OTHER☐ see over.

INTERPRETATION:

FERRITIC IRON - HOT ROLLED OR ANNEALED

A.M. Lab. Metallography Recording Sheet

SAMPLE: 96004

ARTEFACT: HARTLEY'S FIRE PLATE

Condition: CORRODED, SOME METAL SURVIVING.

Sample location: SEE REVERSE

Permission to sample ☑ **After care:**

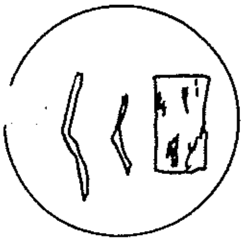
X-radiographs:
Line drawings:
Photos-Colour slide:
135 b/w print:
other:

RECORDING: T. FINNEY

ARCHAEOLOGICAL CONTEXT
Site name: PORTSMOUTH HISTORIC DOCKYARD
Specific context: STOREHOUSE 9.
Dating of context: 1779

AML Ref:

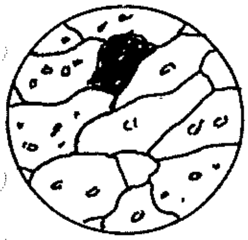
MACROSTRUCTURE



MICROSTRUCTURE
unetched X400

10% CORROSION/SLAG.

MICROSTRUCTURE
etched: 2% NITAL X400



COARSE GRAINED (ASTM 4)
ELONGATED FERRITE
WITH ETCH PITTING.

PHOTOS

Film No.	Exp.No.	Mag.	Subject
96001	9	50	SURFACE
	10	100	CORROSION
96001	97	50	
	18	100	CORROSION
	19	100	"
	20	50	EDGE
	21	100	"

ANALYSES:
SEM/EDX☑ SEM/WDX☑ XRF☐ XRD☐ OTHER☐ see over.

INTERPRETATION:

FERRITIC IRON

960004

PORTSMOUTH DOCKYARD - FIREPLATE

SAMPLE
TAKEN, CUT & MOUNTED
FLAT & ON EDGE

Nail folded over

A.M. Lab. Metallography Recording Sheet

SAMPLE: 960005

ARTEFACT: DRAIN GRILL

Condition: SURFACE CORROSION, SOLID CORE

Sample location:

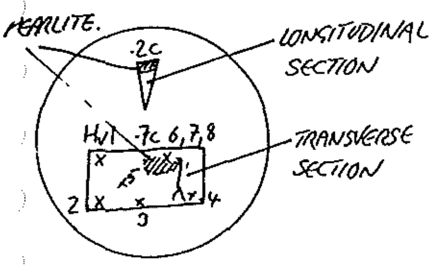
X-radiographs:
Line drawings:
Photos-Colour slide:
135 b/w print:
other:

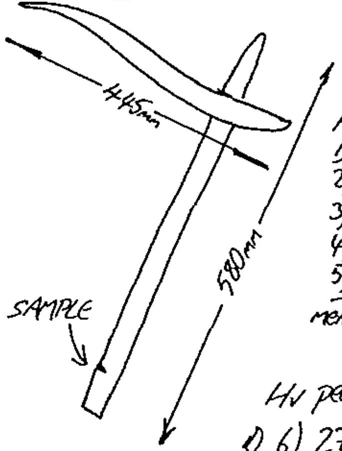
Permission to sample ☑ After care:
(SARAH JENNINGS, JAN SUMMERFIELD)

RECORDING : D. STARLEY

ARCHAEOLOGICAL CONTEXT
Site name: WINDSOR CASTLE, ROUND TOWER (CEU SITE 431) AML Ref: 9100035
Specific context: 7347
Dating of context: Prob. C4 - to be confirmed

MACROSTRUCTURE

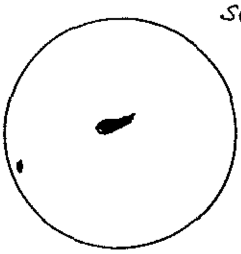




Hv ferrite
1) 98.45
2) 133.3
3) 123.2
4) 139.2
5) 111.4
MEAN 121.1

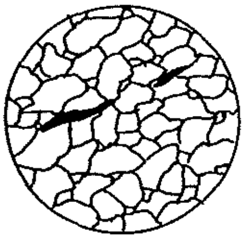
Hv pearlite
~~1)~~ 6) 276.4
~~2)~~ 7) 274.3
~~3)~~
~~4)~~ 8) 311.5
~~5)~~ MEAN 287.4

MICROSTRUCTURE
unetched x500 LONGITUDINAL SECTION



< 1%
ELONGATED SINGLE PHASE
BRIGHT SPECKS.

MICROSTRUCTURE
etched: 2% NITAL x250 LONGITUDINAL SECTION - CENTRE.



FERRITIC ASTM 5
POSSIBLY SLIGHT P GHOSTING

NEAR SURFACE 25% PEARLITE
27% FERRITE

PHOTOS

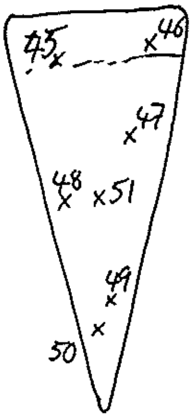
Film No.	Exp.No.	Mag.	Subject
96002	9	x50	LONGIT.
	10	x50	TRANSV.
96003	31A	x6	LONGITUDINAL
	32A	x25	" (SHARP END)
	33A	x25	" (BLUNT END)
	34A	x100	" "
	35A	x25	TRANSV.
	36A	x100	" PEARLITIC
96005	6A	x4	LONGIT.
	7A	x4	TRANSV.
96008(slide)	4,5,6	x4 x4, x12	LONGIT

ANALYSES:
SEM/EDX☑ SEM/WDX☑ XRF☐ XRD☐ OTHER☐ see over.

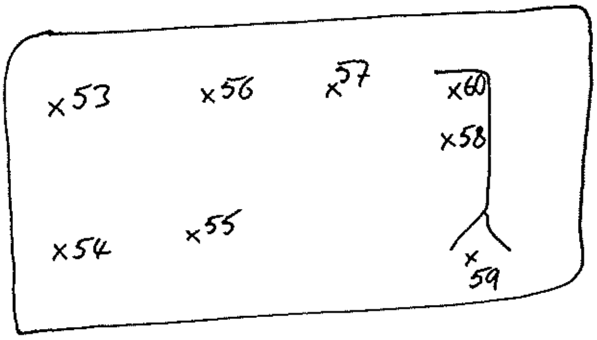
INTERPRETATION:
HETEROGENOUS STRUCTURE LARGELY FERRITIC BUT WITH AREAS OF UP TO 0.2% CARBON. AIR COOLED AFTER HOT WORKING

960005

WINDSOR CASTLE, DRAIN GRILL



LOCATION OF INCLUSIONS
ANALYSED



A.M. Lab. Metallography Recording Sheet

SAMPLE: 960006

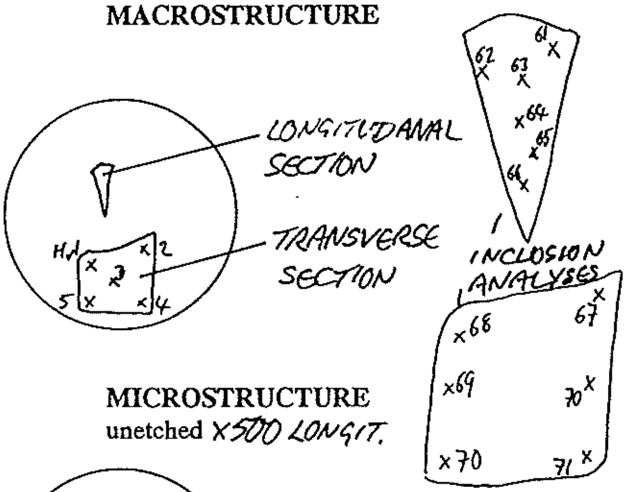
ARTEFACT: SHORT WALL TIE - DISPLAYED IN GT. YARMOUTH OLD MERCHANTS HO. (Acc. No. 78100038)
Condition: GOOD
Sample location: HORIZONTAL TIE 180mm FROM INTERNAL END SEE OVER
Permission to sample ☑ **After care:**
SARAH JENNINGS

X-radiographs:
Line drawings:
Photos-Colour slide:
135 b/w print:
other:

RECORDING : D.STARLEY

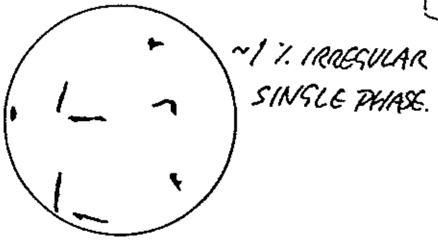
ARCHAEOLOGICAL CONTEXT
Site name: BUILDING BEHIND 54 SOUTH QUAY
AML Ref:
Specific context:
Dating of context: 156..... "EARLIEST AND LARGEST IRON WALL ANCHORS KNOWN TO EXIST IN GT. YARMOUTH

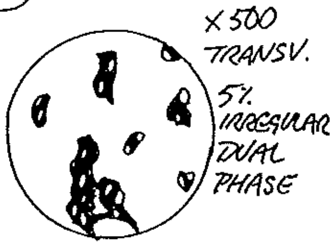
MACROSTRUCTURE



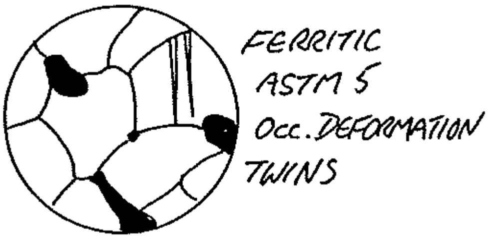
Hv 1) 147.1
2) 109.8
3) 146.3
4) 121.9
5) 141.5
MEAN 133.3

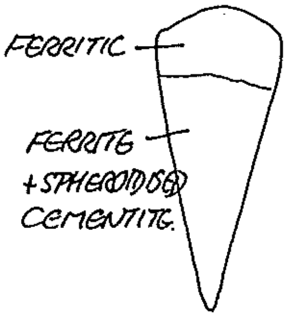
MICROSTRUCTURE
unetched X500 LONGIT.





MICROSTRUCTURE
etched: X1250 TRANS.





PHOTOS

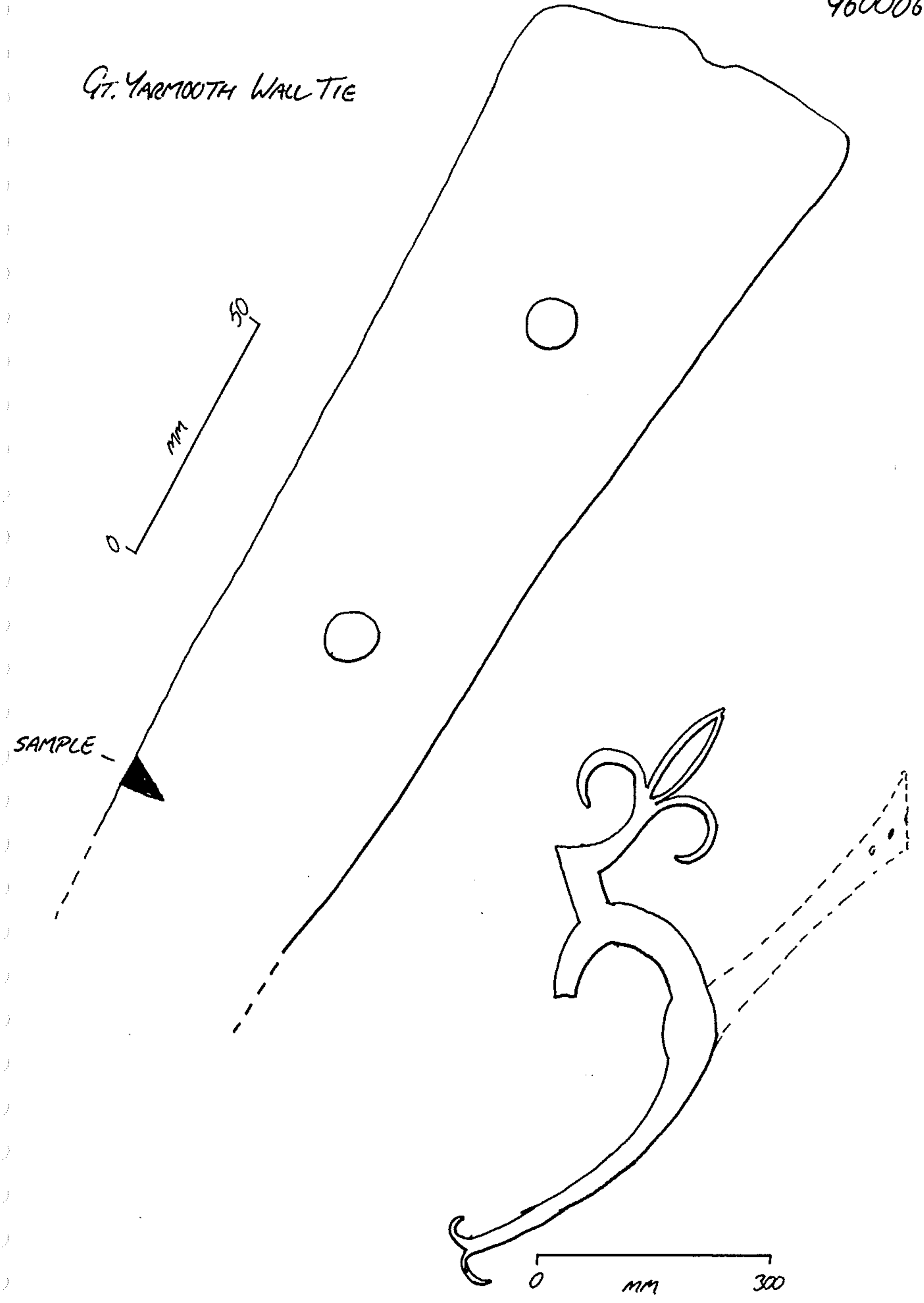
Film No.	Exp.No.	Mag.	Subject
96002	11	x50	LONGIT.
	12	x12.5	TRANSV.
96004	1	x12.5	TRANSV.
	2	x50	" DEFORMATIONTW
	3	x25	" "
	4	x6	LONGIT.
96005	8A	x5	LONGIT.
	9A	x4	TRANS
96008	7,8	x12.5	LONGIT.
	9	x4	"

ANALYSES:
SEM/EDX☑ SEM/WDX☑ XRF☐ XRD☐ OTHER☐ see over.

INTERPRETATION:
HETEROGENOUS FERRITIC / LOW CARBON STEEL. AIR COOLED

960006

Gt. Yarmouth Wall Tie



A.M. Lab. Metallography Recording Sheet

SAMPLE: 960007

ARTEFACT: SHORT WALL TIE (Acc. No. 78100041) - figure "6"
(DISPLAYED IN. OLD MERCHANTS Ho, GT. YARMOUTH)
Condition: GOOD

X-radiographs:
Line drawings:
Photos-Colour slide:
135 b/w print: B934631
other:

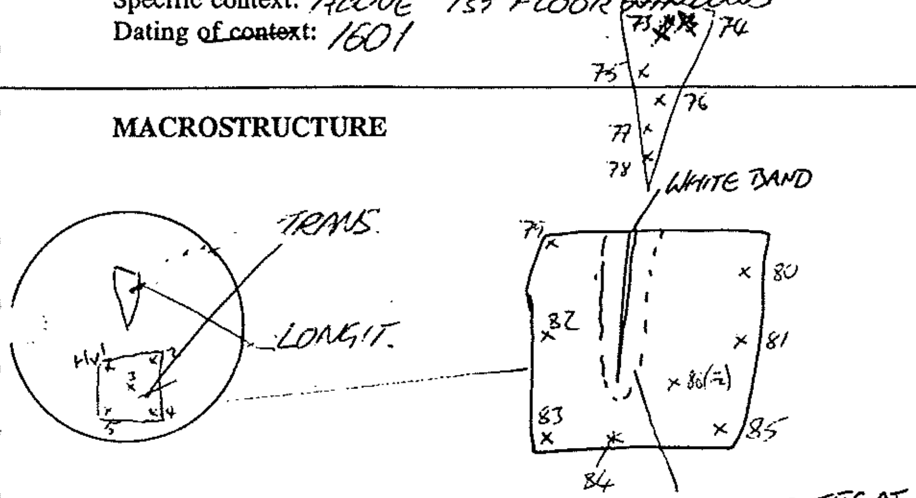
Sample location: HORIZONTAL TIEBAR 185mm FROM END
(SEE OVER)
Permission to sample ☑ **After care:**
SARAH JENNINGS.

RECORDING: D. STARLEY

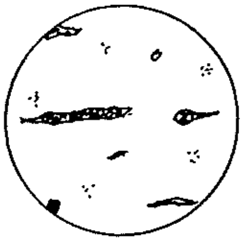
ARCHAEOLOGICAL CONTEXT
Site name: 44 MIDDLEGATE ST., GT. YARMOUTH
Specific context: ABOVE 1ST FLOOR WINDOWS
Dating of context: 1601

AML Ref:

MACROSTRUCTURE



MICROSTRUCTURE
unetched LONGIT. x500



3% Dual phase elong / stringers
many "bright" patches
? = carbide / phosphide.

(TRANSV. = ELONG 4% SINGLE PHASE)

MICROSTRUCTURE
etched: TRANSV. x500
VARIABLE - SEE ABOVE
ASTM 4

OC · CEMENTITE AT G.B.s.
REST FERRITE
(ALL LONGIT LIKE THIS & MOST OF TRANS. EXCEPT FOR BAND THROUGH CENTRE.
(MORE SLAG IN BAND)

Hv. 1) 99.8
2) 101.2
3) 121.9
4) 107.7
5) 115.9
109.3

PHOTOS

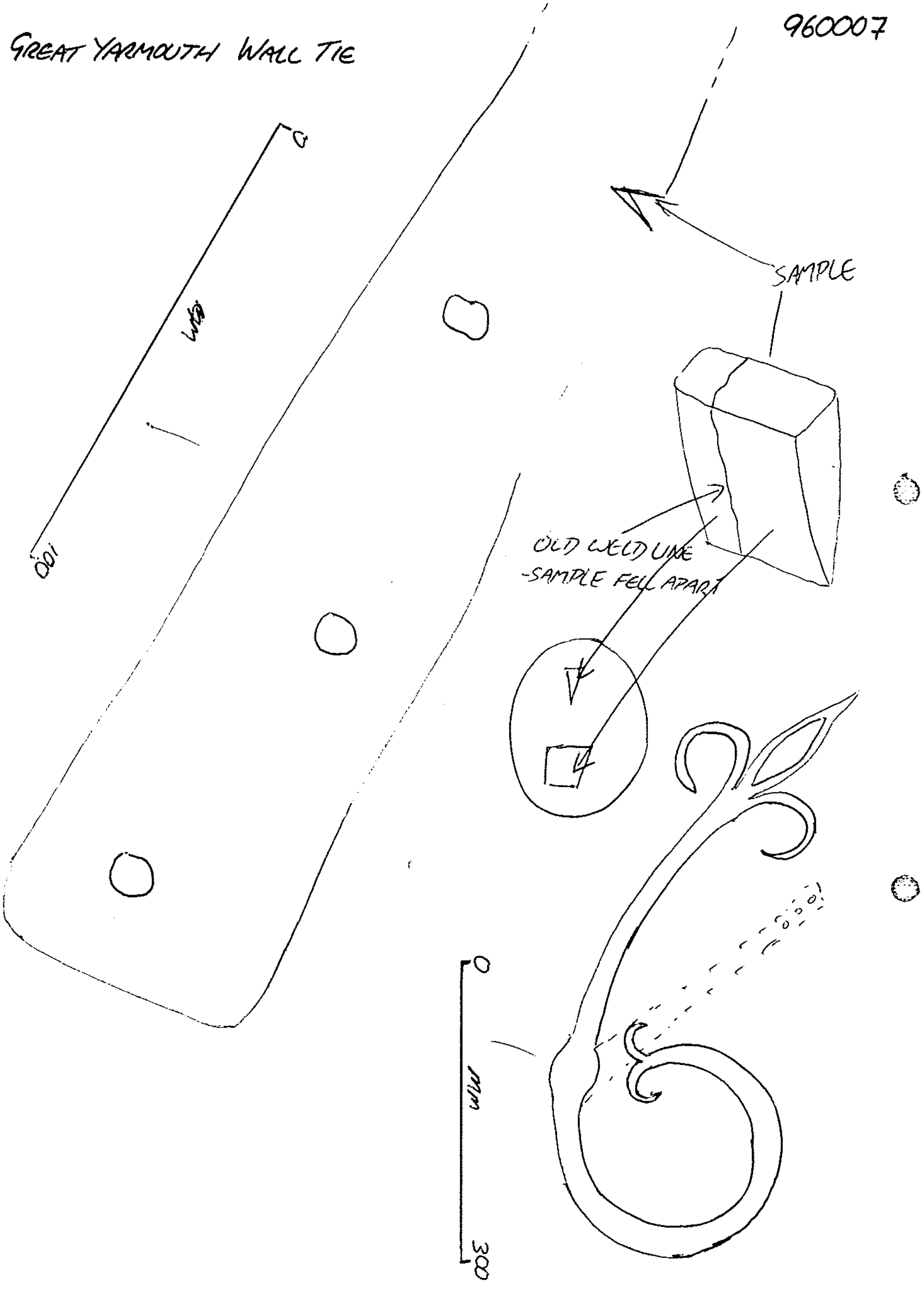
Film No.	Exp.No.	Mag.	Subject
96002	14	x 50	LONGIT.
	15	x 50	TRANSV.
96005	5	X25	TRANSV.
	6	X 50	"
	7	X25	" (BAND.)
96005	10A	X 5	LONGIT
	11A	X4	TRANS
96008	10,11,12	X25	LONG, LONG, TRANS

ANALYSES:
SEM/EDX☑ SEM/WDX☑ XRF☐ XRD☐ OTHER☐ see over.

INTERPRETATION:
FERRITIC IRON HOT WORKED

960007

GREAT YARMOUTH WALL TIE



A.M. Lab. Metallography Recording Sheet

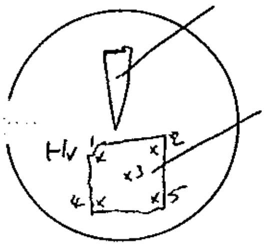
SAMPLE: 960008

ARTEFACT: SHORT WALL TIE (Acc. No. 78100048) FIGURE "6"
(DISPLAYED AT THE OLD MERCHANTS Ho, GT. YARMOUTH)
Condition: GOOD
Sample location: 240mm FROM END OF HORIZONTAL TIEBAR (SEE OVER)
Permission to sample ☑ **After care:**
SARAH JENNINGS

X-radiographs:
Line drawings:
Photos-Colour slide:
135 b/w print: B934637
other:
RECORDING: D. STARLEY

ARCHAEOLOGICAL CONTEXT
Site name: 15 & 16, ROW 118, GT. YARMOUTH
Specific context:
Dating of context: 1636 or 1637
AML Ref:

MACROSTRUCTURE

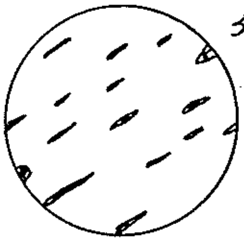


LONGIT

TRANSV.

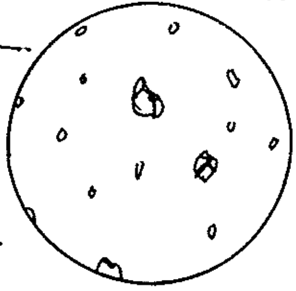
Hv 1) 155.8
2) 143.1
3) 167.2
4) 148.0
5) 153.1
153.4

MICROSTRUCTURE
unetched LONGIT. X500



5% Dual phase elongated. fine

TRANS X500



dual/phase mainly dove grey.

MICROSTRUCTURE
etched: X250 LONGIT.
ASTM 4
FERRITIC
V. SMALL Q CEMENTITE AT GBs.

TRANSV. AREAS OF P GHOSTING

PHOTOS

Film No.	Exp.No.	Mag.	Subject
96002	16	X50	LONGIT
96004	8	X25	LONGIT.
	9	X25	TRANS (P. GHOST.)
	10	X25	" <
96005	12A	X 4	LONGIT
	13A	X 4	TRANSV.
SLIDE 96008	13/14,15	25,25,12.5	TRANS.

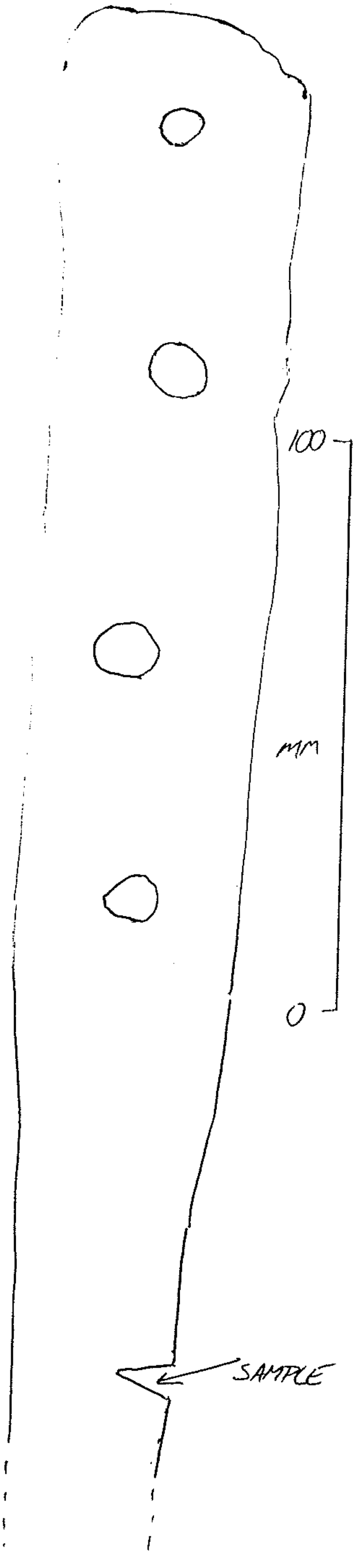
ANALYSES:
SEM/EDX☑ SEM/WDX☑ XRF☐ XRD☐ OTHER☐ see over.

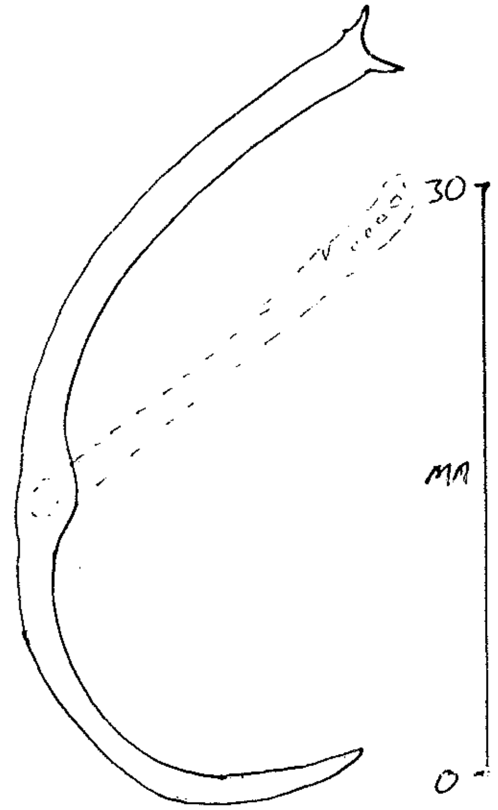
INTERPRETATION:
FERRITIC / PHOSPHORIC IRON HOT WORKED

960008

GREAT YARMOUTH

WALL TIE





A.M. Lab. Metallography Recording Sheet

SAMPLE: 960009

ARTEFACT: SHORT WALL TIE (Acc. No. 78100046) FIGURE "5" (DISPLAYED AT THE OLD MERCHANTS Ho., GT. YARMOUTH)

Condition: GOOD

X-radiographs:
Line drawings:
Photos-Colour slide:
135 b/w print: B934635
other:

Sample location: 220mm FROM END OF HORIZONTAL TIE BAR

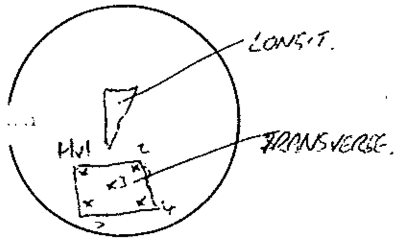
Permission to sample ☑ **After care:**
SARAH JENNINGS

RECORDING: D. STARLEY

ARCHAEOLOGICAL CONTEXT
Site name: 3&4, ROW 91, GT. YARMOUTH
Specific context:
Dating of context: 1651

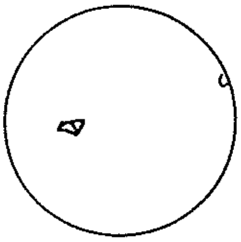
AML Ref:

MACROSTRUCTURE



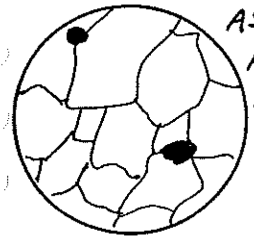
Hv. 1) 105.6
2) 142.3
3) 130.5
4) 129.8
5) 121.9
126.0

MICROSTRUCTURE
unetched LONGIT x500



< 1% dualphase elong.

MICROSTRUCTURE
etched: x500 NITAL



ASTM 1-4
FERRITIC
OCC. DEFORMATION TWINS.

PHOTOS

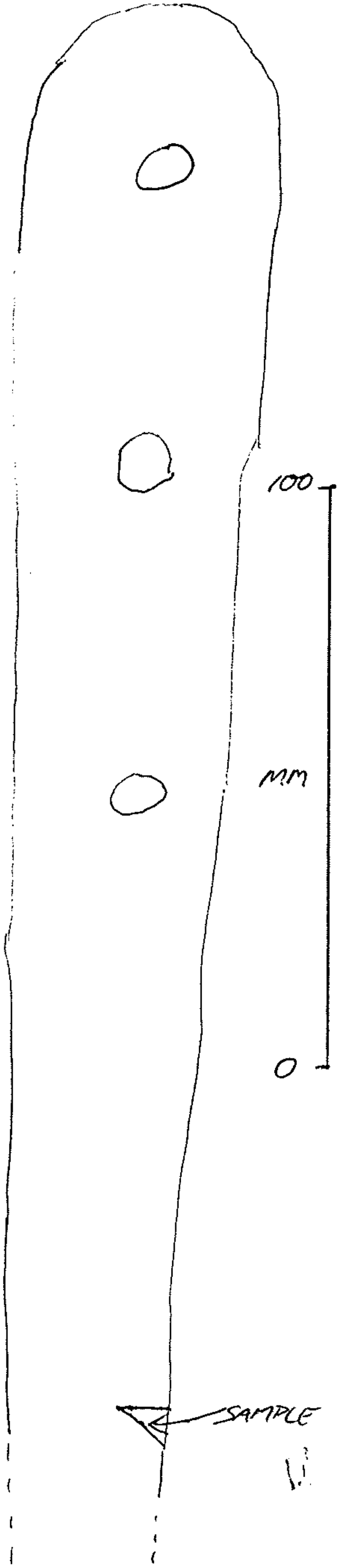
Film No.	Exp.No.	Mag.	Subject
96002	18	x50	LONG.
	19	x50	TRANSV.
96004	11	x25	TRANS.
	12	x12.5	LARGE GRAINS W/ DEF. TWINS.
	13	x6	LONGIT
	14	x50	DEF TWINS
96005	14A	x4	TRANSV.
SLIDE 96008	16 17 18	x12.5 25 25	TRANS

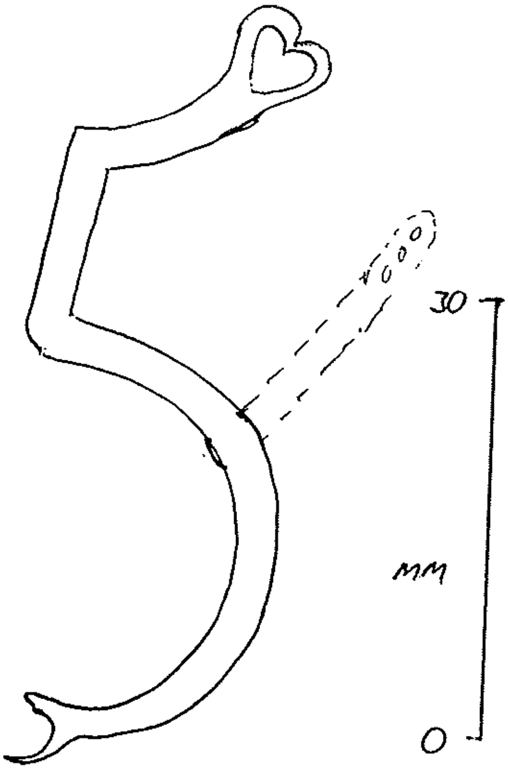
ANALYSES:
SEM/EDX☑ SEM/WDX☑ XRF☐ XRD☐ OTHER☐ see over.

INTERPRETATION:
METALLOGRAPHY & MICROHARDNESS INDICATES FERRITIC BUT WLD MICROANALYSIS SHOWS MEAN PHOSPHORUS LEVELS OF 0.14

960009

GREAT YARMOUTH





A.M. Lab. Metallography Recording Sheet

SAMPLE: 960010

ARTEFACT: SHORT WALL TIE (Acc.No. 78100051) FIGURE "6" (DISPLAYED AT THE OLD MERCHANTS Ho., GT. YARMOUTH

Condition: GOOD

Sample location: 175mm FROM END OF HORIZONTAL TIE BAR. (SEE DIAG. OVER)

Permission to sample ☑ **After care:**

SARAH JENNINGS

X-radiographs:
Line drawings:
Photos-Colour slide:
135 b/w print: B934639
other:

RECORDING: D. STARLEY

ARCHAEOLOGICAL CONTEXT

Site name: 11 & 12 ROW 50, GT. YARMOUTH

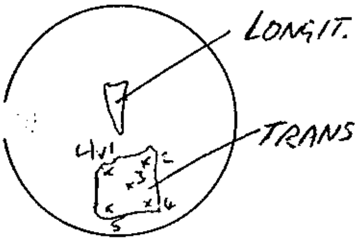
AML Ref:

Specific context:

Dating of context: 1691

"By now anchors served no usefull purpose'

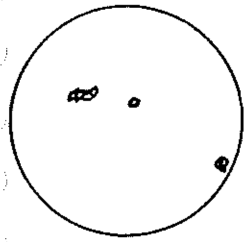
MACROSTRUCTURE



Hv (100g)
1) 140.0
2) 120.7
3) 144.7
4) 134.0
5) 118.9

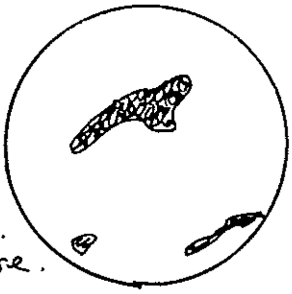
131.7

MICROSTRUCTURE
unetched X500 LONGIT



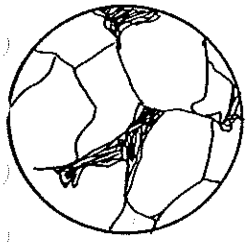
< 1% SINGLE PHASE ELONGATED

X500 "TRANSV."



2% elong. dual phase.

MICROSTRUCTURE
etched: LONGIT. X500



12% PEARLITE
88% FERRITE

TRANSV.

100% FERRITE.

PHOTOS

Film No.	Exp.No.	Mag.	Subject
96002	20	X50	LONGIT
	21	"	TRANS
96004	15	X25	LONGIT.
	16	X50	"
	17	X12.5	TRANSV.
96005	15A	X6	LONGIT
	16A	X4	TRANS

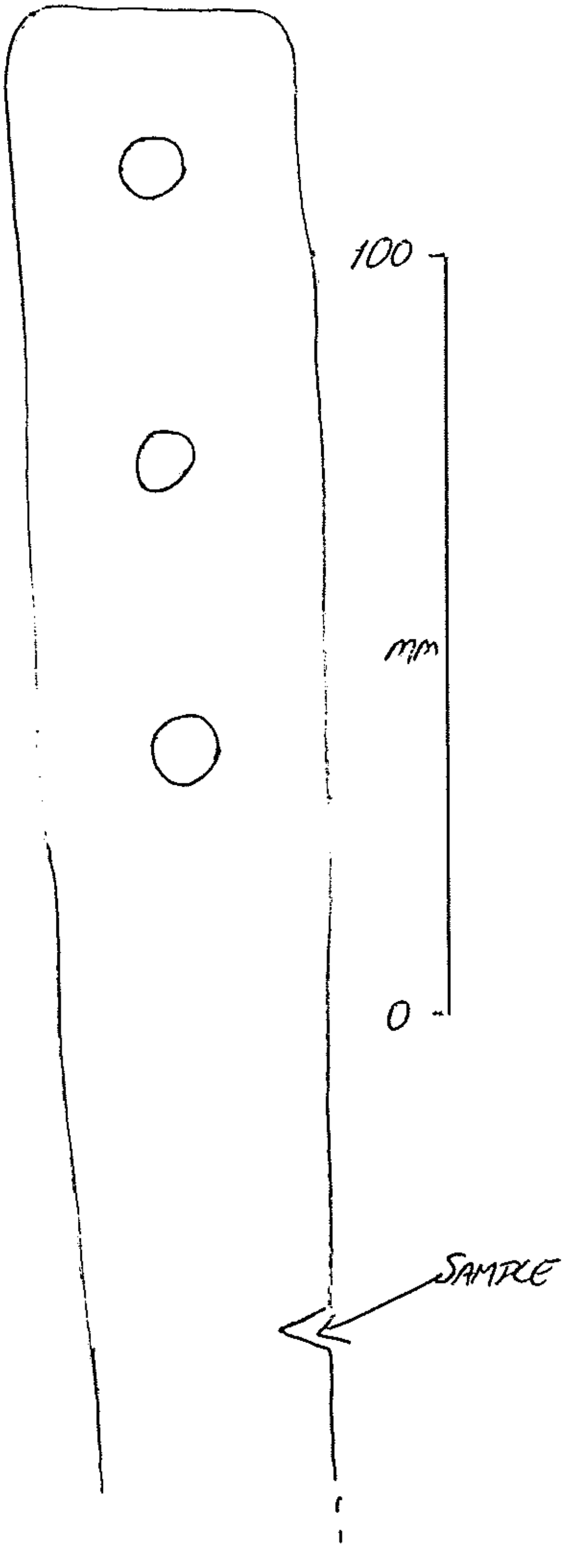
ANALYSES:
SEM/EDX☑ SEM/WDX☑ XRF☐ XRD☐ OTHER☐ see over.

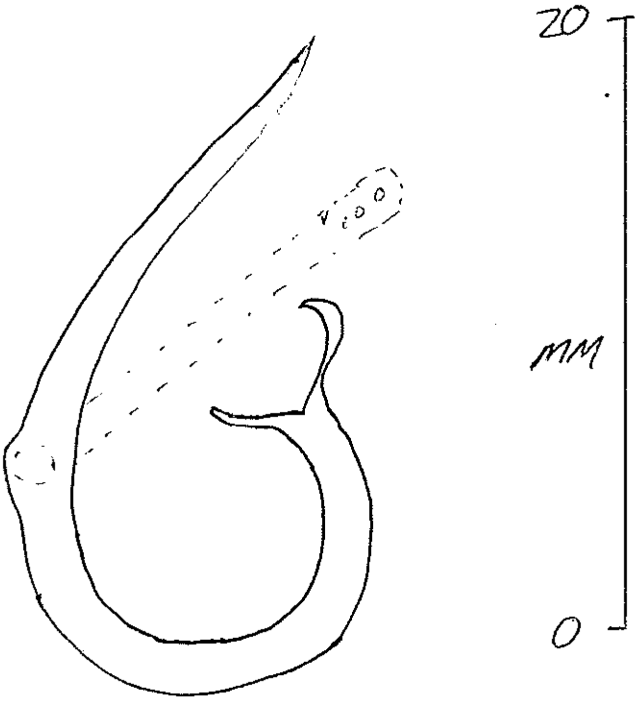
INTERPRETATION:

HETEROGENEOUS FERRITIC UP TO 0.1% C IN AREAS HOT WORKED AIR COOLED

960010

GREAT YARMOUTH WALL TIE





A.M. Lab. Metallography Recording Sheet

SAMPLE: 960011

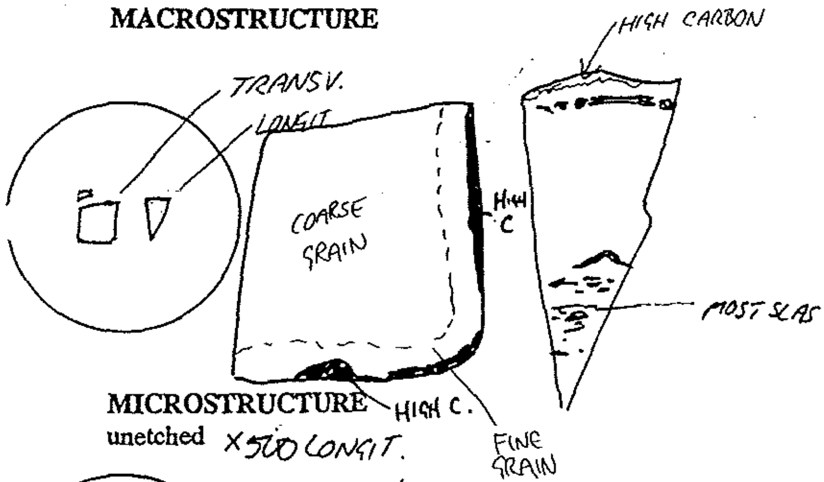
ARTEFACT: HOLDFAST (ATTACHES SKIRTING TO WALL & PANELLING) - FROM ARCHITECTURAL STUDY
~~Condition:~~ COLLECTION
AR.HB.S 1668.
Sample location: SEE OVER
Permission to sample ☑ After care:
TREVE ROSOMAN

X-radiographs:
Line drawings:
Photos-Colour slide:
135 b/w print: 85/14/4
other:
RECORDING: D. STANLEY

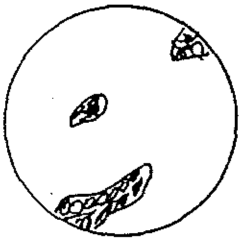
ARCHAEOLOGICAL CONTEXT
Site name: RANGERS Ho., BLACK HEATH
Specific context:
Dating of context: 17/4

AML Ref:

MACROSTRUCTURE

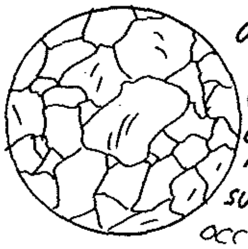


MICROSTRUCTURE
unetched X500 LONGIT.



SLAG <0.1 → 5%
dual phase

MICROSTRUCTURE
etched: LONGIT. X500



OUTER SURFACE (TOP OF WEDGE)
%100 PEARLITE FOR
V. NARROW REGION - C DROPS
OFF RAPIDLY
INTERIOR 100% FERRITE ASTM3
SUB GRAIN? BOUNDRIES
OCC. ETCH PITTING

PHOTOS

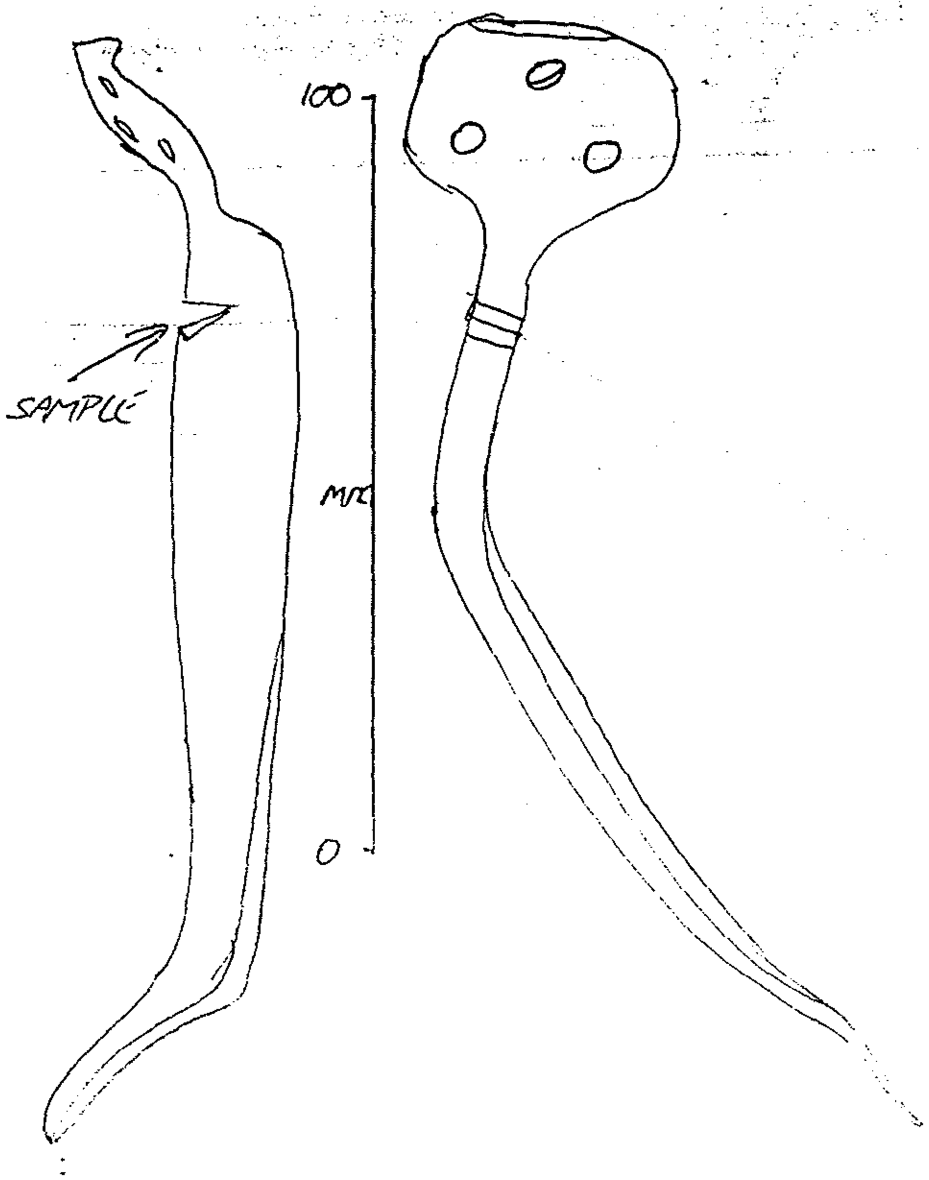
Film No.	Exp.No.	Mag.	Subject
96002	22	x6	LONGIT.
	23	x100	"
	24	x50	"
	25	x50	TRANSV.
96004	18	x6	LONGIT
	19	x50	" EDGE
	20	x50	" CENTRE
	21	x6	TRANS
	22	x12.5	"

ANALYSES:
SEM/EDX☑ SEM/WDX☐ XRF☐ XRD☐ OTHER☐ see over.

INTERPRETATION:
FERRITIC IRON WITH SURFACE CARBURISATION. MAINLY HOT WORKED BUT SOME EVIDENCE OF LOW TEMP. DEFORMATION. AIR COOLED

960017

RANGERS HOUSE - HOLDFAST



A.M. Lab. Metallography Recording Sheet

SAMPLE: 960012

ARTEFACT: HOOK FOR WINDOW HINGE
from ARCHITECTURAL STUDY COLLECTION No: AR.HB.S 1670A
Condition: GOOD

Sample location: SEE OVER

Permission to sample ☑ After care:
TREVE ROSOMAN

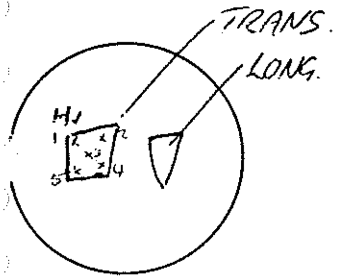
X-radiographs:
Line drawings:
Photos-Colour slide:
135 b/w print: 85/14/16 & B 921264
other:

RECORDING : D.STARLEY

ARCHAEOLOGICAL CONTEXT
Site name: TRINITY CHAPEL, TRINITY ALMS HOUSES
Specific context:
Dating of context: 1694? - POSSIBLY NOT AUTHENTIC

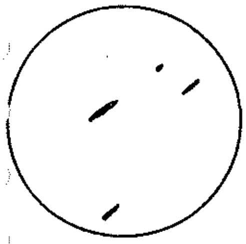
AML Ref:

MACROSTRUCTURE



HV(100g)
1) 123.8
2) 121.3
3) 116.5
4) 106.1
5) 129.1
119.4

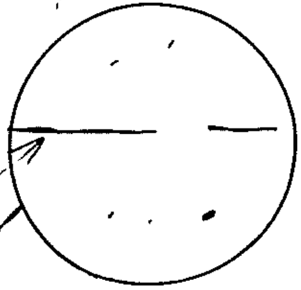
MICROSTRUCTURE
unetched LONGIT X500



< 1% SINGLE PHASE ELONGATED

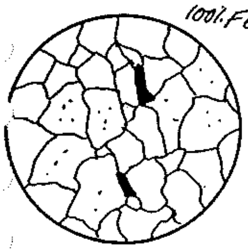
lots of bright specks

TRANS × 50



MICROSTRUCTURE
etched: X500 LONGIT.

100% FERRITE ASTM 4



PHOTOS

	Film No.	Exp.No.	Mag.	Subject
	96002	26	x50	LONG.
		27	x12.5	WELD LINE
	96004	23	x6	LONG.
		24	x25	"
		25	x25	TRANS.
		26	x6	"
	96005	.17A.	x4	TRANS
SLIDE	96008	19, 20, 21	12.5	

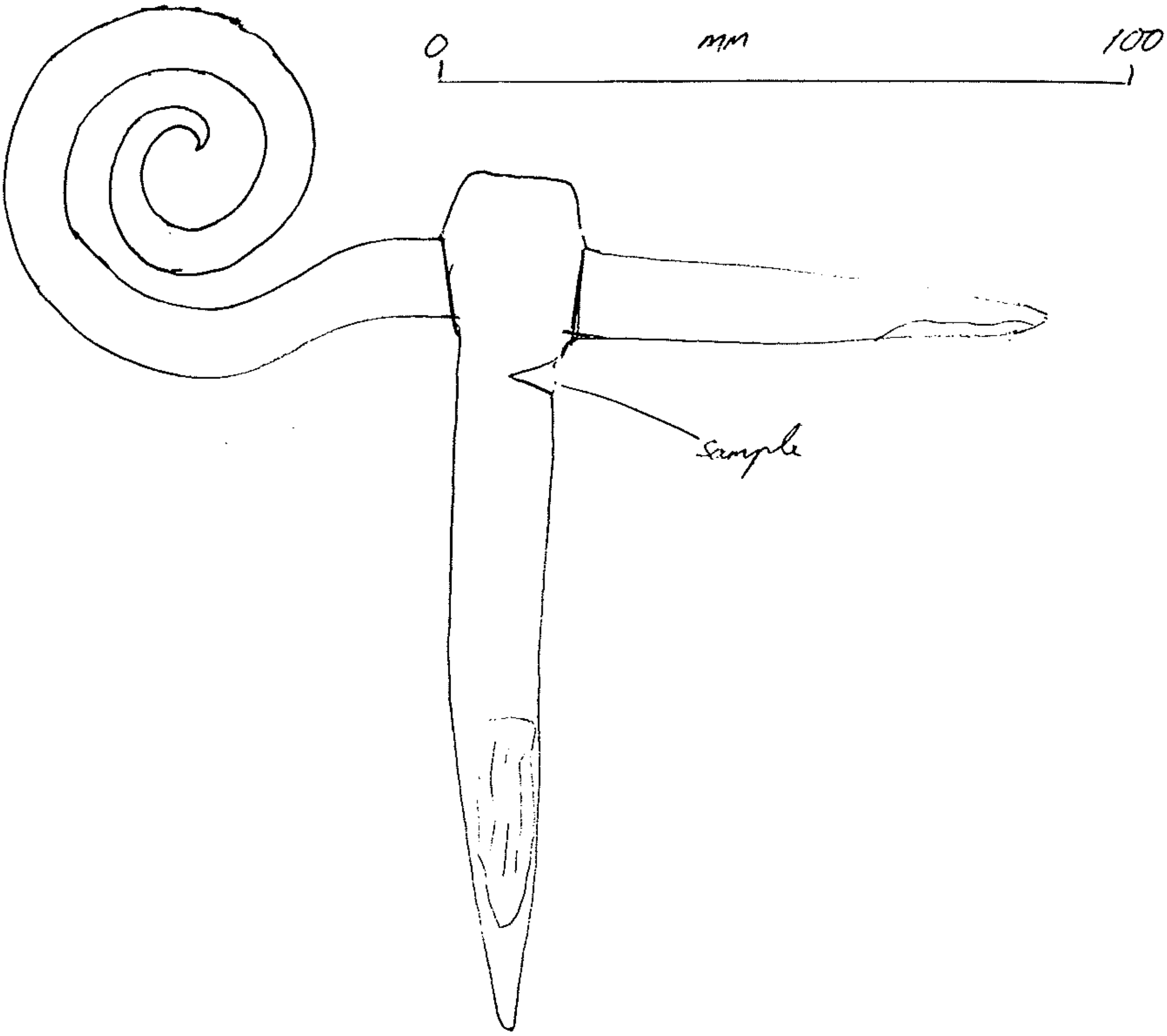
ANALYSES: INCS. V. VARIABLE - Many FeOx. = corrosion?
SEM/EDX☑ SEM/WDX☑ XRF☐ XRD☐ OTHER☐ see over.

INTERPRETATION:

FERRITIC IRON HOT WORKED

960012

TRINITY CHAPEL – HOOK FOR WINDOW HINGE



A.M. Lab. Metallography Recording Sheet

SAMPLE: 960013

ARTEFACT: STRAP OF RING BEAM
FROM ARCHITECTURAL STUDY COLLECTION No: AR HBS 1695
Condition: SURFACE CORROSION

Sample location: SEE OVER

Permission to sample ☑ **After care:**
TREVE ROSOMAN

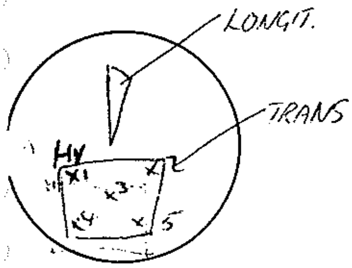
X-radiographs:
Line drawings:
Photos-Colour slide:
135 b/w print: ?
other:

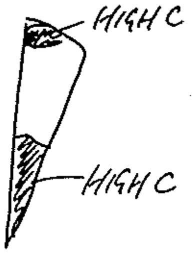
RECORDING: D. STARLEY

ARCHAEOLOGICAL CONTEXT
Site name: ST. MARY LE STRAND
Specific context: TOWER
Dating of context: 1714-1717

AML Ref:

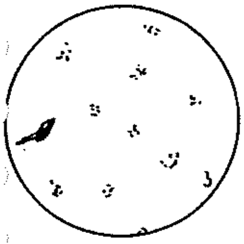
MACROSTRUCTURE





HV 100g
1) 154.0
2) 108.2
3) 145.5
4) 102.2
5) 114.7
124.9

MICROSTRUCTURE
unetched X500 "LONG"

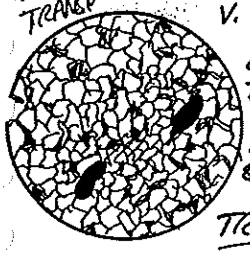


< 1% SINGLE PHASE
ELONG.
MANY BRIGHT SPOTS

"TRANS"
OCC. ELONGATED
SOME CORROSION
PENETRATION

MICROSTRUCTURE
etched: LONGIT.

1250
X500
TRANSV



V. VARIABLE (SEE ABOVE)
80% PEARLITE } ESP. ~~[illegible]~~
20% FERRITE } TO CENTRE
↓
20% PEARLITE
80% FERRITE.

TRANSV. MORE UNIFORM
10-30% PEARLITE

ASTM 8

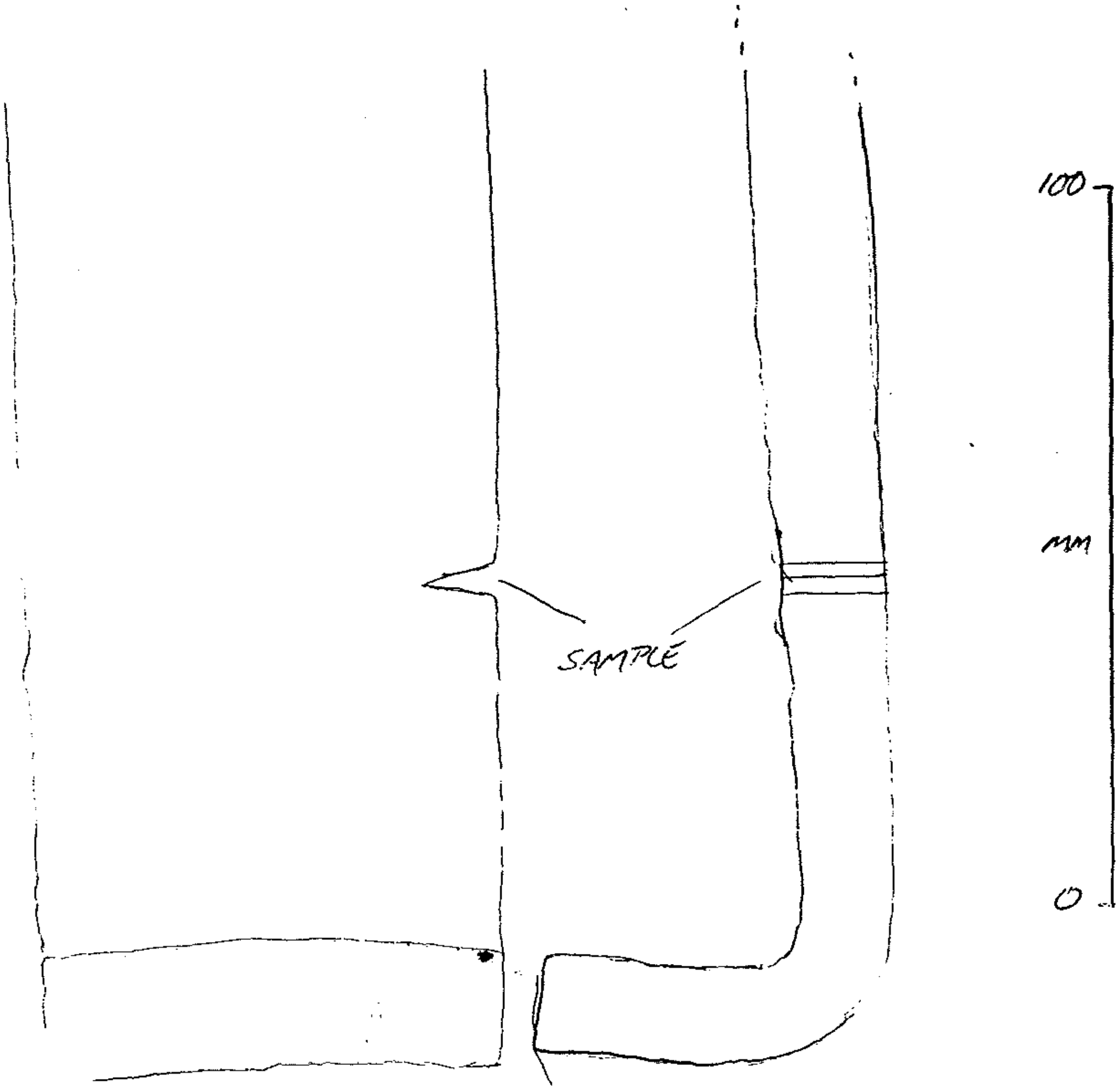
PHOTOS			
Film No.	Exp.No.	Mag.	Subject
96002	28 29	× 50 ×50	"LONGIT." "TRANS"
96004	27 28 29 30	× 6 × 6 ×25 ×25	LONGIT. " " HIGH C. " LOW C
96005	18A 19A	×4 ×4	LONGIT. TRANS

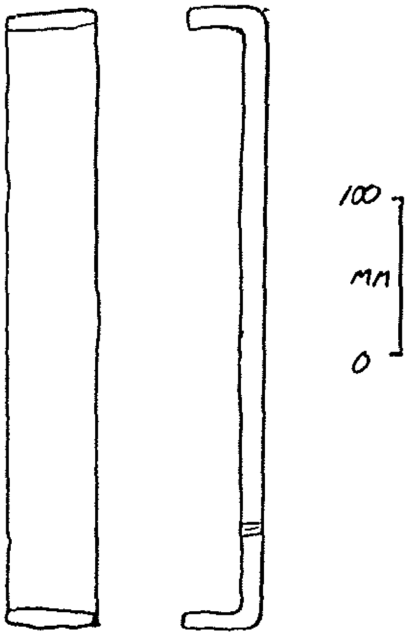
ANALYSES:
SEM/EDX☑ SEM/WDX☐ XRF☐ XRD☐ OTHER☐ see over.

INTERPRETATION:
HETEROGENEOUS STEEL 0.1 TO 0.6% CARBON FINE GRAINED AIR COOLED

960013

ST MARY LE STRAND - STRAP OF RING BEAM





A.M. Lab. Metallography Recording Sheet

SAMPLE: 960014

ARTEFACT: DOWN PIPE BRACKET

Condition: SURFACE CORROSION

Sample location: SEE OVER

Permission to sample ☑ **After care:**
TREVE ROSOMAN

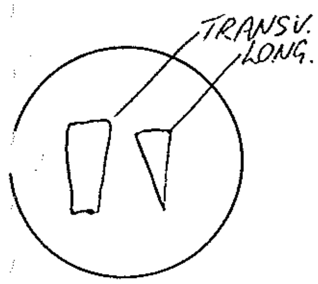
X-radiographs:
Line drawings:
Photos-Colour slide:
135 b/w print:
other:

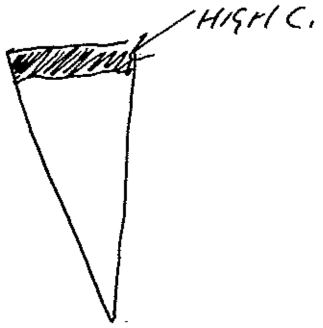
RECORDING: D. STARLEY

ARCHAEOLOGICAL CONTEXT
Site name: ROYAL NAVAL COLLEGE, GREENWICH
Specific context:
Dating of context: 1720s (CHECK w/ MICHAEL TURNER.)

AML Ref:

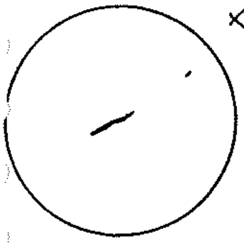
MACROSTRUCTURE



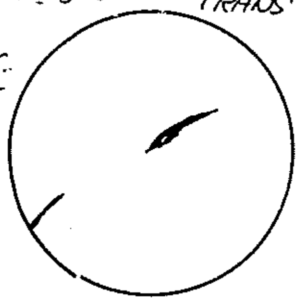


MICROSTRUCTURE
unetched

×500 'LONGIT'
<1% ELONG. SINGLE PHASE



×500 "TRANS"
<1% ELONG. SINGLE PHASE



MICROSTRUCTURE
etched: LONGIT. V. VARIABLE (SEE ABOVE)
SURFACE HIGH C (90% PEARLITE/
10% FERRITE (GRAIN BOUNDRIES)
ASTM 2
INTERIOR (MAJORITY) 20% PEARLITE
80% FERRITE ASTM6 w/P. GHOSTING
TRANS MORE UNIFORM 0-10% PEARLITE
FERRITE ASTM 6 P. GHOSTING.

SLIDE

PHOTOS

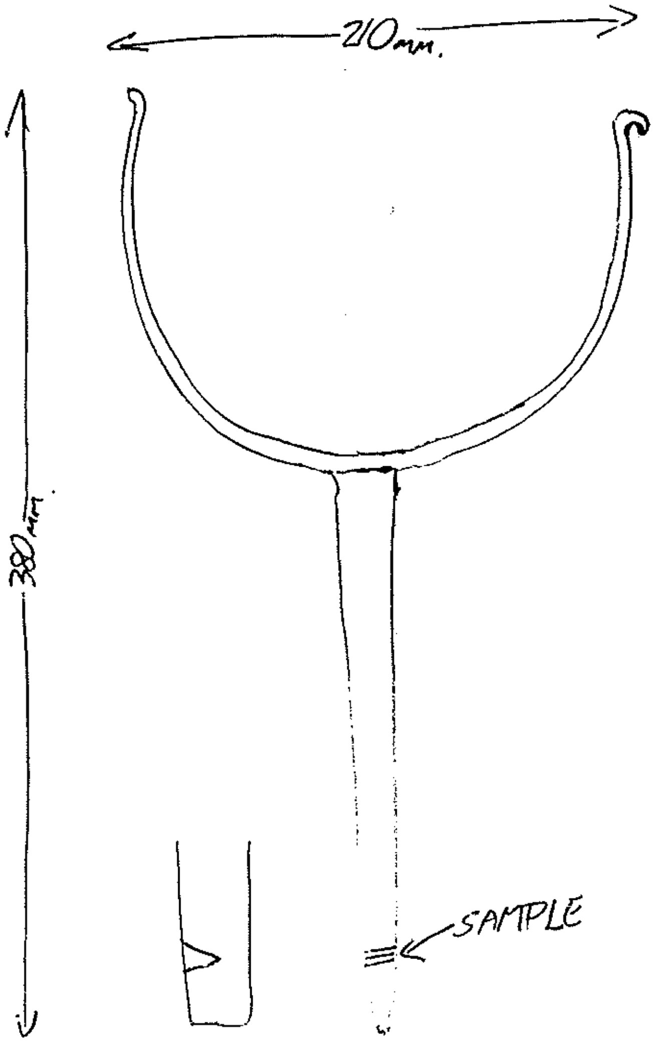
Film No.	Exp.No.	Mag.	Subject
96002	30	X50	"LONGIT"
	31	X50	"TRANS"
96004	31 32	×6 X6	LONGIT LONGIT }
	33	X25	" HIGH C
	34	X50	" "
	35	X50	" LOW C.
	36	X25	TRANS
	36A	X100	" w/P.
96005	20A	X4	TRANS.
96008	22,23,24	X12.5 X25 X50	CONS

ANALYSES:
SEM/EDX☑ SEM/WDX☑ XRF☐ XRD☐ OTHER☐ see over.

INTERPRETATION:
HETEROGENEOUS FERRITIC (LITTLE PHOSPHORUS DETECTED BY ANALYSIS)/
HIGH CARBON (0.7%) STEEL HOT WORKED AIR COOLED

960014

GREENWICH ROYAL NAVAL COLLEGE
DOWN PIPE BRACKET



A.M. Lab. Metallography Recording Sheet

SAMPLE: 960015

ARTEFACT: WROUGHT IRON GATE

Condition: SURFACE CORROSION

Sample location: UNKNOWN, SUPPLIED BY IRONSMITHS' STUDIO

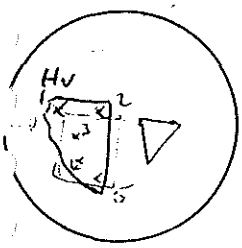
Permission to sample ☐ **After care:**

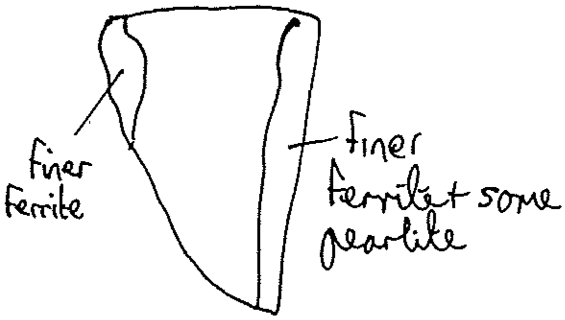
X-radiographs:
Line drawings:
Photos-Colour slide:
135 b/w print:
other:

RECORDING: D. STARLEY

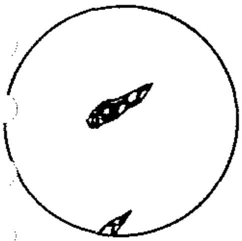
ARCHAEOLOGICAL CONTEXT
Site name: MILTON NEAR PETERBOROUGH
AML Ref:
Specific context: (HORIZONTAL BAR REPLACED DURING CONSERVATION)
Dating of context: 1720s

MACROSTRUCTURE





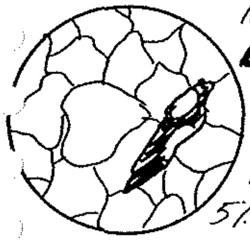
MICROSTRUCTURE
unetched X500 LONG



< 1% DUAL PHASE ENLONGATED

Hv. (100g)
1) 113.6
2) 139.2
3) 117.1
4) 113.1
5) 121.9
121.0

MICROSTRUCTURE
etched: SMALL X 1250



100% Ferrite
< ASTM 6
slight? P ghosting

LARGE sample - VARIABLE - As above +
5% Agglomorated pearlite }
95% fine (< ASTM 8) Ferrite }

PHOTOS

Film No.	Exp.No.	Mag.	Subject
96002	32	X50	LONGIT.
	33	X50	TRANSV.
96005	21A	X4	SMALL
	22A	X4	LARGE
96006	9	X12.5	SMALL
	10	X12.5	LARGE
	11	X50	LARGE

ANALYSES:
SEM/EDX☑ SEM/WDX☑ XRF☐ XRD☐ OTHER☐ see over.

INTERPRETATION:

FERRITIC IRON, HOT WORKED

A.M. Lab. Metallography Recording Sheet

SAMPLE: 960016

ARTEFACT: BALCONY SUPPORT (Acc. No. 1787A)
(EH. ARCHITECTURAL STUDY COLLECTION)
Condition: GOOD

Sample location: SEE OVER.

Permission to sample ☐ **After care:**

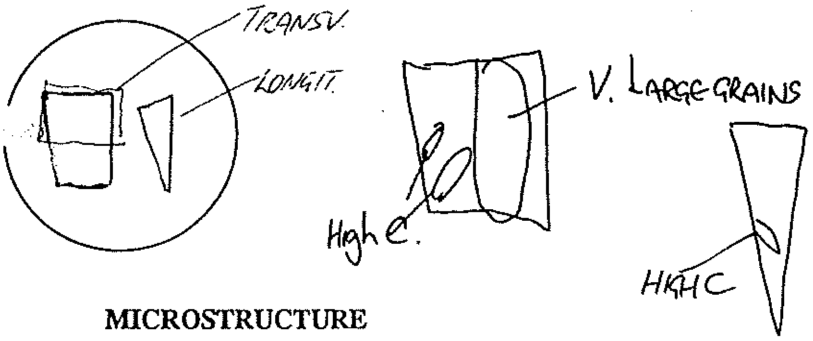
X-radiographs:
Line drawings:
Photos-Colour slide:
135 b/w print: B921365
other:

RECORDING: D. STARLEY

ARCHAEOLOGICAL CONTEXT
Site name: FOURNIER ST. MOSQUE
Specific context: W.I. T. SHAPED SUPPORT
Dating of context: 1743

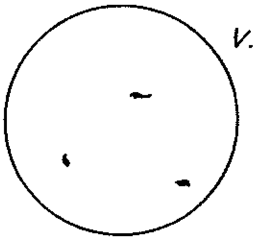
AML Ref:

MACROSTRUCTURE

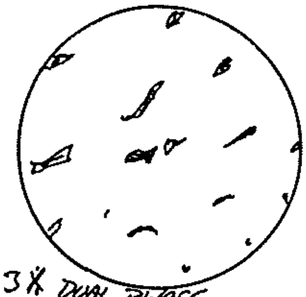


MICROSTRUCTURE
unetched X500 LONGIT.

X500 TRANS.



V. FEW <1% INCS
? SINGLE PHASE
IRREGULAR



3% DUAL PHASE
ELONGATED

MICROSTRUCTURE
etched: TRANSV 500
V. Variable

CENTRE ASTM 1 FERRITE w/P GHOSTING
REMAINDER FINER FERRITE w OCC. PEARLITE -5% SLIDE
ASTM 6 w/ SOME P GHOSTING
2 REGIONS OF HIGH C
→WIDMANSTÄTTEN w 80% FINE PEARLITE 20% FERRITE

LONG. ALSO V. VARIABLE 20-70% Pearlite

PHOTOS

Film No.	Exp.No.	Mag.	Subject
96002	34	x50	"LONGIT."
	35	x50	"TRANS"
96005	21A	x4	LONGIT.
	22A	x4	TRANS
96006	12	x12.5	TRANSV.
	13	"	" (LARGE GRAIN)
	14	x25	
	15	x50	P GHOST.
	16	x25	LONGIT.
96008	25,26,27	x50	LONG
	28,29	x25,12.5	TRANS

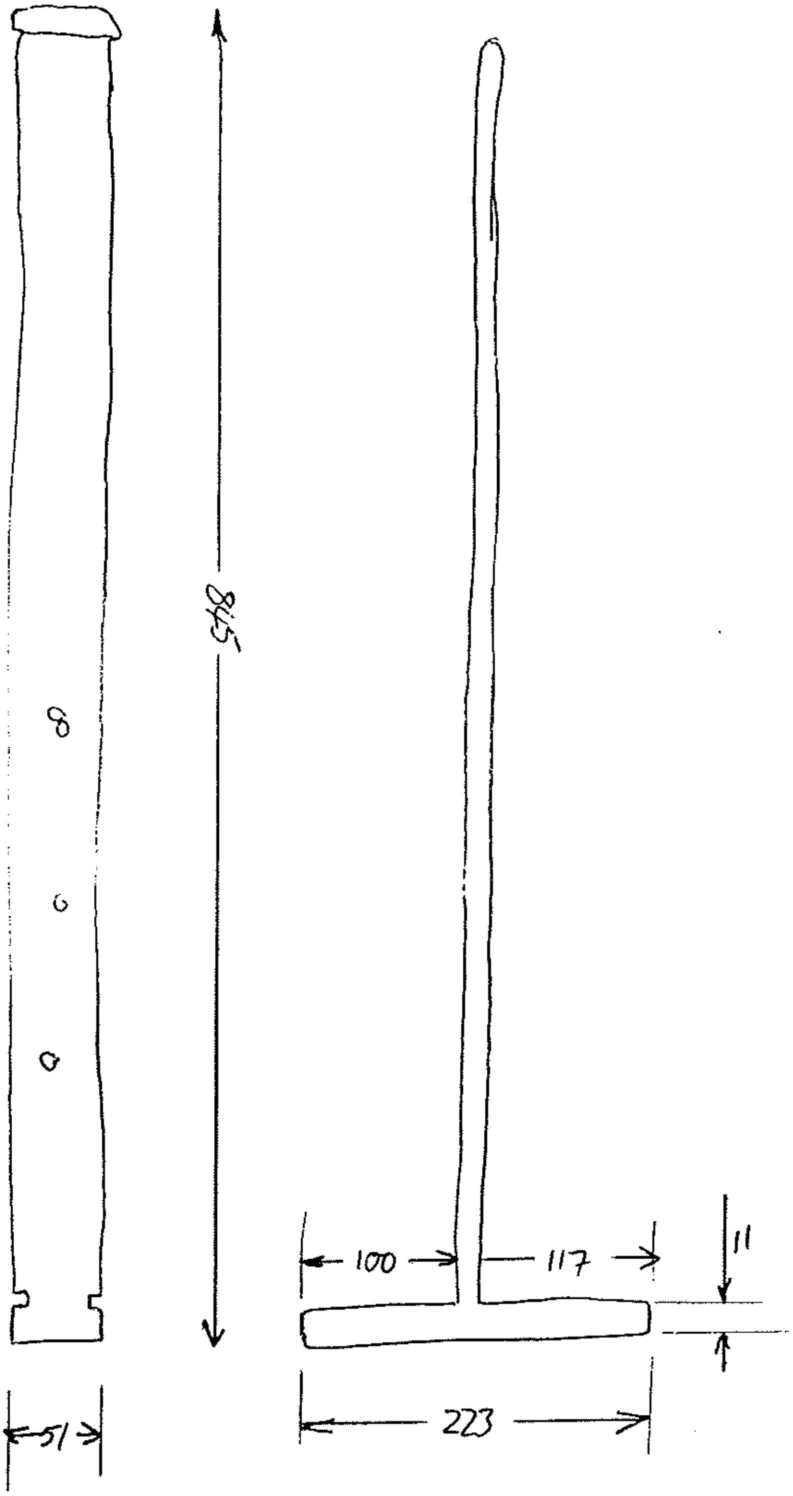
ANALYSES:
SEM/EDX☑ SEM/WDX☑ XRF☐ XRD☐ OTHER☐ see over.

INTERPRETATION:
HETEROGENEOUS FERRITIC/HIGH CARBON (UP TO 0.6%) STEEL HOT WORKED & AIR COOLED. SOME PHOSPHORUS PRESENT

960016

FOURNIER ST. MOSQUE

BALCONY SUPPORT



A.M. Lab. Metallography Recording Sheet

SAMPLE: 960017

ARTEFACT: STAIR BALLUSTRADE EH ASC 4025
E.H. ARCHITECTURAL STUDY COLLECTION
Condition: GOOD – BUT STAIR DESTROYED IN CONFLAGRATION
Sample location:

Permission to sample ☐ **After care:**

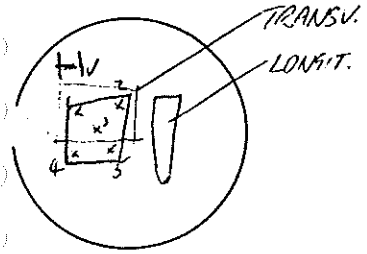
X-radiographs:
Line drawings:
Photos-Colour slide:
135 b/w print:
other:

RECORDING: D.STARLEY

ARCHAEOLOGICAL CONTEXT
Site name: 1 BLOOMSBURY ST. WC1
Specific context:
Dating of context: 1767-70

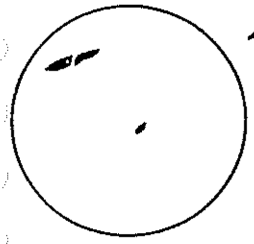
AML Ref:

MACROSTRUCTURE



Hv. 1) 154.0
2) 148.8
3) 143.9
4) 143.9
5) 147.1
147.5

MICROSTRUCTURE
unetched X500 LONGIT

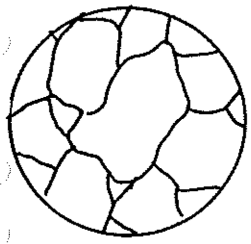


<1% SINGLE PHASE ELONGATED

TRANSVERSE

<1% ELONG. SINGLE PHASE.

MICROSTRUCTURE
etched: X1200 LONG.



100% FERRITE ASTM 4

PHOTOS

Film No.	Exp.No.	Mag.	Subject
96002	36	X50	LONGIT
	36A	X50	TRANSV
96005	25A	X4	LONG.
	26A	X4	TRANS
96006	17	X12.5	LONG.
	18	X 12.5	TRANSV.

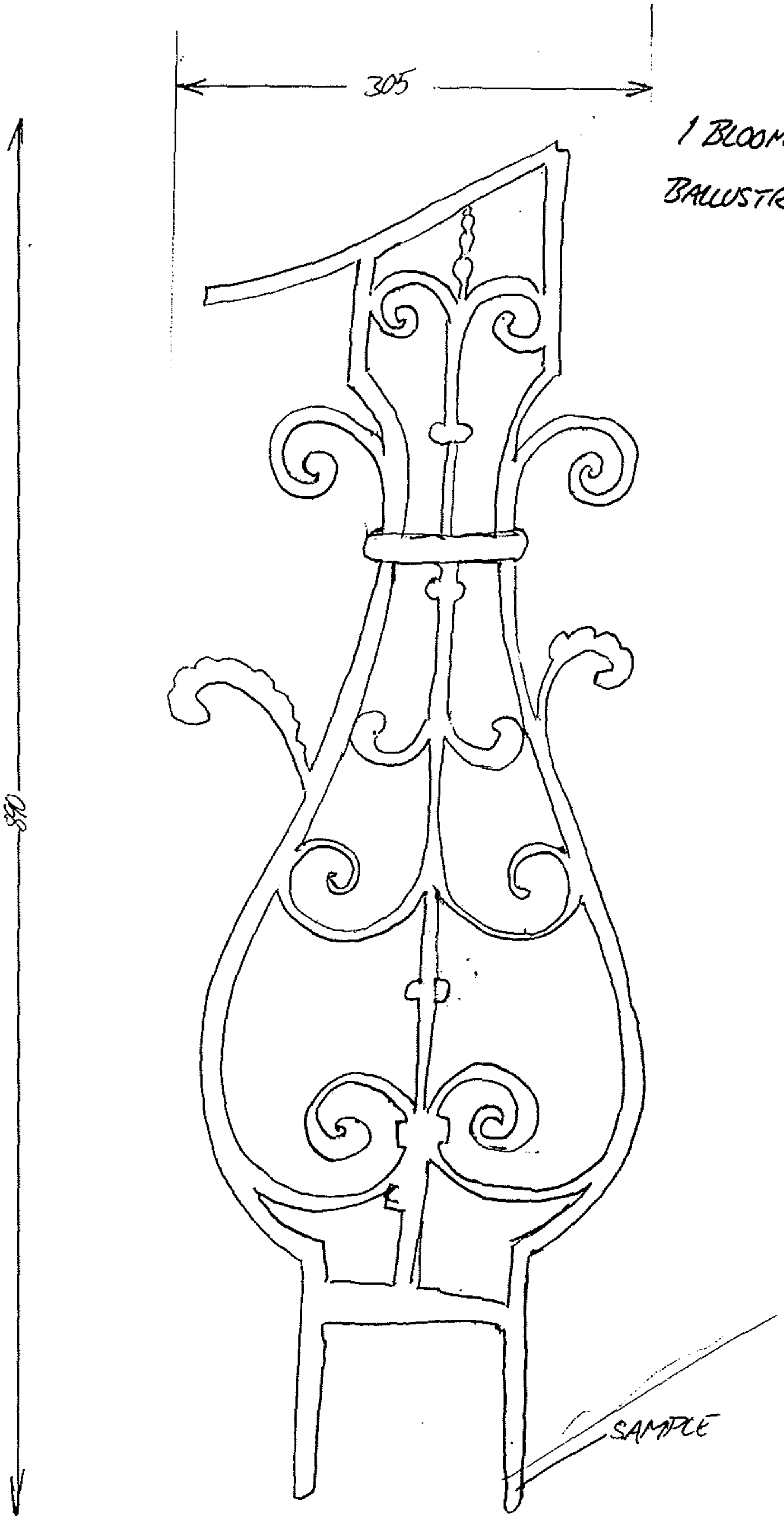
ANALYSES: (INCS. v. variable – transv. mainly pure FeO$_x$)
SEM/EDX☑ SEM/WDX☑ XRF☐ XRD☐ OTHER☐ see over.

INTERPRETATION:
FERRITIC/PHOSPHORIC (ANALYSIS UP TO 1.4%P) HOT WORKED
CONTAINS ENTRAPPED SCALE

960017

1 BLOOMSBURY ST

BALLUSTRADE



A.M. Lab. Metallography Recording Sheet

SAMPLE: 960018

ARTEFACT: STAIR BALUSTER
EH ARCHITECTURAL STUDY COLLECTION
Condition:

Sample location: SEE OVER

Permission to sample ☑ **After care:**
TREVE ROSOMAN

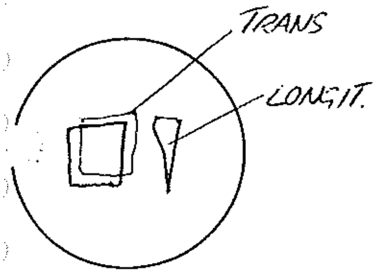
X-radiographs:
Line drawings:
Photos-Colour slide:
135 b/w print:
other:

RECORDING: D.STARLEY

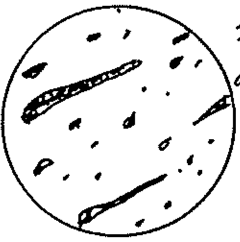
ARCHAEOLOGICAL CONTEXT
Site name: 50 PORTLAND PLACE
Specific context:
Dating of context: 1776-82

AML Ref:

MACROSTRUCTURE



MICROSTRUCTURE
unetched X500 LONGIT.



5% spher-stringer
dual phase

MICROSTRUCTURE
etched: X1250 LONG

100% FERRITE ASTM6 EQUIAXED
P. GHOSTING

TRANSV. SHOWS SLAG INCS WITHIN GRAINS
ASTM 5

PHOTOS

Film No.	Exp.No.	Mag.	Subject
96003	0A	x50	LONGIT.
	1A	x50	TRANSV.
96005	27A	X4	LONGIT
	28A	X4	TRANS.
96006	19	X 15.5	LONGIT
	20	X25	"
	21	X25	TRANS
	22	X50	"
SLIDE 96008	30,31,32	X25?	

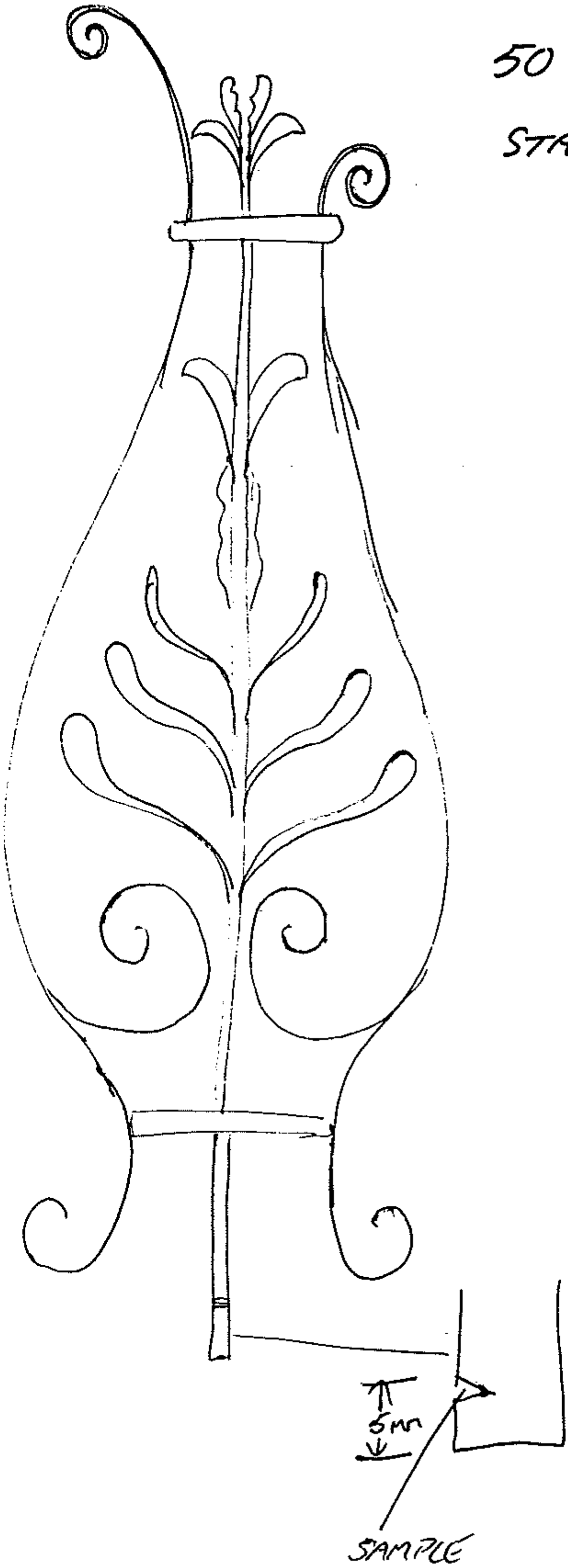
ANALYSES:
SEM/EDX☑ SEM/WDX☑ XRF☐ XRD☐ OTHER☐ see over.

INTERPRETATION:

FERRITIC IRON (OCCASIONAL CONCENTRATIONS OF PHOSPHORUS)
HOT WORKED

960018

50 PORTLAND PLACE
STAIR BALLUSTER



A.M. Lab. Metallography Recording Sheet

SAMPLE: 960019

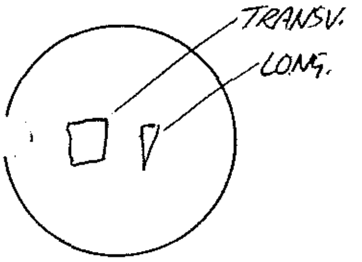
ARTEFACT: IRON RAILING
EX BROOKINS COLLECTION
Condition: GOOD
Sample location: SEE OVER
Permission to sample ☑ **After care:**
TREVE ROSOMAN

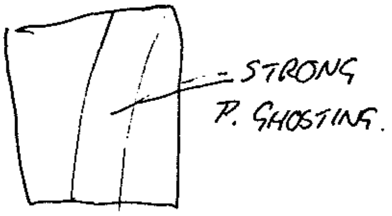
X-radiographs:
Line drawings:
Photos-Colour slide:
135 b/w print:
other:
RECORDING : D. STARLEY

ARCHAEOLOGICAL CONTEXT
Site name: 5 KNIGHTSBRIDGE
Specific context:
Dating of context: ~ 1790s

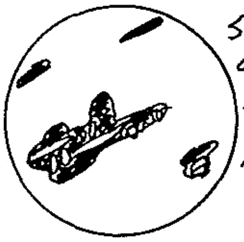
AML Ref:

MACROSTRUCTURE





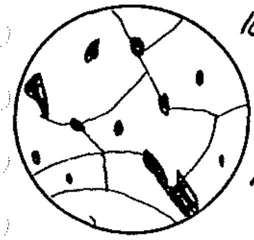
MICROSTRUCTURE
unetched X500 LONGIT.



5% IREGULAR/ELONGATED
LARGE: DUAL PHASE/DENDR.
SMALL : SINGLE PHASE
MANY BRIGHT SPOTS.

"TRANSV" MORE
ELONGATED/STRINGER

MICROSTRUCTURE
etched:



100% FERRITE ASTM 5 EQUIAXED.
P GHOSTING ESP. IN CENTRAL BAND
THROUGH TRANSV. SAMPL
MANY SMALL INCS WITHIN GRAINS

PHOTOS

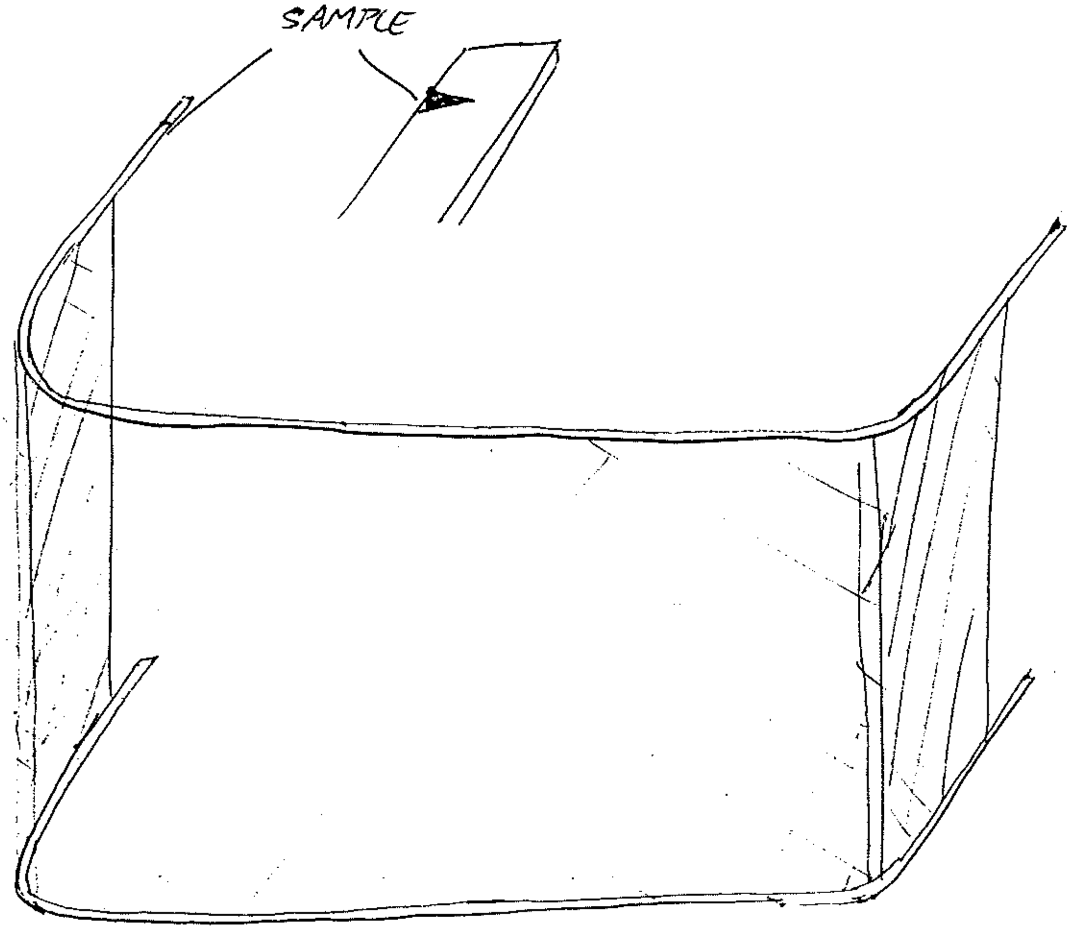
Film No.	Exp.No.	Mag.	Subject
96003	2A	X50	"LONGIT"
	3A	X50	"TRANS."
96005	29A	X6	LONG.
	30A	X5	TRANSV.
96006	23	X125	TRANSV
	24	X25	"
	25	X25	LONG.

ANALYSES:
SEM/EDX☑ SEM/WDX☑ XRF☐ XRD☐ OTHER☐ see over.

INTERPRETATION:
HOT WORKED PHOSPHORIC IRON

960019

5 KNIGHTSBRIDGE
IRON RAILING.



A.M. Lab. Metallography Recording Sheet

SAMPLE: 960020

ARTEFACT: RAILING AR HBS 5152
E.H. ARCHITECTURAL STUDY COLLECTION
Condition: GOOD

Sample location: SEE OVER

Permission to sample ☑ **After care:**
TREVE ROSOMAN

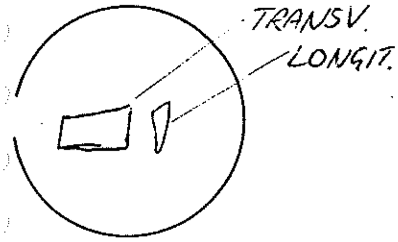
X-radiographs:
Line drawings:
Photos-Colour slide:
135 b/w print:
other:

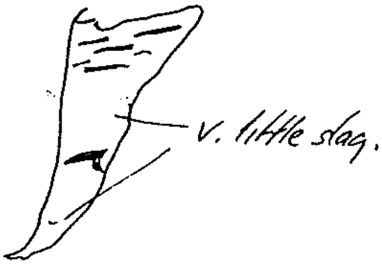
RECORDING: D. STARLEY

ARCHAEOLOGICAL CONTEXT
Site name: 143 PICCADILLY
Specific context: UPPER BALCONY
Dating of context: 18/3

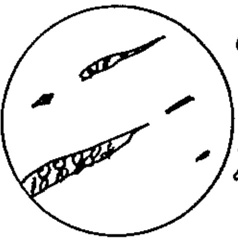
AML Ref:

MACROSTRUCTURE





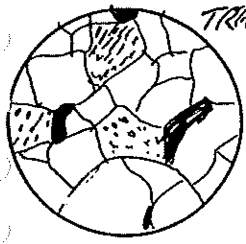
MICROSTRUCTURE
unetched X500 LONGIT



0-5%
DUAL PHASE
STRINGERS
NEAR SURFACE
OF ARTEFACT

TRANSV.
LARGER AREA OF
5% DUAL PHASE STRINGERS

MICROSTRUCTURE
etched:



TRANSV. ~100% Ferritic ASTM4 EQUIAXED
STRONG ETCH PITTING.
OCC. PEARLITE (<5%)
LONGIT. UP TO 5% FINE PEARLITE

PHOTOS

Film No.	Exp.No.	Mag.	Subject
96003	4A	X6	LONGIT
	5A	X50	"
	6A	X50	
96005	31A	X8	LONGIT
	32A	X4	TRANSV
96006	26	X25	LONG
	27	X50	"
	28	X100	
	29	X25	TRANS.

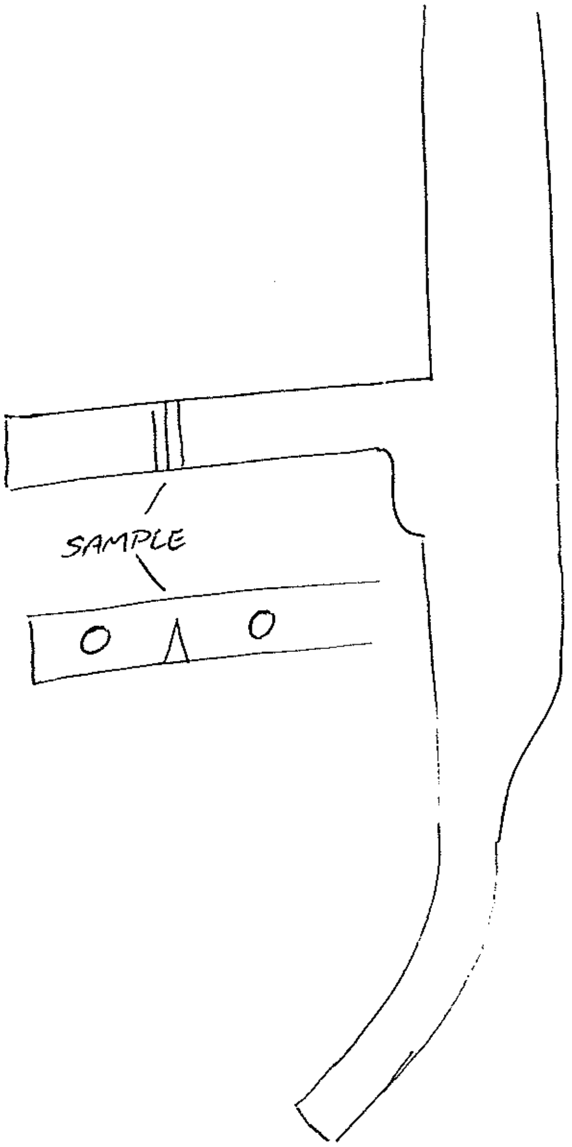
ANALYSES:
SEM/EDX ☑ SEM/WDX ☑ XRF ☐ XRD ☐ OTHER ☐ see over.

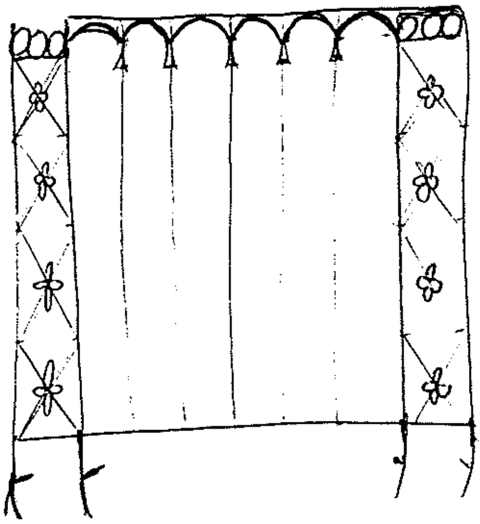
INTERPRETATION:

FERRITIC IRON HOT WORKED AND AIR COOLED

960020

143 PICADILLY
RAILING.





A.M. Lab. Metallography Recording Sheet

SAMPLE: 960021

ARTEFACT: UPRIGHT
EH ARCHITECTURAL STUDY COLLECTION
Condition: GOOD

Sample location: SEE OVER

Permission to sample ☑ **After care:**
TREVE ROSOMAN

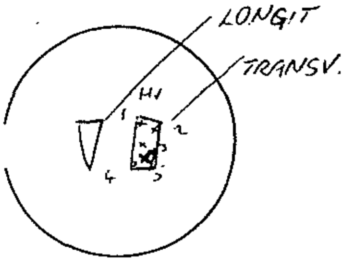
X-radiographs:
Line drawings:
Photos-Colour slide:
135 b/w print:
other:

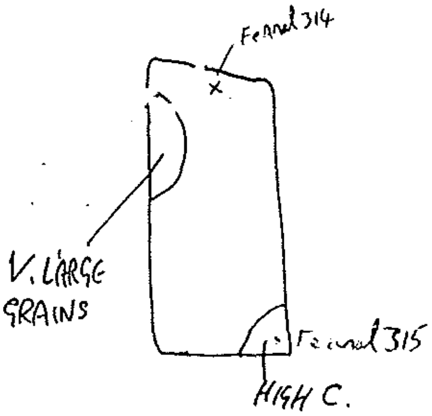
RECORDING: D. STARLEY

ARCHAEOLOGICAL CONTEXT
Site name: LINDSAY Ho., LINCOLNS INN FIELDS
Specific context:
Dating of context: 18/4

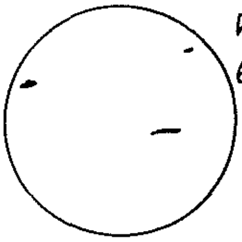
AML Ref:

MACROSTRUCTURE





MICROSTRUCTURE
unetched X500 LONGIT



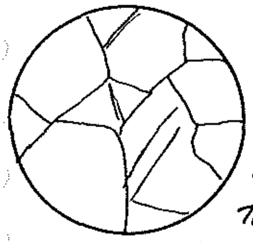
V. OCCASIONAL (<1%) ELONGATED SINGLE PHASE INCLUSIONS

TRANSV.

<1% SUBROUND - ELONGATED SINGLE/DUAL PHASE INCS

HV (100g)
1) 107.2
2) 113.6
3) 99.8
4) 113.6
5) 117.7
110.4

MICROSTRUCTURE
etched: X1250 LONGIT.



V. VARIABLE

LONGIT.
100% FERRITE ASTM 1-5
W/ OCC. DEFM. TWINS
TRANS. & BRIGHT SPECKS

TRANS MORE VARIABLE. CORNER OF SPECIMEN V. FINE GRAINED <ASTM 8 & ~50% ASSLOM PEARLITE ELSEWHERE 100% FERRITE OF ASTM 6→>1

PHOTOS

Film No.	Exp.No.	Mag.	Subject
96003	7A	X50	LONGIT
	8A	"	TRANSV.
96005	32A	X5	LONGIT
	33A	X5	TRANS.
96006	30	X25	LONGIT (Defm Twins)
	31	X12.5	" "
	32	X12.5	TRANSV.
	33	X12.5	TRANSV.
SLIDE 96008	33, 34	X25	TRANS
	35, 36	X12.5 X25	} DEFM. TWINS.

ANALYSES:
SEM/EDX☑ SEM/WDX☑ XRF☐ XRD☐ OTHER☐ see over.

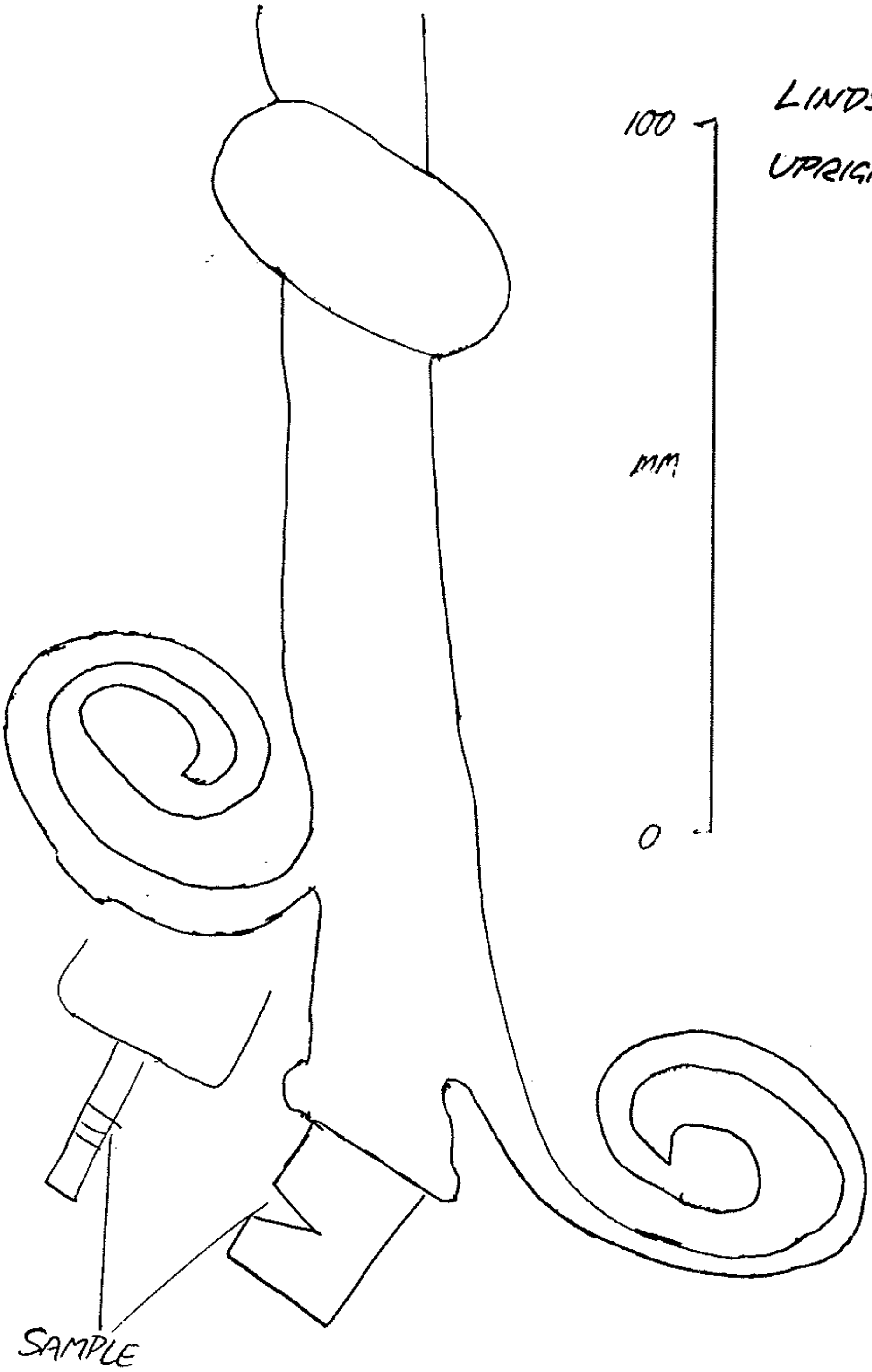
INTERPRETATION:

HETEROGENEOUS: FERRITIC IRON & 0.4% C STEEL
HOT WORKED + SOME COLD DEFORMATION + OVERHEATED

960021

LINDSAY Ho.

UPRIGHT



A.M. Lab. Metallography Recording Sheet

SAMPLE: 960022

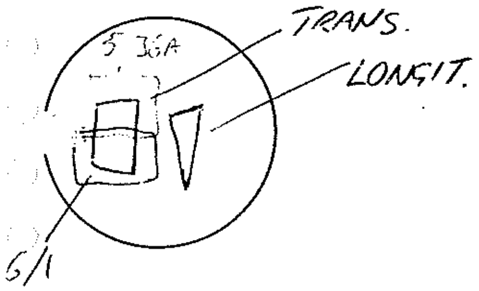
ARTEFACT: STAIRCASE UPRIGHT EH ASC No. 4548
EH ARCHITECTURAL STUDY COLLECTION
Condition: GOOD
Sample location: BELOW LOOSE LEAD (SEE OVER)
Permission to sample ☑ **After care:**
TREVE ROSOMAN

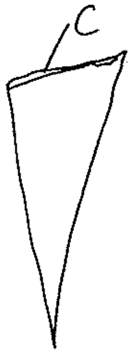
X-radiographs:
Line drawings:
Photos-Colour slide:
135 b/w print:
other:
RECORDING: D.STARLEY

ARCHAEOLOGICAL CONTEXT

Site name: COVENTRY HALL, STREATHAM
Specific context:
Dating of context: c 1800
AML Ref:

MACROSTRUCTURE





MICROSTRUCTURE
unetched X500 LONGIT

2% SINGLE PHASE ELONG. FRAGMENTED INCS.

LONGIT.

2% SINGLE & DUAL PHASE ELONGATED INCS.

MICROSTRUCTURE
etched: X/250 TRANS

100% FERRITE EXCEPT FOR EXTREME EDGE OF LONGIT. SECTION

ASTM 5-6

PHOTOS

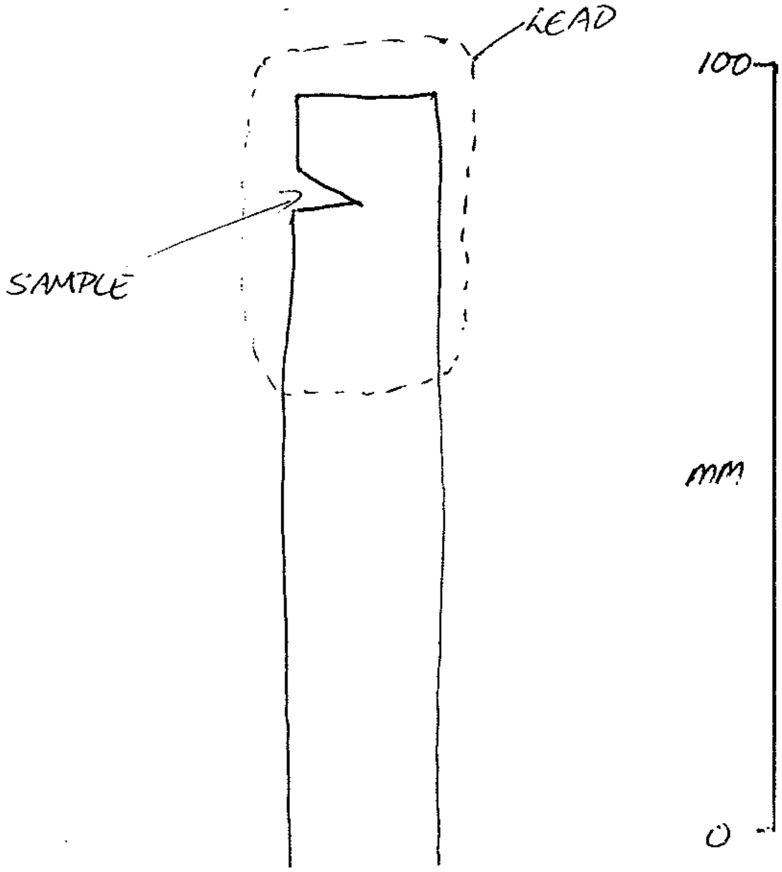
Film No.	Exp.No.	Mag.	Subject
96003	9A 10A	X25 X50	LONGIT TRANS.
96005	35A	X5	LONGIT
"	36A	X5	TRANSV
96006	1	X5	TRANSV
	34	X25	TRANS
	35	X25	LONGIT.

ANALYSES:
SEM/EDX☑ SEM/WDX☑ XRF☐ XRD☐ OTHER☐ see over.

INTERPRETATION:
FERRITIC IRON. SOME WORK BELOW SOLIDUS OF SLAG.
CARBURISED ON OUTER SURFACE

960022

COVENTRY HALL, STREATHAM - STAIRCASE UPRIGHT



32.3

A.M. Lab. Metallography Recording Sheet

SAMPLE: 960023

ARTEFACT: WASHER

Condition: V. GOOD

Sample location: SEE OVER

Permission to sample ☑ **After care:**

TREVE ROSOMAN

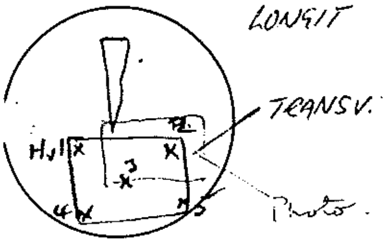
X-radiographs:
Line drawings:
Photos-Colour slide:
135 b/w print:
other:

RECORDING: D. STARLEY

ARCHAEOLOGICAL CONTEXT
Site name: ST. MARY AT HILL, EASTCHEAP
Specific context:
Dating of context: 1822

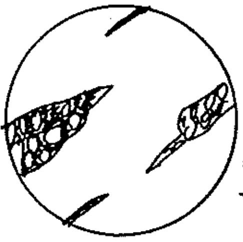
AML Ref:

MACROSTRUCTURE



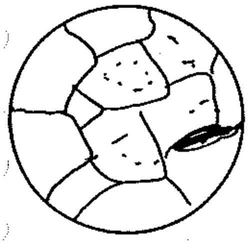
Hv (100g)
1) 189.3
2) 138.4
3) 173.4
4) 161,4
5) 158.8
164,3

MICROSTRUCTURE
unetched X500 LONGIT



5% ELONG.
DUAL PHASE
INCS.
MANY BRIGHT
SPOTS

MICROSTRUCTURE
etched: x 1250



100% FERRITE ASTM 6-1
STRONG P GHOSTING.
ETCH PITTING

PHOTOS

Film No.	Exp.No.	Mag.	Subject
96003	11A 12A	X50 "	LONGIT TRANSV.
96006	2 3 36 36A	X4 X4 X25 X125	LONGIT TRANS. LONG. TRANS.

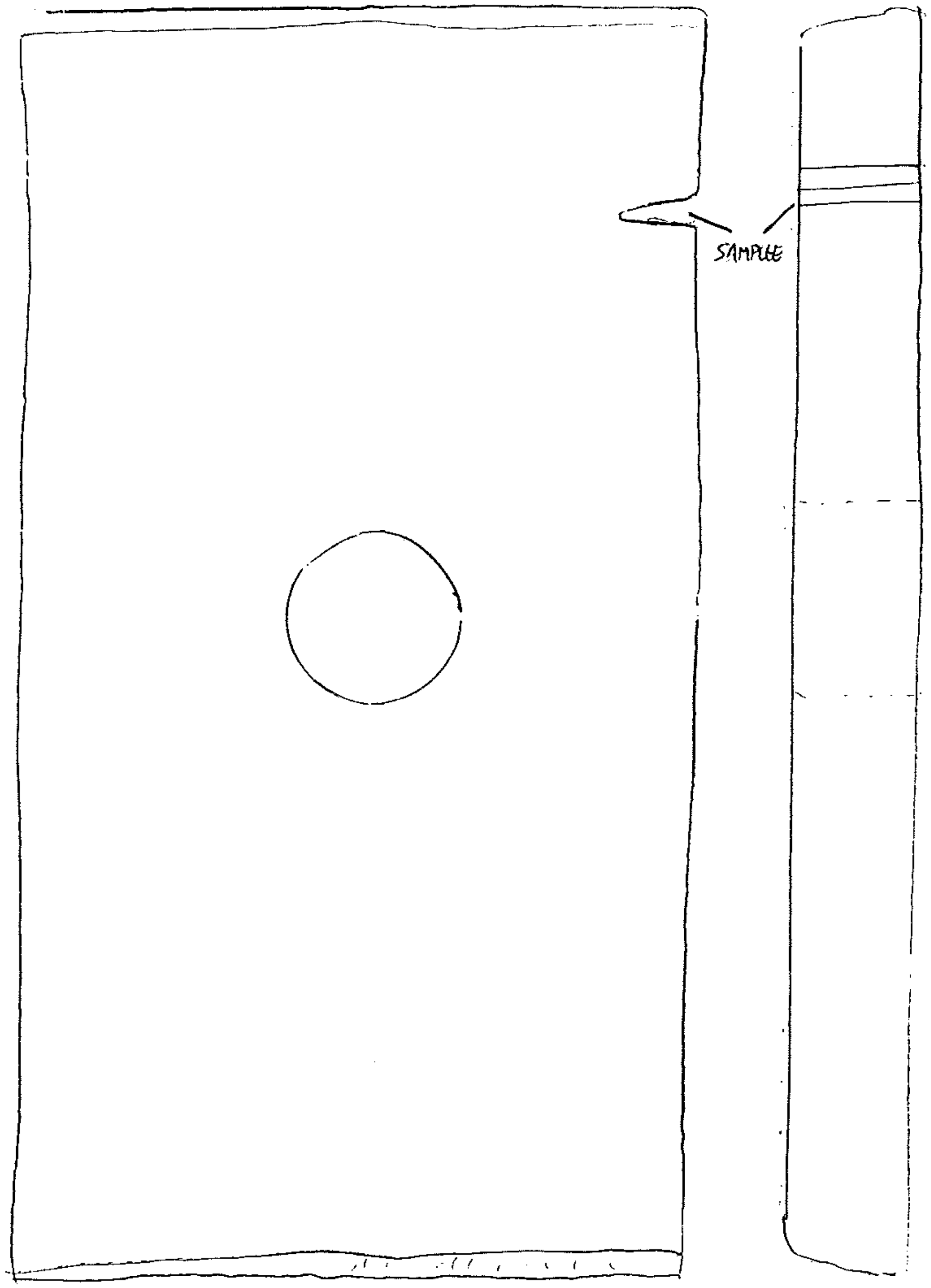
ANALYSES:
SEM/EDX ☑ SEM/WDX ☑ XRF ☐ XRD ☐ OTHER ☐ see over.

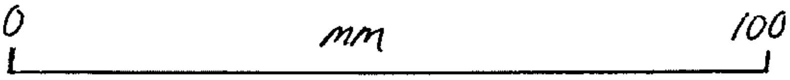
INTERPRETATION:

PHOSPHORIC IRON, HOT WORKED

960023

ST. MARY AT HILL, EASTCHEAP – WASHER





A.M. Lab. Metallography Recording Sheet

SAMPLE: 960024

ARTEFACT: DOG (STAPLE)
(EH ARCHITECTURAL STUDY COLLECTION AR HBS 1515)
Condition: SURFACE CORROSION

Sample location: (SEE OVER)

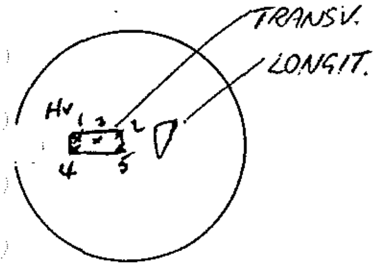
Permission to sample ☑ **After care:**
TREVE ROSOMAN

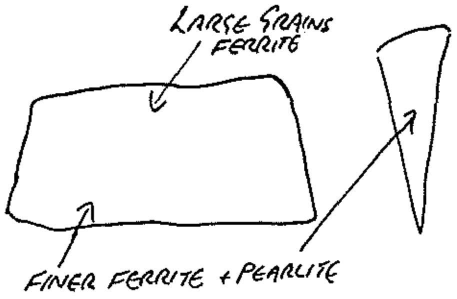
X-radiographs:
Line drawings:
Photos-Colour slide:
135 b/w print: 84/10/17A
other:
RECORDING : D. STARLEY

ARCHAEOLOGICAL CONTEXT
Site name: MORDEN GRANGE, MERTON
Specific context: FROM ROOF PLATE
Dating of context: 19/1

AML Ref:

MACROSTRUCTURE



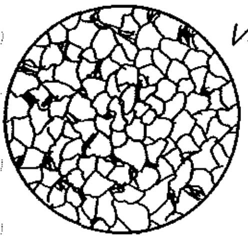


MICROSTRUCTURE
unetched X500 LONGIT

V. VARIABLE
0-5%
SINGLE PHASE
ELONGATED

Hv (100g)
1) 124.5
2) 129.1
3) 133.3
4) 123.8
5) 143.1
130.8

MICROSTRUCTURE
etched: X1250 NITAL TRANSVERSE.



V. VARIABLE 100-80% Ferrite ASTM 7-8
0-20% Pearlite (Fine
SLIGHT P GHOSTING ON LONGIT. & TRANS
BRIGHT SPECKS

PHOTOS

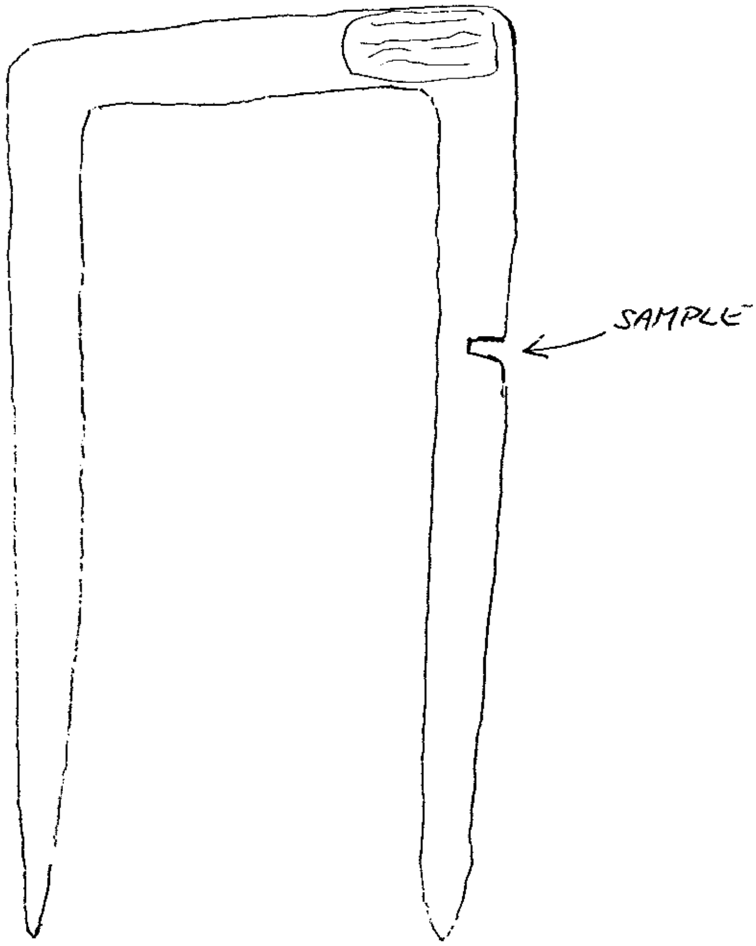
Film No.	Exp.No.	Mag.	Subject
96003	13A 14A	50X "	LONGIT TRANSV.
96006	4 5	X6 X4	LONGIT TRANS
96007	1 2 3	X50 X250 X25	LONGIT. " TRANS

ANALYSES:
SEM/EDX☑ SEM/WDX☑ XRF☐ XRD☐ OTHER☐ see over.

INTERPRETATION:
FERRITIC IRON/LOW CARBON (0.15MAX) STEEL HOT WORKED & AIR COOLED

960024

MORDEN GRANGE, MERTON -DOG



A.M. Lab. Metallography Recording Sheet

SAMPLE: 960025

ARTEFACT: BALCONY RAIL LEAF
EH ARCHITECTURAL STUDY COLLECTION: AR. HB.S 1551
Condition: GOOD. - pon stamped.
Sample location: SEE OVER
Permission to sample ☑ **After care:**
TREVE ROSOMAN

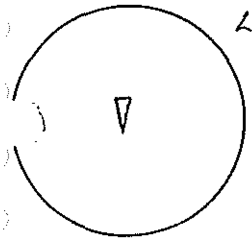
X-radiographs:
Line drawings:
Photos-Colour slide:
135 b/w print: 84/10/18A
other:

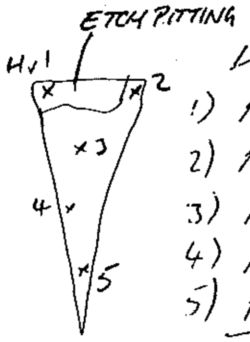
RECORDING: D. STARLEY

ARCHAEOLOGICAL CONTEXT
Site name: 23 ONSLOW GARDENS, SOUTH KENSINGTON
Specific context: 1st FLOOR BALCONY RAILINGS
Dating of context: 1871-2

AML Ref:

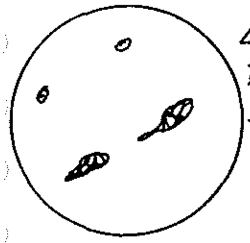
MACROSTRUCTURE


LONGITUDINAL

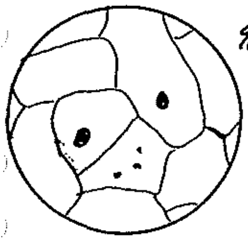


Hv 100g
1) 136.2
2) 149.7
3) 136.2
4) 129.8
5) 127.1
133.8

MICROSTRUCTURE
unetched X500


<1-2%
DUAL PHASE
SUBROUND - ELONGATED

MICROSTRUCTURE
etched: X1250


98 ~~100~~% FERRITE ASTM 5 UNIFORM
2% PEARLITE.
+ ETCH PITTING TOWARDS SURFACE

PHOTOS

Film No.	Exp.No.	Mag.	Subject
96003	~~16~~ 15A	X50	LONGIT
96006	6	X4	
96007	4	X25	LONGIT
96007	5	X50	"
	6	X25	TRANS
	7	X100	TRANS

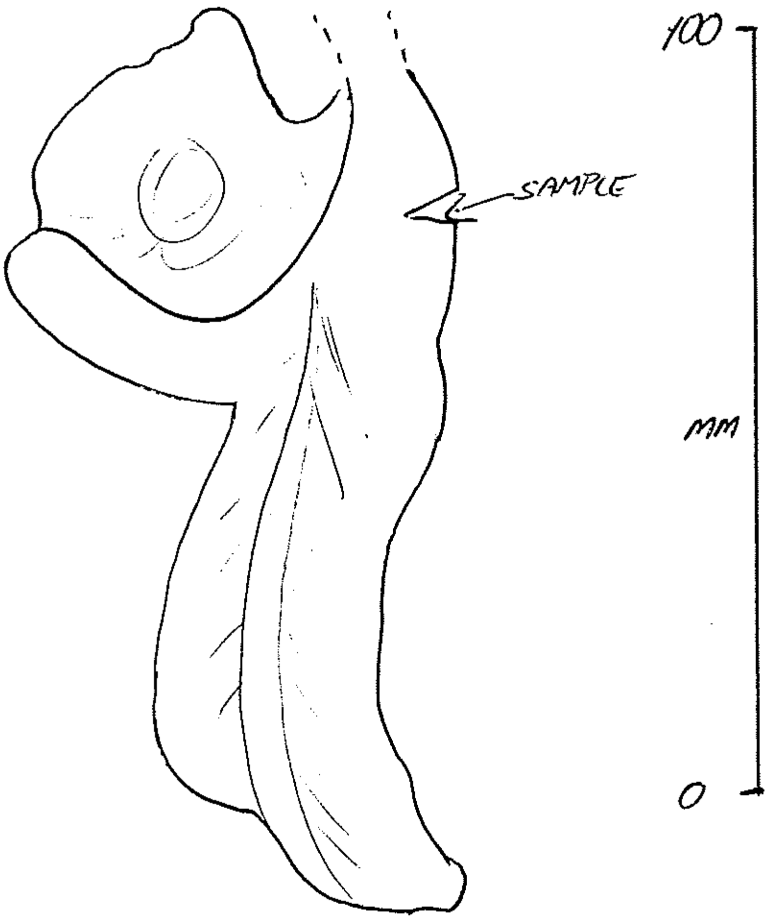
ANALYSES:
SEM/EDX ☑ SEM/WDX ☑ XRF ☐ XRD ☐ OTHER ☐ see over.

INTERPRETATION:
FERRITIC / PHOSPHORIC IRON (ANALYSIS TO 0.18% P)

960025

23 ONSLOW GARDENS, SOUTH KENSINGTON

BALCONY RAIL LEAF



A.M. Lab. Metallography Recording Sheet

SAMPLE: 960026

ARTEFACT: WATER LEAF FROM WROUGHT IRON GATES EH ARCHITECTURAL STUDY COLLECTION: AR HB S 1508

Condition: GOOD

Sample location: SEE OVER

Permission to sample ☑ **After care:**

TREVE ROSOMAN

X-radiographs:

Line drawings:

Photos-Colour slide:

135 b/w print: 84/10/10A B921266

other:

RECORDING : D.STANLEY

ARCHAEOLOGICAL CONTEXT

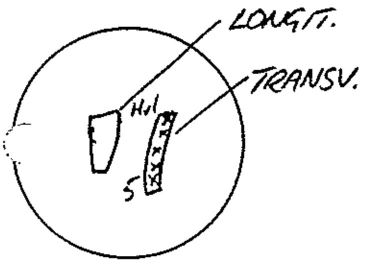
Site name: AVERY HILL COLLEGE, GREENWICH

Specific context: WEST GATES.

Dating of context: 1888-91

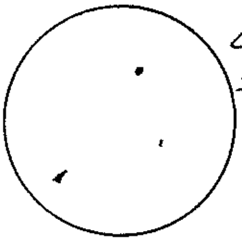
AML Ref:

MACROSTRUCTURE



Hv(100g)
1) 129.8
2) 108.7
3) 113.9
4) 122.5
5) 131.2
121.6

MICROSTRUCTURE
unetched X500 LONGIT.

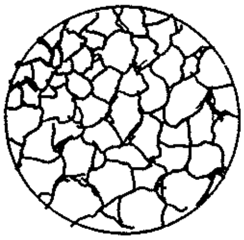


<<1% SUBROUND SINGE PHASE

TRANSV.

<<1% ANGULAR =WELD LINE?

MICROSTRUCTURE
etched: 2% NITAL LONG X1250



5% AGGLOMERATED PEARLITE
95% FERRITE ASTM 5

PHOTOS

Film No.	Exp.No.	Mag.	Subject
98003	16A 17A	X100 X50	LONGIT TRANSV.
96006	7 8	X5 X4	LONGIT TRANSV.

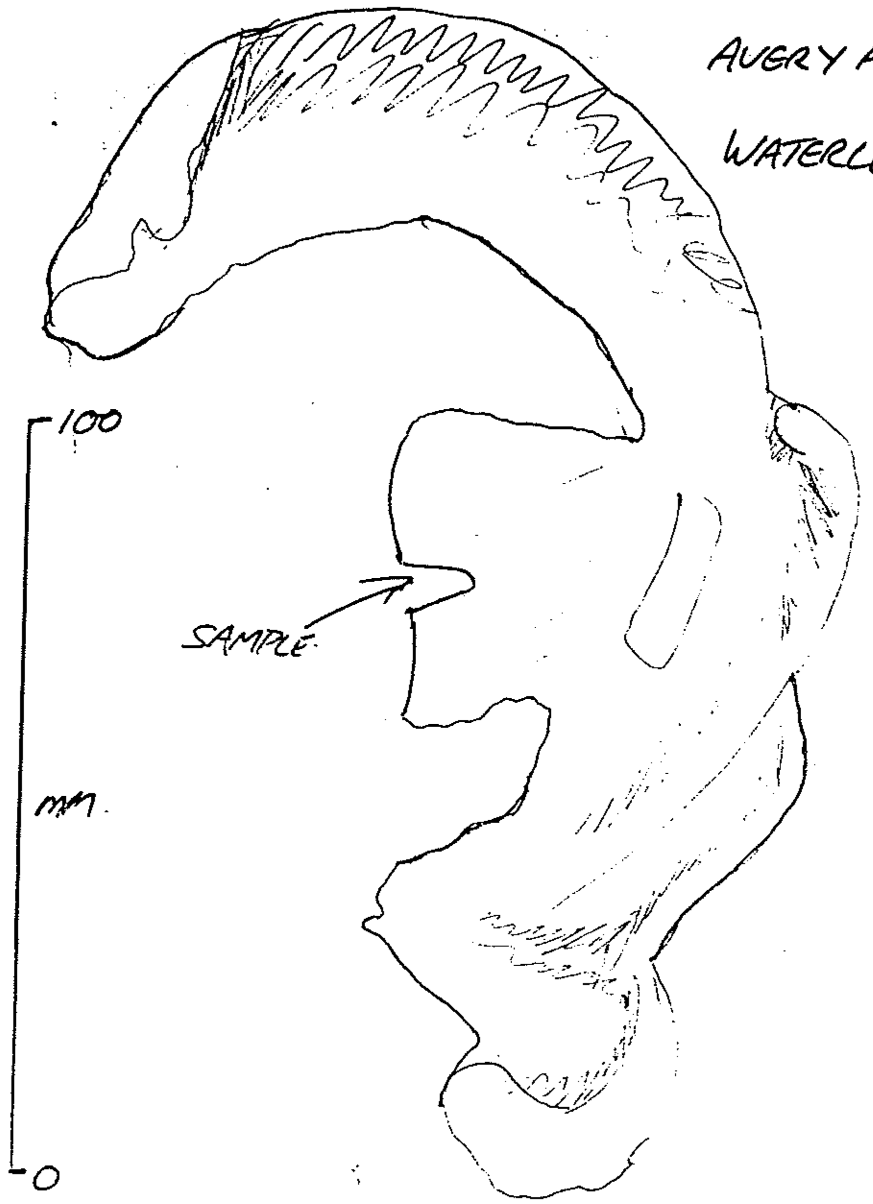
ANALYSES: ✓
SEM/EDX☑ SEM/WDX☑ XRF☐ XRD☐ OTHER☐ see over.

INTERPRETATION: MILD STEEL

960026

AVERY HILL COLLEGE

WATERLEAF



Appendix II SEM (EDXA) analyses of slag inclusions in historical iron samples (date order)

Sample details	Inclusion			Composition weight %												
	AML ref.	length (μm)	width (μm)	S	Cl	Na_2O	MgO	Al_2O_3	SiO_2	P_2O_5	K_2O	CaO	TiO_2	V_2O_3	MnO	FeO
950009	HI033	30	10	0.2	0.0	0.4	0.4	2.7	10.0	10.2	1.3	2.9	0.2	0.0	0.3	71.4
Castle Hedlingham: window grill	HI034	130	15	0.1	0.0	0.6	1.0	1.9	18.0	7.2	0.1	0.6	0.0	0.0	0.7	70.2
Phosphoric iron, 1% slag	HI035	100	20	0.4	0.0	0.3	0.5	1.5	8.4	3.5	0.4	0.9	0.0	0.0	0.4	83.7
	HI036	100	100	0.3	0.1	0.6	1.3	3.6	19.0	7.3	2.3	2.7	0.0	0.0	0.6	61.8
Before 1200	HI037	100	10	0.3	0.0	0.5	0.2	0.7	18.0	3.6	0.7	1.1	0.1	0.0	0.2	74.1
	HI039	120	70	0.1	0.0	0.3	0.1	0.6	29.0	0.7	0.3	0.9	0.1	0.0	0.1	67.5
	HI040	30	30	0.1	0.1	0.7	0.0	0.5	26.0	1.6	0.3	0.8	0.0	0.0	0.1	70.1
	HI041	10	10	0.4	0.1	0.5	0.5	1.0	24.0	3.3	0.8	1.5	0.2	0.0	0.2	67.5
	HI042	80	6	0.5	0.0	0.0	0.0	0.5	26.0	2.9	0.4	0.8	0.0	0.2	0.2	69.0
	HI043	30	8	0.2	0.1	0.3	0.7	0.9	14.0	10.8	0.0	0.5	0.0	0.0	0.4	72.1
	HI044	10	6	0.4	0.1	0.4	0.2	0.7	18.0	3.2	0.3	0.8	0.0	0.1	0.2	76.0
	mean	67	26	0.3	0.0	0.4	0.4	1.3	19.1	4.9	0.6	1.2	0.1	0.0	0.3	71.2
960005	HI045	100	8	0.2	0.1	0.5	0.5	4.7	25.0	0.8	1.9	2.1	0.2	0.0	3.0	60.5
Windsor Castle: drain grill	HI046	6	4	0.1	0.0	0.8	1.1	8.4	40.0	0.2	2.8	3.6	0.3	0.0	5.8	36.8
Ferritic iron / steel,	HI047	9	9	0.2	0.0	0.5	1.2	6.5	30.0	0.8	2.1	2.9	0.2	0.0	1.6	53.6
<1% slag	HI048	40	4	0.1	0.0	0.7	1.4	8.2	34.0	1.4	3.2	3.8	0.4	0.1	2.1	45.0
	HI049	20	6	0.0	0.0	0.9	1.9	10.0	53.0	0.2	4.7	7.1	0.5	0.0	2.6	18.6
Before 1400	HI050	30	8	0.1	0.0	0.6	1.3	9.0	44.0	0.0	3.7	6.0	0.5	0.0	4.5	30.0
	HI053	50	4	0.1	0.0	0.7	1.7	10.0	48.0	0.2	4.8	4.4	0.4	0.1	3.0	26.6
	HI054	20	4	0.0	0.0	0.6	1.6	10.0	54.0	0.0	4.6	6.1	0.5	0.0	5.1	16.9
	HI055	70	30	0.1	0.0	0.8	0.5	3.2	17.0	1.0	1.0	1.1	0.1	0.0	2.3	72.9
	HI056	30	20	0.1	0.1	0.6	0.6	5.6	28.0	1.0	2.2	2.8	0.0	0.0	2.8	56.7
	HI057	80	20	0.6	0.1	0.3	0.3	2.4	12.0	0.5	0.7	0.9	0.2	0.0	1.8	80.6
	HI058	120	30	0.0	0.0	0.5	0.9	6.4	33.0	0.4	2.8	2.7	0.3	0.0	4.1	48.3
	HI059	60	20	0.1	0.1	0.6	0.6	4.7	23.0	0.8	1.9	1.7	0.2	0.0	2.6	63.4
	HI060	20	20	0.5	0.0	0.7	0.3	2.9	15.0	3.4	1.2	0.9	0.2	0.0	2.1	72.6
	mean	47	13	0.2	0.0	0.6	0.9	6.6	32.6	0.8	2.7	3.3	0.3	0.0	3.1	48.8
960006	HI062	30	6	0.1	0.1	0.5	0.4	3.4	12.0	3.5	0.1	0.6	0.1	0.0	0.7	78.5
Great Yarmouth: short wall tie	HI063	70	30	0.1	0.0	0.6	0.3	2.1	14.0	4.1	0.1	0.8	0.0	0.0	0.9	76.9
Ferritic iron, 1% slag	HI064	15	9	0.0	0.0	0.7	0.2	0.9	4.3	0.5	0.0	0.2	0.1	0.0	0.3	92.7
	HI065	25	10	0.0	0.0	0.5	0.1	6.4	9.8	2.1	0.0	0.2	0.1	0.3	0.5	80.0
1560 - 1569	HI066	18	6	0.1	0.0	0.5	0.4	2.8	18.0	5.3	0.3	0.8	0.3	0.0	2.1	69.8
	HI067	200	100	0.2	0.0	0.5	0.6	1.0	13.0	1.6	0.1	0.6	0.3	0.2	4.0	78.1
	HI068	60	20	0.4	0.0	0.5	0.4	10.0	15.0	2.6	0.1	0.9	0.6	0.4	4.4	64.6
	HI069	100	60	0.4	0.0	0.6	0.5	0.9	20.0	2.6	0.3	1.3	0.3	0.1	5.3	67.3
	HI070	150	100	0.8	0.0	0.5	0.5	0.9	18.0	3.7	0.4	1.8	0.4	0.1	4.1	69.4
	HI071	160	80	0.3	0.0	0.4	0.4	1.4	21.0	3.6	0.6	1.7	0.3	0.0	4.9	65.7
	HI072	200	100	0.3	0.0	0.5	0.6	0.9	20.0	4.6	0.4	1.5	0.1	0.0	4.6	66.3
	mean	93	47	0.2	0.0	0.5	0.4	2.8	15.0	3.1	0.2	0.9	0.2	0.1	2.9	73.6
960007	HI073	500	50	0.1	0.1	0.3	0.7	3.4	14.0	0.6	1.3	1.3	0.1	0.1	2.2	75.6
Great Yarmouth: short wall tie	HI074	50	20	0.1	0.0	0.3	0.5	2.8	12.0	0.3	1.0	1.1	0.2	0.0	1.2	81.1
Ferritic iron, 3% slag	HI075	200	200	0.1	0.1	0.5	0.5	3.4	13.0	0.4	1.1	1.2	0.1	0.1	2.1	76.9
	HI076	150	100	0.1	0.1	0.6	0.5	3.4	13.0	0.4	1.3	1.4	0.2	0.1	2.0	77.1
1601	HI077	300	70	0.0	0.0	0.7	0.7	6.1	26.0	0.7	2.5	2.4	0.0	0.0	2.6	58.5
	HI078	100	80	0.2	0.1	0.5	0.7	3.4	15.0	0.8	1.2	1.5	0.0	0.0	1.8	74.9
	HI079	80	30	0.1	0.0	0.7	1.0	6.9	31.0	0.3	3.0	4.1	0.1	0.1	3.3	49.7
	HI080	100	20	0.0	0.0	0.6	0.6	4.5	21.0	0.6	1.9	2.1	0.2	0.0	2.0	66.7
	HI081	130	60	0.1	0.0	0.6	0.4	5.1	23.0	0.6	2.0	2.3	0.2	0.0	2.7	63.1
	HI082	100	30	0.1	0.0	0.5	0.7	5.2	22.0	0.2	2.1	2.6	0.2	0.0	2.9	63.6
	HI083	150	100	0.1	0.0	0.7	0.9	7.0	29.0	0.5	2.8	3.4	0.2	0.0	3.1	52.2
	HI085	120	60	0.2	0.1	0.7	0.6	4.9	23.0	0.7	2.0	2.1	0.1	0.0	2.1	64.1
	mean	165	68	0.1	0.0	0.6	0.7	4.7	20.2	0.5	1.9	2.1	0.1	0.0	2.3	67.0

Sample details	Inclusion			Composition weight %												
	AML ref.	length (µm)	width (µm)	S	Cl	Na_2O	MgO	Al_2O_3	SiO_2	P_2O_5	K_2O	CaO	TiO_2	V_2O_3	MnO	FeO
960008	HI088	100	60	0.2	0.1	0.4	0.5	0.3	4.3	2.2	0.1	0.9	0.0	0.2	2.9	87.8
Great Yarmouth: short wall tie	HI089	120	50	0.3	0.0	0.4	0.4	0.3	5.5	2.8	0.1	0.3	0.0	0.0	3.0	87.0
Ferritic / phosphoric iron, 5% slag	HI090	200	200	0.3	0.1	0.2	0.1	0.3	4.1	2.2	0.1	0.8	0.0	0.1	2.7	89.0
	HI091	100	40	0.4	0.0	0.6	0.4	0.3	4.9	3.0	0.1	1.0	0.0	0.1	3.4	85.8
1637	HI092	80	40	0.1	0.0	0.3	0.6	0.3	1.8	4.0	0.0	0.0	0.0	0.2	2.9	89.7
	HI093	140	30	0.3	0.1	0.5	0.2	0.3	3.6	1.7	0.1	0.6	0.1	0.0	3.0	89.7
	HI094	100	70	0.2	0.1	0.8	0.6	0.3	7.7	3.8	0.1	1.3	0.1	0.0	3.4	81.5
	HI095	120	40	0.4	0.0	0.4	0.5	0.4	9.8	5.0	0.3	1.7	0.2	0.0	3.3	77.9
	HI099	60	60	0.2	0.0	0.2	0.2	0.4	4.5	1.2	0.2	0.8	0.0	0.0	2.9	89.4
	HI100	100	15	0.3	0.1	0.5	0.6	0.3	7.3	2.4	0.3	1.3	0.1	0.1	2.9	83.9
	HI102	60	30	0.5	0.0	0.3	0.4	0.1	6.4	2.9	0.1	1.4	0.2	0.0	2.3	85.4
	mean	107	58	0.3	0.0	0.4	0.4	0.3	5.4	2.8	0.1	0.9	0.1	0.1	3.0	86.1
960009	HI103	80	30	0.1	0.0	0.6	0.2	1.1	8.9	5.7	0.2	0.3	0.1	0.0	0.5	82.4
Great Yarmouth: short wall tie	HI104	30	10	0.1	0.0	1.1	0.3	1.8	9.8	7.2	0.5	1.1	0.1	0.1	0.4	77.4
Ferritic /phosphoric iron, <1% slag	HI107	60	40	0.1	0.1	0.6	0.2	2.0	7.3	5.7	0.2	0.5	0.1	0.1	0.6	82.6
	HI108	100	30	0.0	0.0	0.5	0.2	1.8	12.0	3.9	0.1	0.4	0.0	0.0	1.0	79.8
1651	HI109	150	20	0.0	0.0	1.1	0.6	2.6	15.0	2.9	0.6	1.0	0.2	0.2	0.8	74.6
	HI110	80	60	0.1	0.0	0.7	0.4	1.5	7.8	2.1	0.2	0.6	0.0	0.0	0.7	86.0
	HI111	100	50	0.0	0.5	0.8	0.4	2.2	13.0	2.3	0.5	0.7	0.0	0.1	0.6	78.9
	HI112	300	60	0.0	0.0	0.5	0.2	2.3	10.0	1.1	0.4	0.5	0.0	0.2	0.5	83.9
	HI113	20	15	0.0	0.0	0.8	0.3	1.6	9.9	2.8	0.4	0.5	0.0	0.0	0.8	83.0
	HI114	100	30	0.0	0.1	1.1	0.2	3.4	20.0	2.4	0.7	1.1	0.3	0.0	0.8	69.9
	mean	102	35	0.0	0.0	0.8	0.3	2.0	11.0	3.6	0.4	0.7	0.1	0.1	0.7	80.0
960010	HI120	80	10	0.4	0.1	0.4	0.4	2.1	16.0	1.7	1.0	1.3	0.1	0.0	2.0	74.5
Great Yarmouth: short wall tie	HI121	50	10	0.3	0.1	0.4	0.5	1.6	12.0	1.7	0.8	0.6	0.0	0.2	1.5	80.3
Ferritic iron, <1% slag	HI122	30	10	0.1	0.0	0.3	0.4	1.6	11.0	1.2	0.7	0.8	0.0	0.1	1.3	82.9
	HI123	80	30	0.3	0.0	0.4	0.4	2.4	17.0	1.7	1.0	1.0	0.1	0.0	1.6	74.4
1691	HI124	40	20	0.6	0.1	0.6	0.5	1.1	7.8	1.6	0.3	0.5	0.0	0.0	1.0	86.0
	HI125	400	60	0.1	0.0	0.7	0.8	3.1	19.0	0.2	1.3	1.6	0.0	0.1	2.6	70.4
	HI126	600	300	0.2	0.0	0.3	0.9	3.2	23.0	1.4	1.6	1.9	0.0	0.0	2.6	64.7
	HI127	100	80	0.1	0.2	0.6	1.0	4.0	24.0	0.8	2.2	2.4	0.3	0.1	2.7	61.3
	HI128	300	80	0.2	0.1	0.8	1.2	3.8	24.0	0.9	1.9	2.3	0.3	0.0	2.8	61.8
	HI129	200	100	0.2	0.2	1.0	1.2	3.7	24.0	1.0	1.9	2.3	0.1	0.0	2.5	61.8
	HI130	90	20	0.5	0.1	0.8	1.0	3.2	21.0	1.3	1.4	1.7	0.2	0.0	2.8	66.3
	mean	179	65	0.3	0.1	0.6	0.8	2.7	18.1	1.2	1.3	1.5	0.1	0.0	2.1	71.3
960012	HI144	70	6	0.2	0.0	0.6	0.3	0.5	2.1	6.3	0.0	0.4	0.0	0.0	0.3	89.3
Trinity Chapel: hook for window hinge	HI145	70	10	0.0	0.0	0.4	0.4	0.4	1.8	4.8	0.0	0.3	0.0	0.0	0.3	91.6
Ferritic iron, 0.5% slag	HI146	200	6	0.0	0.0	0.5	0.3	1.2	1.1	0.1	0.0	0.3	0.0	0.0	0.0	96.5
	HI147	30	20	0.1	0.1	0.6	0.8	1.7	12.0	3.7	0.5	3.5	0.0	0.0	0.3	76.3
1694	HI148	40	6	0.1	0.0	0.4	0.4	0.5	2.2	3.1	0.1	0.5	0.0	0.0	0.1	92.6
	HI149	20	6	0.2	0.1	0.2	0.0	0.0	0.1	2.8	0.0	0.0	0.0	0.0	0.3	96.3
	HI151	15	10	0.2	0.0	0.5	0.6	0.9	9.5	2.7	0.2	1.3	0.0	0.0	0.4	83.8
	HI152	40	4	0.2	0.0	0.5	0.2	0.6	4.6	5.9	0.1	0.8	0.0	0.2	0.7	86.1
	HI153	70	15	0.2	0.1	0.3	0.1	0.1	0.1	1.3	0.0	0.0	0.0	0.0	0.2	97.5
	HI154	60	10	0.0	0.1	0.2	0.1	0.0	0.1	5.9	0.1	0.0	0.0	0.0	0.3	93.1
	mean	62	9	0.1	0.0	0.4	0.3	0.6	3.4	3.7	0.1	0.7	0.0	0.0	0.3	90.3

Sample details	Inclusion			Composition weight %												
	AML ref.	length (μm)	width (μm)	S	Cl	Na_2O	MgO	Al_2O_3	SiO_2	P_2O_5	K_2O	CaO	TiO_2	V_2O_3	MnO	FeO
960011	HI131	30	6	0.1	0.0	0.9	0.4	2.3	14.0	1.5	1.0	2.0	0.1	0.0	0.4	77.4
Rangers House: holdfast	HI132	150	7	0.1	0.0	0.7	0.5	1.7	9.3	1.0	0.5	1.5	0.0	0.0	0.4	84.3
Ferritic iron, 0.5% slag	HI133	100	40	0.0	0.0	0.7	0.4	1.5	9.8	0.9	0.5	1.3	0.3	0.1	0.3	84.2
	HI134	90	40	0.1	0.0	0.6	0.8	1.9	13.0	1.4	0.7	1.9	0.0	0.2	0.4	78.7
1699	HI135	150	30	0.1	0.0	0.8	0.6	2.4	15.0	1.2	0.9	2.5	0.1	0.0	0.4	75.7
	HI136	150	80	0.0	0.0	1.1	0.9	2.6	21.0	1.5	1.0	2.8	0.0	0.1	0.5	68.8
	HI139	25	12	0.1	0.0	0.9	1.0	2.9	21.0	1.1	1.2	2.8	0.0	0.0	0.7	68.3
	HI140	9	9	0.1	0.0	0.7	0.7	2.5	15.0	2.0	0.6	2.2	0.2	0.1	0.5	74.9
	HI141	60	40	0.2	0.0	0.5	0.4	0.9	9.1	4.6	0.2	1.6	0.0	0.1	0.2	82.1
	HI142	10	10	0.0	0.1	0.7	0.7	1.9	14.0	1.3	0.7	1.8	0.1	0.0	0.6	78.5
	HI143	80	15	0.0	0.0	0.9	0.7	2.8	21.0	0.5	1.1	3.2	0.1	0.1	0.4	69.5
	mean	78	26	0.1	0.0	0.8	0.6	2.1	14.7	1.5	0.8	2.1	0.1	0.1	0.4	76.7
960013	HI156	50	10	0.0	0.0	2.1	3.9	9.2	46.0	0.2	3.5	7.1	0.4	0.0	0.3	27.3
St May le Strand: strap of ring beam	HI157	30	30	0.0	0.0	2.1	3.9	9.2	46.0	0.2	3.5	7.2	0.4	0.0	0.3	27.4
Ferritic iron/steel, <1% slag	HI159	50	30	0.0	0.0	2.7	4.5	12.0	54.0	0.0	5.0	9.8	0.4	0.0	0.2	12.1
	HI161	20	7	0.0	0.0	1.8	3.2	8.4	52.0	0.0	3.0	7.1	0.4	0.0	1.1	23.3
1717	HI162	70	20	0.1	0.0	1.9	2.9	9.3	52.0	0.6	4.1	7.2	0.4	0.0	1.3	20.5
	HI163	160	10	0.0	0.1	1.7	3.4	8.6	56.0	0.1	3.8	8.5	0.3	0.0	1.4	16.3
	mean	63	18	0.0	0.0	2.1	3.6	9.5	51.0	0.2	3.8	7.8	0.4	0.0	0.8	21.1
960014: Greenwich Naval College:	HI167	150	8	0.0	0.0	2.1	2.7	12.0	61.0	0.0	2.5	9.2	0.5	0.0	3.7	6.5
down pipe bracket	HI168	100	10	0.1	0.0	1.9	2.9	11.0	53.0	0.1	2.5	8.1	0.4	0.1	2.5	18.0
Ferritic iron/steel, <1% slag	HI169	40	20	0.0	0.0	2.3	3.2	14.0	57.0	0.0	3.1	9.3	0.6	0.0	1.3	9.7
	HI172	40	8	0.1	0.1	2.3	2.6	9.7	46.0	0.2	2.5	6.8	0.5	0.0	2.2	27.0
1729	HI173	8	5	0.1	0.0	1.3	4.6	19.0	38.0	0.5	0.9	16.0	1.0	0.0	0.9	17.9
	HI174	20	10	0.0	0.0	1.9	1.3	5.8	29.0	0.8	1.9	3.9	0.3	0.0	1.6	53.6
	mean	60	10	0.1	0.0	2.0	2.9	11.9	47.3	0.3	2.2	8.9	0.6	0.0	2.0	22.1
960015	HI175	100	100	0.1	0.1	0.5	0.9	0.5	18.0	0.3	0.0	1.1	0.1	0.0	4.8	73.9
Milton House: gate	HI176	80	80	0.0	0.0	0.4	1.6	1.0	21.0	0.2	0.3	2.8	0.1	0.0	12.0	60.4
Ferritic iron, <1% slag	HI177	100	100	0.0	0.1	0.5	0.8	1.0	13.0	0.2	0.2	1.8	0.1	0.2	5.8	76.6
	HI178	80	30	0.1	0.0	0.3	0.6	0.6	3.0	0.1	0.0	0.3	0.1	0.1	3.1	91.7
1729	HI179	60	60	0.1	0.0	0.6	0.3	0.3	3.0	0.4	0.0	0.3	0.0	0.0	2.6	92.2
	HI180	30	4	1.6	0.0	0.8	0.4	0.4	11.0	2.0	0.3	1.6	0.1	0.0	6.3	76.0
	HI181	25	10	0.1	0.0	0.4	0.2	0.6	3.1	0.1	0.2	0.5	0.0	0.0	3.9	90.9
	HI182	30	20	0.7	0.0	0.5	0.4	0.9	10.0	1.3	0.3	1.6	0.1	0.0	5.1	79.0
	HI183	40	20	0.8	0.1	0.5	0.7	0.7	12.0	1.1	0.3	1.5	0.0	0.0	5.2	77.5
	mean	61	47	0.4	0.0	0.5	0.7	0.7	10.5	0.6	0.2	1.3	0.1	0.3	5.4	79.8
960016	HI185	100	30	0.3	0.1	0.9	0.8	3.6	23.0	4.4	0.5	2.7	0.1	0.2	1.6	61.6
Fournier St. Mosque: balcony support	HI186	120	20	0.1	0.1	0.7	0.5	1.3	8.5	0.3	0.2	0.7	0.1	0.0	1.2	86.2
Ferritic iron / steel, <1% slag	HI187	150	90	0.1	0.0	1.3	0.6	2.9	24.0	0.7	1.1	2.1	0.1	0.1	1.6	65.2
	HI188	100	60	0.3	0.0	0.9	0.4	2.8	27.0	3.8	1.0	2.2	0.1	0.0	1.8	59.4
1743	HI189	40	40	0.1	0.1	1.5	0.8	3.8	30.0	3.3	2.3	2.6	0.3	0.0	2.6	52.3
	HI190	100	30	0.1	0.1	1.2	0.7	2.1	19.0	1.2	0.9	1.7	0.0	0.0	1.7	71.0
	HI191	100	15	0.2	0.0	1.4	1.9	7.8	66.0	0.8	1.8	5.2	0.3	0.0	6.9	7.3
	HI192	20	6	0.1	0.1	3.4	5.7	18.0	38.0	0.7	4.7	13.0	0.6	0.1	0.6	15.2
	HI193	30	30	0.3	0.0	0.9	1.2	4.0	40.0	1.7	1.3	3.3	0.2	0.1	5.1	42.4
	HI194	15	10	0.1	0.0	1.3	1.8	7.0	63.0	0.4	2.2	5.2	0.3	0.0	5.3	13.6
	mean	78	33	0.2	0.1	1.4	1.4	5.3	33.9	1.7	1.6	3.9	0.2	0.1	2.8	47.4

Sample details	Inclusion			Composition weight %												
	AML ref.	length (μm)	width (μm)	S	Cl	Na_2O	MgO	Al_2O_3	SiO_2	P_2O_5	K_2O	CaO	TiO_2	V_2O_3	MnO	FeO
960017	HI196	100	12	0.0	0.0	0.5	0.0	0.0	0.2	0.2	0.0	0.0	0.0	0.1	0.4	98.5
1 Bloomsbury St.: stair ballustrade	HI197	25	10	0.0	0.0	0.7	0.1	0.1	0.2	0.0	0.0	0.0	0.1	0.0	0.4	98.3
Ferritic/ phosphoric iron, <1% slag	HI198	15	10	0.5	0.0	0.0	0.1	0.4	7.9	10.2	0.0	0.0	0.0	0.0	0.0	80.7
	HI199	100	15	0.0	0.0	0.6	0.1	0.1	0.2	0.0	0.0	0.0	0.2	0.1	0.2	98.5
1770	HI200	15	4	0.1	0.0	0.6	1.3	2.0	24.0	9.2	0.4	3.0	0.2	0.0	2.8	56.3
	HI201	7	6	0.2	0.0	0.5	0.1	0.1	11.0	16.4	0.0	0.0	0.1	0.0	2.4	69.5
	HI202	6	5	0.5	0.1	0.5	0.1	0.2	8.6	22.3	0.0	0.0	0.1	0.1	2.4	65.3
	HI203	10	7	0.3	0.0	0.3	0.1	0.0	21.0	12.8	0.0	0.1	0.0	0.2	4.3	61.1
	HI204	30	20	0.1	0.0	0.5	1.0	2.5	23.0	8.8	0.2	2.2	0.3	0.0	2.9	58.9
	HI205	10	8	0.0	0.0	0.4	2.0	3.4	23.0	9.9	0.2	3.9	0.0	0.0	2.4	54.9
	HI206	20	9	0.1	0.0	0.3	1.1	1.8	19.0	11.0	0.2	2.4	0.2	0.0	2.3	61.8
	mean	31	10	0.2	0.0	0.4	0.5	1.0	12.6	9.2	0.1	1.1	0.1	0.0	1.9	73.1
960020	HI234	70	70	0.0	0.0	0.8	0.9	3.3	22.0	1.4	1.1	5.5	0.1	0.1	3.9	60.6
143 Upper Picadilly: balcony railing	HI235	100	60	0.0	0.1	0.6	0.7	1.4	9.8	0.7	0.4	2.3	0.0	0.1	2.9	80.9
Ferritic iron, 0.5% slag	HI236	100	80	0.0	0.1	0.9	1.0	2.4	15.0	0.6	0.8	3.5	0.3	0.0	3.3	72.4
	HI238	60	50	0.1	0.0	0.7	0.9	1.8	11.0	0.5	0.7	2.2	0.0	0.3	3.1	79.3
1775	HI239	200	30	0.0	0.1	0.9	0.9	2.9	19.0	1.0	1.1	4.1	0.0	0.1	3.5	66.4
	HI240	70	6	0.1	0.0	1.2	1.6	4.8	34.0	1.6	1.7	8.2	0.3	0.0	6.1	41.1
	HI242	250	25	0.0	0.1	1.1	0.7	1.9	9.3	0.5	0.5	1.6	0.2	0.3	2.7	81.3
	HI243	150	25	0.0	0.0	0.8	1.3	2.0	14.0	0.4	0.6	2.3	0.1	0.2	3.6	74.3
	HI244	1500	150	0.1	0.1	1.3	1.2	6.5	30.0	1.3	2.4	8.9	0.2	0.2	4.2	44.1
	HI245	30	15	0.2	0.1	1.1	2.4	4.1	29.0	2.2	1.6	5.9	0.2	0.0	5.8	47.1
	mean	253	51	0.1	0.1	0.9	1.2	3.1	19.3	1.0	1.1	4.5	0.1	0.1	3.9	64.8
960002		10	5	0.0	0.0	0.6	n.s.	0.4	16.0	5.8	0.2	0.6	0.0	ns	0.4	76.6
Bedford Sq. Gardens: fireplate		10	5	0.1	0.0	0.5	n.s.	0.4	8.4	6.4	0.2	0.9	0.0	ns	0.2	83.2
Ferritic iron, 5% slag		6	4	0.0	0.0	0.2	n.s.	0.0	10.1	0.3	0.0	0.1	0.0	ns	0.0	89.1
		8	8	0.1	0.0	0.2	n.s.	0.2	10.6	1.4	0.1	0.3	0.0	ns	0.0	87.0
1779	mean	9	6	0.1	0.0	0.4	n.s.	0.2	11.3	3.5	0.1	0.5	0.0	ns	0.2	84.0
960004		16	6	0.0	0.0	0.5	n.s.	0.5	12.5	1.7	0.3	2.1	0.1	ns	0.6	82.3
Portsmouth: fireplate		12	8	0.0	0.0	0.4	n.s.	0.6	16.7	2.2	0.2	2.0	0.0	ns	0.5	77.5
Ferritic iron, 10% slag		10	8	0.0	0.0	0.4	n.s.	0.2	4.2	8.1	0.0	1.2	0.0	ns	n.d.	86.0
		6	4	0.0	0.0	0.3	n.s.	0.2	4.5	9.8	0.0	0.5	0.0	ns	1.4	83.4
1779		16	5	0.0	0.0	0.3	n.s.	0.3	12.9	5.9	0.1	0.5	0.0	ns	0.1	79.8
	mean	12	6	0.0	0.0	0.4	n.s	0.3	10.2	5.5	0.1	1.2	0.0	ns	0.7	81.8
950012		12	6	0.3	0.0	0.3	n.s.	1.0	6.5	16.6	0.1	0.3	0.0	ns	1.1	73.6
Norbury Park: fireplate		18	6	0.2	0.0	0.3	n.s.	0.4	4.6	8.4	0.1	0.2	0.0	ns	0.8	85.1
Ferritic iron, 2% slag		8	8	0.0	0.0	0.4	n.s.	0.3	5.9	10.8	0.1	0.3	0.0	ns	0.6	81.7
		12	6	0.0	0.0	0.6	n.s.	0.3	8.1	12.4	0.0	0.2	0.0	ns	0.6	78.0
1779		9	7	0.0	0.0	0.4	n.s.	1.4	7.3	16.2	0.0	3.6	0.0	ns	0.9	70.2
	mean	12	7	0.1	0.0	0.4	n.s.	0.7	6.5	12.9	0.0	0.9	0.0	ns	0.8	77.2
960018	HI208	150	100	0.1	0.0	0.7	0.0	1.3	11.0	2.3	0.0	0.1	0.5	0.4	3.8	79.3
50 Portland Place: stair balustrade	HI209	200	70	0.1	0.1	0.5	0.1	1.3	22.0	4.2	0.2	0.2	0.3	0.1	6.5	64.6
Ferritic Iron, 5% slag	HI210	80	80	0.2	0.1	0.5	0.0	1.4	15.0	3.1	0.2	0.3	0.3	0.1	4.7	73.9
	HI211	140	50	0.2	0.0	0.8	0.0	0.6	18.0	3.2	0.1	0.2	0.2	0.0	3.0	73.7
1782	HI213	160	160	0.5	0.0	0.8	0.0	0.6	6.4	4.1	0.0	0.0	0.1	0.1	1.2	86.3
	HI214	180	10	0.2	0.1	0.3	0.3	2.3	23.0	3.9	0.2	0.3	0.3	0.2	6.2	62.7
	HI215	200	10	0.3	0.1	0.5	0.1	1.8	18.0	7.0	0.3	0.2	0.2	0.0	5.3	66.0
	HI217	100	15	0.0	0.0	0.3	0.1	3.3	4.3	1.5	0.0	0.1	0.0	0.0	1.1	89.1
	HI218	120	20	0.3	0.1	0.3	0.0	1.7	19.0	6.7	0.1	0.3	0.1	0.0	4.8	66.2
	HI219	25	10	0.0	0.1	0.6	0.0	1.0	15.0	11.1	0.3	0.6	0.0	0.1	2.6	68.6
	mean	136	53	0.2	0.1	0.5	0.0	1.5	15.2	4.7	0.1	0.2	0.2	0.1	3.9	73.0

Sample details	Inclusion			Composition weight %												
	AML ref.	length (μm)	width (μm)	S	Cl	Na_2O	MgO	Al_2O_3	SiO_2	P_2O_5	K_2O	CaO	TiO_2	V_2O_3	MnO	FeO
960021	HI246	20	15	0.1	0.0	0.7	1.6	3.6	31.0	2.5	1.5	6.9	0.1	0.0	0.8	51.3
Lindsay House: upright	HI249	80	20	0.1	0.1	0.5	0.9	1.6	10.0	0.9	0.5	2.0	0.1	0.1	0.5	82.6
Ferritic iron / steel, <1% slag	HI250	100	15	0.2	0.1	0.5	0.9	1.2	11.0	0.9	0.5	2.7	0.0	0.1	0.7	81.5
	HI251	20	10	0.1	0.0	0.8	2.9	5.1	41.0	1.6	2.6	9.3	0.2	0.3	1.6	34.5
1799	mean	55	15	0.1	0.1	0.6	1.6	2.9	23.3	1.5	1.3	5.2	0.1	0.1	0.9	62.5
960003		10	2	n.d	0.0	0.2	n.s.	1.1	11.2	0.5	0.2	0.2	0.4	ns	5.7	80.5
Quarry Bank Mill: fireplate		10	10	0.5	0.0	0.2	n.s.	0.6	12.7	5.9	0.1	0.1	0.3	ns	4.3	75.6
Ferritic iron 3% slag		6	6	0.5	0.0	0.3	n.s.	0.9	13.8	6.4	0.0	0.2	0.4	ns	5.7	72.0
		10	2	n.d	0.0	0.3	n.s.	0.8	11.2	5.6	0.1	0.1	0.0	ns	4.1	77.7
1799		10	6	0.4	0.0	0.2	n.s.	2.2	24.4	0.2	0.3	0.4	0.9	ns	12.7	58.7
	mean	9	5	0.4	0.0	0.2	n.s.	1.1	14.6	3.7	0.1	0.2	0.4	ns	6.5	72.9
960019	HI221	300	50	0.5	0.1	0.5	0.0	1.3	11.0	6.5	0.0	0.3	0.0	0.3	1.8	77.8
5 Knightsbridge: railing	HI222	90	10	0.4	0.0	0.5	0.2	1.4	8.0	3.7	0.1	0.3	0.0	0.1	1.6	83.6
Phosphoric iron, 3% slag	HI223	50	30	0.4	0.0	0.5	0.2	1.4	8.0	3.7	0.1	0.3	0.0	0.1	1.6	83.6
	HI224	100	25	0.5	0.0	1.1	0.4	2.5	15.0	6.0	0.1	0.2	0.3	0.0	1.7	72.1
1799	HI226	300	200	0.3	0.0	1.1	0.0	2.4	12.0	4.9	0.1	0.3	0.3	0.0	1.7	77.2
	HI228	300	70	1.0	0.0	0.7	0.1	1.5	11.0	5.1	0.1	0.4	0.1	0.2	2.1	78.3
	HI229	200	30	0.3	0.1	0.5	0.2	1.4	7.5	4.4	0.0	0.1	0.1	0.2	1.3	83.8
	HI230	70	30	0.4	0.1	0.3	0.1	1.7	14.0	5.9	0.1	0.4	0.0	0.2	2.7	74.2
	HI231	50	20	0.4	0.0	0.3	0.2	1.8	7.4	3.3	0.1	0.1	0.2	0.3	1.6	84.3
	HI232	60	30	0.1	0.0	0.4	0.2	1.4	13.0	6.3	0.1	0.3	0.2	0.1	2.4	75.6
	HI233	300	250	0.3	0.0	0.2	0.0	2.2	15.0	4.3	0.1	0.5	0.3	0.0	2.8	74.2
	mean	165	68	0.4	0.0	0.6	0.1	1.7	11.1	4.9	0.1	0.3	0.1	0.1	1.9	78.6
960022	HI253	70	60	0.2	0.0	0.7	0.2	0.9	8.2	0.9	0.1	0.0	0.1	0.0	0.2	88.5
Coventry Hall: stair upright	HI254	70	30	0.5	0.0	0.5	0.1	0.6	13.0	2.9	0.1	0.2	0.0	0.0	0.6	81.6
Ferritic iron, 3% slag	HI255	100	50	0.2	0.0	0.6	0.1	0.5	15.0	1.9	0.1	0.1	0.0	0.0	0.5	81.4
	HI256	70	60	0.2	0.0	0.6	0.0	0.5	8.1	1.4	0.1	0.0	0.1	0.1	0.5	88.4
1800	HI257	70	60	0.2	0.1	0.7	0.0	1.2	28.0	0.8	0.8	0.1	0.1	0.1	0.8	67.5
	HI258	70	40	0.1	0.0	0.3	0.1	0.5	6.5	0.9	0.1	0.0	0.1	0.0	0.4	91.0
	HI259	120	30	0.0	0.1	0.5	0.0	0.5	11.0	3.8	0.1	0.0	0.0	0.0	0.5	83.8
	HI260	100	40	0.3	0.1	0.7	0.1	0.6	9.5	2.4	0.1	0.0	0.1	0.0	0.4	85.6
	HI261	60	60	0.2	0.0	0.8	0.2	0.6	7.7	1.9	0.1	0.1	0.1	0.0	0.4	87.9
	HI262	30	30	0.4	0.0	0.6	0.2	1.3	24.0	2.7	0.8	0.1	0.1	0.1	1.8	67.7
	HI263	120	50	0.4	0.0	0.3	0.0	1.7	37.0	0.7	0.6	0.1	0.0	0.1	1.5	57.8
	HI264	250	60	0.3	0.1	0.6	0.1	1.5	28.0	0.9	0.5	0.0	0.1	0.0	1.4	67.0
	mean	94	48	0.3	0.0	0.6	0.1	0.9	16.3	1.8	0.3	0.1	0.1	0.0	0.8	79.0
960023	HI265	70	6	2.4	0.0	0.4	0.2	1.8	13.0	4.1	0.1	0.4	0.2	0.1	3.0	73.9
St Mary at Hill Church, washer	HI266	120	10	0.9	0.0	0.5	0.1	3.8	36.0	3.7	0.1	1.1	0.6	0.4	11.0	41.6
Phosphoric iron, 5% slag	HI267	70	30	0.7	0.1	0.7	0.6	9.9	49.0	1.0	0.6	2.5	1.1	0.2	15.0	18.7
	HI268	300	60	1.0	0.0	0.6	0.1	2.2	22.0	8.7	0.2	0.5	0.2	0.3	4.8	59.6
1822	HI269	200	30	0.2	0.0	0.5	0.1	0.7	7.3	11.9	0.0	1.5	0.0	0.1	1.7	75.9
	HI270	250	250	0.4	0.0	0.6	0.0	1.2	17.0	2.9	0.3	0.1	0.0	0.0	0.7	77.2
	HI272	70	30	0.3	0.0	0.6	0.1	1.7	14.0	6.6	0.1	0.1	0.1	0.1	2.3	74.1
	HI271	140	60	0.0	0.0	0.5	0.1	0.1	1.0	0.3	0.0	0.0	0.1	0.1	0.0	97.9
	HI273	200	60	0.4	0.1	0.5	0.0	0.6	7.5	8.3	0.1	0.5	0.0	0.1	1.3	80.5
	HI274	300	30	0.6	0.0	0.5	0.1	0.5	4.8	4.5	0.0	0.1	0.3	0.1	0.9	87.6
	HI275	200	40	0.4	0.1	0.6	0.2	0.7	8.8	5.5	0.2	0.3	0.1	0.0	1.4	81.8
	HI276	150	40	0.2	0.0	0.5	0.1	0.9	11.0	4.3	0.1	0.1	0.0	0.0	0.7	82.4
	mean	173	54	0.6	0.0	0.5	0.1	2.0	16.0	5.2	0.2	0.6	0.2	0.1	3.6	70.9

Sample details	Inclusion			Composition weight %												
	AML ref.	length (μm)	width (μm)	S	Cl	Na_2O	MgO	Al_2O_3	SiO_2	P_2O_5	K_2O	CaO	TiO_2	V_2O_3	MnO	FeO
960024 Mordon Grange, dog (staple) Ferritic iron/steel, 5% slag 1825	HI277	15	7	0.1	0.0	1.9	0.8	7.1	36.0	1.4	2.7	5.8	0.3	0.0	2.2	41.1
	HI278	300	60	0.0	0.1	1.1	1.2	3.0	31.0	0.8	1.2	2.9	0.2	0.0	2.7	56.1
	HI279	300	80	0.1	0.1	1.6	1.2	5.0	34.0	0.9	2.0	3.8	0.4	0.0	2.5	48.3
	HI280	80	80	0.2	0.1	1.1	1.2	4.3	33.0	0.9	1.4	2.6	0.2	0.1	2.9	51.9
	HI282	30	7	0.1	0.0	0.9	1.2	3.3	31.0	0.8	1.5	3.3	0.1	0.1	2.8	55.4
	HI283	120	20	0.1	0.0	1.1	0.9	4.4	34.0	0.9	2.3	3.9	0.2	0.2	2.9	49.7
	HI284	100	12	0.1	0.1	1.0	1.0	3.0	26.0	0.5	1.9	3.9	0.1	0.1	2.8	59.4
	HI285	50	10	0.0	0.0	1.2	1.4	4.7	38.0	0.6	1.8	4.0	0.2	0.2	3.4	45.0
	HI286	100	30	0.1	0.0	1.5	1.1	5.7	35.0	0.9	1.9	3.9	0.3	0.2	2.6	46.4
	HI287	120	40	0.1	0.0	1.4	1.3	4.5	36.0	0.5	1.6	3.6	0.2	0.0	2.9	47.5
	HI288	20	10	0.1	0.1	1.2	1.5	4.2	35.0	0.7	1.4	3.3	0.2	0.1	3.0	49.1
	mean	112	32	0.1	0.0	1.3	1.2	4.5	33.5	0.8	1.8	3.7	0.2	0.1	2.8	50.0
960025 23 Onslow Gardens: balcony rail leaf Ferritic/ phosphoric iron, <1-2% slag 1872	HI289	12	12	0.1	0.1	0.4	0.3	0.4	2.2	1.6	0.1	1.0	0.0	0.0	0.6	93.2
	HI290	30	15	0.1	0.1	0.7	0.5	0.3	2.4	2.8	0.1	1.0	0.1	0.1	0.8	91.3
	HI291	30	30	0.1	0.1	0.6	0.4	0.6	6.3	1.8	0.2	1.0	0.0	0.1	0.9	88.0
	HI292	100	60	0.1	0.0	0.3	0.5	0.4	1.8	3.8	0.3	2.1	0.0	0.0	0.5	90.1
	HI293	30	30	0.0	0.0	0.5	0.4	0.4	2.1	3.4	0.0	0.6	0.1	0.0	0.5	92.1
	HI294	100	10	0.2	0.1	0.6	0.2	0.6	4.1	16.6	0.1	1.1	0.1	0.2	0.8	75.4
	HI295	10	10	0.1	0.1	0.5	0.0	0.0	0.1	7.7	0.0	0.0	0.0	0.1	0.3	91.2
	HI297	30	10	1.6	0.1	0.4	0.1	0.1	0.8	27.7	0.1	0.7	0.0	0.0	0.8	67.5
	mean	43	22	0.3	0.1	0.5	0.3	0.4	2.5	8.2	0.1	0.9	0.0	0.1	0.7	86.1
950006 Albert Memorial: bolt Phosphoric iron, 10% slag 1876	HI001	200	50	0.4	0.1	0.5	1.2	0.8	13.0	14.5	0.0	2.9	0.3	0.6	4.8	61.1
	HI002	150	60	0.4	0.1	0.4	1.2	0.9	19.0	12.3	0.1	1.7	0.2	0.2	5.3	58.0
	HI003	300	10	1.4	0.1	0.5	1.1	1.6	21.0	6.3	0.2	2.3	0.5	0.6	4.7	59.3
	HI004	50	6	0.7	0.1	0.5	0.8	0.8	6.4	13.3	0.1	6.1	0.1	0.2	2.4	68.6
	HI005	250	70	0.2	0.0	0.5	1.6	0.9	19.0	9.8	0.1	1.5	0.1	0.3	4.7	61.3
	HI006	150	20	0.4	0.1	0.5	1.2	1.0	14.0	12.9	0.0	1.9	0.2	0.5	4.6	62.6
	HI007	80	20	0.3	0.1	0.2	1.1	2.0	21.0	9.8	0.1	1.6	0.3	0.5	4.9	58.7
	HI009	60	60	0.5	0.0	0.4	0.9	0.9	20.0	9.2	0.0	1.5	0.1	0.2	4.9	61.3
	HI010	120	70	0.3	0.0	0.5	1.2	0.7	17.0	7.9	0.2	1.4	0.1	0.6	4.7	65.7
	HI014	120	100	0.6	0.0	0.5	0.7	0.7	6.2	5.4	0.0	0.8	0.2	0.9	2.8	81.1
	mean	148	47	0.5	0.1	0.5	1.1	1.0	15.7	10.1	0.1	2.2	0.2	0.5	4.4	63.8
950007 Albert Memorial: bolt Phosphoric iron, 12% slag 1876	HI018	120	30	0.3	0.0	0.5	1.3	1.4	14.0	5.3	0.0	2.3	0.2	0.2	4.1	70.5
	HI019	500	50	0.6	0.0	0.3	1.6	2.1	23.0	4.0	0.6	3.0	0.3	0.1	5.5	58.9
	HI020	100	25	0.8	0.1	0.5	1.3	1.3	14.0	5.8	0.0	2.3	0.2	0.2	4.1	69.9
	HI021	40	6	0.3	0.0	0.6	1.4	1.7	14.0	7.9	0.2	2.6	0.3	0.0	3.8	67.0
	HI022	50	15	1.2	0.1	0.2	0.9	3.0	7.7	2.6	0.0	0.9	0.2	0.0	1.9	81.3
	HI023	30	6	0.1	0.1	0.2	1.8	2.0	18.0	6.5	0.2	1.9	0.4	0.1	4.3	64.1
	HI024	7	6	0.2	0.1	0.5	1.1	0.9	22.0	2.1	0.1	1.4	0.4	0.1	4.1	66.9
	HI025	80	40	0.4	0.0	0.5	1.6	2.1	20.0	4.8	0.1	3.3	0.3	0.0	5.6	61.6
	HI026	5	4	0.2	0.0	0.4	1.7	1.8	17.0	4.4	0.0	2.0	0.1	0.0	3.4	69.4
	HI027	20	9	0.3	0.0	0.5	1.3	1.7	17.0	4.1	0.1	2.1	0.1	0.1	4.3	68.8
	HI028	130	30	0.4	0.1	0.3	1.9	1.7	19.0	4.6	0.0	1.6	0.2	0.0	4.6	66.1
	HI029	6	6	0.1	0.0	0.3	0.8	1.6	10.0	8.9	0.4	3.6	0.4	0.1	6.1	67.6
	mean	91	19	0.4	0.0	0.4	1.4	1.8	16.3	5.1	0.1	2.3	0.3	0.1	4.3	67.7
960026 Avery Hill College: water leaf from gates Mild steel <1% slag 1891	HI298	15	4	3.3	0.0	0.3	0.0	0.1	26.0	0.2	0.0	0.0	0.4	0.0	64.0	6.0
	HI299	10	3	4.6	0.0	0.1	0.0	0.1	20.0	0.7	0.0	0.0	0.3	0.1	66.0	8.8
	HI301	30	10	30.0	0.0	0.0	0.0	0.3	0.1	0.0	0.0	0.0	0.0	0.0	66.0	3.6
	HI302	40	10	0.5	0.0	0.4	0.6	8.0	38.0	0.3	0.8	2.9	0.9	0.0	40.0	7.2
	HI303	25	7	0.1	0.1	0.2	0.0	0.2	30.0	0.0	0.0	0.0	0.0	0.0	64.0	5.0
	HI304	25	15	0.0	0.0	0.3	0.2	0.1	30.0	0.0	0.1	0.0	0.0	0.2	66.0	4.2
	HI305	8	4	4.5	0.0	0.5	0.1	0.2	19.0	0.0	0.0	0.1	0.0	0.0	67.0	8.8
	HI306	30	6	4.2	0.0	0.3	0.0	0.0	23.0	0.2	0.0	0.0	0.2	0.2	68.0	3.7
	HI307	20	5	2.3	0.0	0.2	0.0	0.1	28.0	0.0	0.0	0.1	1.0	0.1	65.0	3.1
	HI308	9	9	2.9	0.0	0.2	0.1	0.0	26.0	0.6	0.0	0.0	0.4	0.1	67.0	2.7
	mean	21	7	5.2	0.0	0.3	0.1	0.9	24.0	0.2	0.1	0.3	0.3	0.1	63.3	5.3

ns = not sought   nd = not detected

Appendix III SEM (WDX) analyses of iron matices in historical iron samples (date order)

Sample details	Oxford Lab ref.		Composition wt%											
	sample	spec.	Si	P	S	Mn	Co	Ni	Cu	As	Ti	V	Cr	Zn
950009 Castle Hedlingham window grill before 1200	3302EH	1891	0.004	0.196	0.025	0.001	0.014	0.080	0.466	0.126	0.002	0.000	0.002	0.005
	3302EH	1892	0.005	0.189	0.027	0.000	0.021	0.084	0.454	0.137	0.001	0.000	0.002	0.000
	3302EH	1893	0.002	0.174	0.017	0.000	0.014	0.076	0.347	0.103	0.000	0.002	0.004	0.000
	3302EH	1894	0.004	0.181	0.019	0.005	0.002	0.076	0.332	0.116	0.000	0.002	0.000	0.006
	3302EH	1895	0.005	0.180	0.019	0.000	0.000	0.090	0.391	0.131	0.000	0.002	0.003	0.011
	3302EH	1896	0.004	0.180	0.015	0.000	0.009	0.085	0.356	0.125	0.000	0.002	0.001	0.008
	3302EH	1897	0.003	0.175	0.016	0.001	0.007	0.075	0.438	0.118	0.001	0.001	0.000	0.000
	3302EH	1898	0.003	0.161	0.011	0.000	0.012	0.075	0.326	0.138	0.002	0.002	0.005	0.002
	3302EH	1899	0.002	0.207	0.015	0.002	0.020	0.077	0.364	0.106	0.000	0.000	0.000	0.000
	3302EH	1900	0.005	0.163	0.015	0.000	0.013	0.067	0.382	0.107	0.000	0.000	0.003	0.000
	3302EH	1901	0.003	0.160	0.015	0.000	0.015	0.078	0.410	0.123	0.000	0.001	0.002	0.000
	mean		0.004	0.179	0.018	0.001	0.012	0.078	0.388	0.121	0.001	0.001	0.002	0.003
960005 Windsor Castle drain grill before 1400	3303EH	1902	0.073	0.018	0.007	0.009	0.000	0.013	0.049	0.031	0.003	0.000	0.000	0.000
	3303EH	1903	0.049	0.015	0.006	0.005	0.000	0.017	0.048	0.000	0.002	0.002	0.002	0.003
	3303EH	1904	0.038	0.015	0.004	0.000	0.004	0.012	0.036	0.000	0.000	0.004	0.000	0.000
	3303EH	1905	0.037	0.020	0.004	0.000	0.000	0.015	0.036	0.000	0.000	0.000	0.002	0.000
	3303EH	1906	0.029	0.018	0.004	0.004	0.002	0.011	0.041	0.000	0.000	0.000	0.000	0.001
	3303EH	1907	0.115	0.022	0.008	0.010	0.002	0.014	0.038	0.040	0.000	0.000	0.000	0.000
	3303EH	1908	0.015	0.020	0.008	0.000	0.000	0.006	0.034	0.000	0.000	0.000	0.002	0.000
	3303EH	1909	0.015	0.022	0.007	0.009	0.001	0.004	0.043	0.000	0.001	0.001	0.000	0.000
	3303EH	1910	0.102	0.027	0.010	0.000	0.000	0.009	0.054	0.048	0.001	0.000	0.000	0.000
	3303EH	1911	0.041	0.028	0.004	0.003	0.006	0.020	0.057	0.020	0.000	0.000	0.002	0.000
	3303EH	1912	0.016	0.026	0.007	0.003	0.002	0.012	0.041	0.010	0.000	0.003	0.000	0.000
	3303EH	1913	0.007	0.019	0.006	0.002	0.001	0.009	0.034	0.000	0.002	0.000	0.000	0.010
	3303EH	1914	0.024	0.036	0.003	0.000	0.000	0.008	0.034	0.000	0.003	0.000	0.000	0.000
	3303EH	1915	0.021	0.017	0.006	0.002	0.003	0.020	0.046	0.000	0.000	0.000	0.000	0.000
	3303EH	1916	0.009	0.010	0.003	0.000	0.000	0.024	0.031	0.011	0.000	0.000	0.001	0.000
	3303EH	1917	0.063	0.015	0.023	0.015	0.001	0.011	0.053	0.000	0.001	0.000	0.000	0.000
	3303EH	1918	0.087	0.018	0.022	0.021	0.010	0.011	0.053	0.000	0.000	0.000	0.003	0.000
	3303EH	1919	0.037	0.018	0.011	0.011	0.007	0.012	0.047	0.000	0.000	0.002	0.000	0.001
	mean		0.043	0.020	0.008	0.005	0.002	0.013	0.043	0.009	0.001	0.001	0.001	0.001
960006 Great Yarmouth short wall tie 1560-1569	3304EH	1920	0.003	0.062	0.012	0.006	0.006	0.019	0.010	0.036	0.000	0.000	0.001	0.008
	3304EH	1921	0.023	0.054	0.029	0.007	0.000	0.017	0.000	0.000	0.001	0.000	0.000	0.000
	3304EH	1922	0.006	0.107	0.015	0.011	0.003	0.017	0.000	0.000	0.000	0.000	0.002	0.001
	3304EH	1923	0.005	0.109	0.014	0.005	0.000	0.012	0.003	0.000	0.004	0.002	0.000	0.000
	3304EH	1924	0.012	0.053	0.022	0.006	0.003	0.013	0.000	0.000	0.003	0.001	0.005	0.004
	3304EH	1925	0.005	0.064	0.014	0.003	0.000	0.021	0.000	0.000	0.000	0.000	0.000	0.000
	3304EH	1926	0.046	0.086	0.051	0.049	0.006	0.016	0.006	0.000	0.003	0.002	0.002	0.000
	3304EH	1927	0.093	0.126	0.047	0.082	0.000	0.013	0.000	0.000	0.000	0.002	0.001	0.000
	3304EH	1928	0.013	0.101	0.034	0.037	0.003	0.014	0.008	0.000	0.000	0.000	0.000	0.008
	3304EH	1929	0.011	0.029	0.006	0.006	0.006	0.044	0.015	0.065	0.000	0.000	0.000	0.000
	3304EH	1931	0.006	0.042	0.004	0.009	0.007	0.035	0.007	0.002	0.003	0.000	0.000	0.023
	3304EH	1932	0.000	0.015	0.007	0.001	0.008	0.040	0.020	0.000	0.001	0.003	0.002	0.000
	3304EH	1933	0.002	0.008	0.007	0.001	0.009	0.047	0.025	0.000	0.000	0.001	0.002	0.000
	mean		0.017	0.066	0.020	0.017	0.004	0.024	0.007	0.008	0.001	0.001	0.001	0.003
960007 Great Yarmouth short wall tie 1601	3305EH	1934	0.009	0.018	0.004	0.004	0.010	0.032	0.116	0.000	0.000	0.000	0.000	0.001
	3305EH	1935	0.005	0.031	0.006	0.003	0.004	0.021	0.115	0.001	0.001	0.000	0.001	0.000
	3305EH	1936	0.010	0.024	0.012	0.003	0.001	0.013	0.152	0.000	0.001	0.005	0.001	0.003
	3305EH	1937	0.003	0.016	0.001	0.004	0.005	0.020	0.099	0.014	0.000	0.000	0.000	0.001
	3305EH	1938	0.015	0.027	0.007	0.002	0.002	0.016	0.142	0.000	0.000	0.004	0.002	0.000
	3305EH	1939	0.006	0.019	0.004	0.000	0.000	0.013	0.102	0.020	0.000	0.005	0.001	0.000
	3305EH	1940	0.009	0.010	0.005	0.000	0.002	0.017	0.117	0.000	0.000	0.000	0.000	0.000
	3305EH	1941	0.004	0.022	0.003	0.000	0.002	0.024	0.123	0.030	0.000	0.000	0.003	0.009

Sample details	Oxford Lab ref.		Composition wt%											
	sample	spec.	Si	P	S	Mn	Co	Ni	Cu	As	Ti	V	Cr	Zn
960007 cont.	3305EH	1942	0.009	0.020	0.006	0.006	0.000	0.016	0.092	0.008	0.000	0.000	0.000	0.002
	3305EH	1943	0.008	0.016	0.006	0.003	0.000	0.009	0.130	0.041	0.000	0.000	0.000	0.000
	3305EH	1944	0.008	0.011	0.010	0.010	0.006	0.012	0.093	0.000	0.000	0.000	0.001	0.000
	3305EH	1945	0.013	0.005	0.003	0.000	0.001	0.019	0.073	0.007	0.002	0.000	0.001	0.002
	3305EH	1946	0.014	0.004	0.005	0.000	0.002	0.012	0.074	0.000	0.003	0.001	0.003	0.001
	3305EH	1947	0.009	0.000	0.004	0.008	0.007	0.020	0.064	0.021	0.000	0.000	0.000	0.000
	mean		0.009	0.016	0.005	0.003	0.003	0.017	0.107	0.010	0.001	0.001	0.001	0.001
960008		2424	0.008	0.065	0.007	0.004	0.000	0.011	0.000	0.051	0.000	0.001	0.001	0.006
Great Yarmouth		2425	0.004	0.040	0.004	0.003	0.000	0.018	0.000	0.000	0.000	0.001	0.001	0.011
short wall tie		2426	0.006	0.055	0.006	0.001	0.005	0.022	0.002	0.000	0.000	0.001	0.000	0.004
		2427	0.115	0.057	0.024	0.073	0.016	0.011	0.002	0.020	0.001	0.002	0.002	0.003
1637		2428	0.007	0.028	0.004	0.008	0.000	0.019	0.004	0.000	0.000	0.000	0.000	0.011
		2429	0.029	0.143	0.010	0.008	0.004	0.014	0.007	0.005	0.000	0.000	0.005	0.000
		2430	0.012	0.058	0.019	0.015	0.000	0.013	0.000	0.000	0.003	0.002	0.001	0.021
		2431	0.012	0.024	0.009	0.012	0.009	0.016	0.000	0.039	0.000	0.000	0.001	0.000
		2432	0.017	0.142	0.008	0.011	0.000	0.024	0.004	0.054	0.004	0.003	0.003	0.011
		2433	0.023	0.082	0.011	0.009	0.000	0.020	0.006	0.000	0.000	0.000	0.001	0.000
		2434	0.007	0.074	0.005	0.000	0.007	0.018	0.001	0.000	0.000	0.003	0.002	0.007
		2435	0.004	0.111	0.007	0.006	0.004	0.016	0.008	0.031	0.000	0.000	0.002	0.000
		2436	0.007	0.147	0.008	0.003	0.000	0.024	0.011	0.000	0.000	0.000	0.001	0.000
		2437	0.012	0.115	0.009	0.003	0.000	0.013	0.004	0.004	0.000	0.003	0.000	0.008
		2438	0.007	0.138	0.009	0.004	0.000	0.011	0.010	0.011	0.002	0.003	0.001	0.006
		2439	0.055	0.068	0.015	0.023	0.002	0.010	0.000	0.000	0.002	0.000	0.001	0.004
	mean		0.020	0.084	0.010	0.011	0.003	0.016	0.004	0.013	0.001	0.001	0.001	0.006
960009	3306EH	1948	0.005	0.093	0.003	0.001	0.011	0.017	0.015	0.000	0.000	0.003	0.000	0.006
Great Yarmouth mean	3306EH	1949	0.004	0.143	0.004	0.003	0.002	0.009	0.022	0.025	0.000	0.001	0.000	0.015
short wall tie	3306EH	1950	0.008	0.198	0.007	0.000	0.003	0.015	0.020	0.074	0.000	0.000	0.000	0.014
	3306EH	1951	0.002	0.178	0.004	0.000	0.001	0.010	0.018	0.000	0.002	0.001	0.000	0.000
1651	3306EH	1952	0.006	0.147	0.005	0.000	0.007	0.019	0.014	0.000	0.003	0.001	0.000	0.000
	3306EH	1953	0.005	0.150	0.003	0.001	0.000	0.004	0.023	0.000	0.000	0.000	0.000	0.007
	3306EH	1954	0.006	0.116	0.005	0.000	0.006	0.008	0.014	0.000	0.003	0.000	0.001	0.008
	3306EH	1955	0.008	0.122	0.005	0.006	0.004	0.011	0.004	0.015	0.000	0.000	0.002	0.012
	3306EH	1956	0.013	0.123	0.006	0.000	0.010	0.005	0.010	0.034	0.000	0.000	0.001	0.000
	3306EH	1957	0.001	0.087	0.000	0.005	0.004	0.018	0.013	0.022	0.000	0.000	0.000	0.007
	3306EH	1958	0.006	0.137	0.001	0.001	0.007	0.013	0.012	0.019	0.000	0.001	0.001	0.022
	3306EH	1959	0.001	0.153	0.003	0.003	0.005	0.009	0.005	0.005	0.000	0.001	0.000	0.000
	3306EH	1960	0.007	0.103	0.004	0.003	0.017	0.015	0.017	0.000	0.000	0.004	0.000	0.000
	3306EH	1961	0.008	0.157	0.006	0.000	0.010	0.017	0.020	0.000	0.002	0.000	0.000	0.004
	mean		0.006	0.136	0.004	0.002	0.006	0.012	0.015	0.014	0.001	0.001	0.000	0.007
960010	3307EH	1962	0.004	0.024	0.007	0.004	0.006	0.014	0.017	0.000	0.000	0.000	0.000	0.000
Great Yarmouth	3307EH	1963	0.007	0.027	0.008	0.001	0.005	0.014	0.030	0.000	0.000	0.001	0.000	0.003
short wall tie	3307EH	1964	0.000	0.024	0.005	0.000	0.006	0.007	0.025	0.009	0.000	0.000	0.001	0.003
	3307EH	1965	0.003	0.041	0.012	0.002	0.004	0.020	0.055	0.000	0.000	0.000	0.001	0.017
1691	3307EH	1966	0.017	0.047	0.011	0.000	0.007	0.017	0.021	0.000	0.000	0.000	0.002	0.012
	3307EH	1967	0.007	0.059	0.016	0.011	0.000	0.013	0.024	0.000	0.000	0.001	0.000	0.017
	3307EH	1968	0.007	0.022	0.007	0.004	0.000	0.002	0.012	0.012	0.000	0.000	0.000	0.025
	3307EH	1969	0.003	0.036	0.005	0.000	0.004	0.023	0.038	0.000	0.000	0.000	0.000	0.001
	3307EH	1970	0.009	0.018	0.006	0.007	0.004	0.017	0.043	0.004	0.000	0.000	0.002	0.000
	3307EH	1971	0.004	0.047	0.010	0.000	0.006	0.030	0.061	0.000	0.000	0.000	0.002	0.015
	3307EH	1972	0.004	0.037	0.009	0.000	0.010	0.022	0.064	0.031	0.000	0.000	0.000	0.010
	3307EH	1973	0.007	0.031	0.004	0.000	0.004	0.024	0.035	0.000	0.000	0.000	0.001	0.009
	mean		0.006	0.034	0.008	0.002	0.005	0.017	0.035	0.005	0.000	0.000	0.001	0.009

Sample details	Oxford Lab ref.		Composition wt%											
	sample	spec.	Si	P	S	Mn	Co	Ni	Cu	As	Ti	V	Cr	Zn
960012 Trinity Chapel hook for window hinge 1694		2440	0.007	0.066	0.009	0.000	0.001	0.008	0.035	0.000	0.000	0.000	0.000	0.000
		2441	0.010	0.087	0.005	0.000	0.003	0.018	0.032	0.000	0.000	0.003	0.002	0.000
		2442	0.010	0.070	0.007	0.000	0.005	0.022	0.044	0.027	0.004	0.002	0.001	0.000
		2443	0.008	0.043	0.005	0.000	0.007	0.012	0.030	0.000	0.000	0.000	0.000	0.004
		2444	0.005	0.050	0.004	0.000	0.004	0.005	0.023	0.000	0.002	0.000	0.000	0.004
		2445	0.010	0.070	0.005	0.000	0.007	0.019	0.028	0.000	0.000	0.002	0.001	0.000
		2446	0.006	0.070	0.006	0.003	0.000	0.013	0.031	0.000	0.000	0.002	0.000	0.000
		2447	0.011	0.084	0.006	0.004	0.007	0.011	0.037	0.000	0.001	0.000	0.001	0.000
		2448	0.006	0.090	0.008	0.000	0.003	0.019	0.046	0.039	0.000	0.000	0.001	0.000
		2449	0.011	0.068	0.004	0.002	0.012	0.025	0.024	0.000	0.001	0.002	0.000	0.000
		2450	0.010	0.070	0.007	0.000	0.000	0.010	0.035	0.000	0.000	0.003	0.000	0.002
		2451	0.008	0.110	0.006	0.001	0.001	0.018	0.042	0.000	0.000	0.003	0.000	0.000
		2452	0.012	0.098	0.005	0.003	0.000	0.016	0.037	0.000	0.000	0.000	0.000	0.000
		2453	0.055	0.068	0.007	0.000	0.000	0.016	0.035	0.000	0.000	0.001	0.000	0.000
	mean		0.012	0.075	0.006	0.001	0.004	0.015	0.034	0.005	0.001	0.001	0.000	0.001
960011 Rangers House holdfast 1699	3308EH	1974	0.028	0.030	0.007	0.006	0.002	0.010	0.024	0.000	0.002	0.001	0.000	0.000
	3308EH	1975	0.012	0.031	0.006	0.000	0.010	0.006	0.026	0.000	0.000	0.003	0.001	0.011
	3308EH	1976	0.002	0.020	0.005	0.000	0.002	0.009	0.018	0.028	0.001	0.000	0.000	0.008
	3308EH	1977	0.003	0.024	0.003	0.001	0.001	0.016	0.022	0.004	0.003	0.000	0.001	0.000
	3308EH	1978	0.008	0.011	0.004	0.003	0.007	0.007	0.022	0.000	0.000	0.000	0.000	0.000
	3308EH	1979	0.003	0.026	0.004	0.000	0.001	0.012	0.011	0.000	0.000	0.000	0.000	0.000
	3308EH	1980	0.013	0.026	0.009	0.000	0.000	0.024	0.019	0.000	0.000	0.000	0.002	0.002
	3308EH	1981	0.007	0.035	0.006	0.002	0.007	0.006	0.028	0.000	0.000	0.000	0.003	0.000
	3308EH	1982	0.005	0.021	0.004	0.005	0.003	0.009	0.031	0.001	0.000	0.003	0.001	0.000
	3308EH	1983	0.004	0.014	0.008	0.000	0.006	0.025	0.025	0.000	0.000	0.000	0.000	0.010
	mean		0.009	0.024	0.006	0.002	0.004	0.012	0.023	0.003	0.001	0.001	0.001	0.003
960014 Greenwich Naval College down pipe bracket 1729	3309EH	1984	0.011	0.009	0.007	0.000	0.000	0.020	0.000	0.000	0.002	0.001	0.001	0.007
	3309EH	1985	0.006	0.013	0.000	0.000	0.000	0.002	0.001	0.000	0.003	0.000	0.000	0.000
	3309EH	1986	0.005	0.015	0.004	0.002	0.006	0.018	0.001	0.000	0.000	0.003	0.001	0.000
	3309EH	1987	0.032	0.030	0.007	0.004	0.000	0.009	0.014	0.000	0.000	0.000	0.000	0.000
	3309EH	1988	0.003	0.023	0.007	0.000	0.004	0.011	0.000	0.031	0.000	0.000	0.000	0.000
	3309EH	1989	0.007	0.027	0.009	0.004	0.006	0.016	0.013	0.001	0.000	0.000	0.000	0.000
	3309EH	1990	0.002	0.023	0.003	0.004	0.000	0.020	0.000	0.000	0.000	0.003	0.001	0.000
	3309EH	1991	0.004	0.010	0.001	0.001	0.000	0.014	0.005	0.000	0.000	0.001	0.002	0.000
	3309EH	1992	0.007	0.013	0.003	0.001	0.004	0.012	0.000	0.000	0.000	0.001	0.000	0.000
	mean		0.009	0.018	0.005	0.002	0.002	0.014	0.004	0.004	0.001	0.001	0.001	0.001
960015 Milton House gate 1729	EH22	2474	0.030	0.022	0.006	0.006	0.001	0.008	0.003	0.021	0.000	0.000	0.002	0.004
	EH22	2475	0.047	0.018	0.012	0.003	0.000	0.006	0.005	0.000	0.002	0.000	0.000	0.010
	EH22	2476	0.064	0.018	0.008	0.027	0.005	0.000	0.016	0.015	0.000	0.001	0.001	0.000
	EH22	2477	0.031	0.011	0.004	0.005	0.007	0.000	0.007	0.046	0.000	0.000	0.000	0.000
	EH22	2478	0.025	0.013	0.005	0.010	0.000	0.001	0.001	0.000	0.000	0.000	0.000	0.000
	EH22	2479	0.033	0.015	0.004	0.009	0.004	0.009	0.003	0.078	0.000	0.000	0.001	0.015
	EH22	2480	0.023	0.016	0.006	0.009	0.000	0.006	0.004	0.000	0.000	0.001	0.003	0.000
	EH22	2481	0.064	0.035	0.026	0.028	0.002	0.019	0.000	0.049	0.000	0.002	0.000	0.000
	EH22	2482	0.082	0.029	0.020	0.025	0.000	0.007	0.000	0.018	0.001	0.002	0.000	0.00m
			0.044	0.020	0.010	0.014	0.002	0.006	0.004	0.025	0.000	0.001	0.001	0.003
960016 Fournier St. Mosque balcony support 1743	3310EH	1993	0.003	0.057	0.013	0.006	0.027	0.011	0.266	0.026	0.000	0.002	0.000	0.000
	3310EH	1995	0.024	0.035	0.012	0.006	0.022	0.009	0.192	0.000	0.000	0.002	0.000	0.000
	3310EH	1996	0.022	0.093	0.018	0.019	0.017	0.009	0.122	0.000	0.000	0.001	0.002	0.000
	3310EH	1997	0.005	0.042	0.011	0.005	0.015	0.007	0.198	0.000	0.000	0.000	0.000	0.000
	3310EH	1998	0.011	0.042	0.012	0.011	0.022	0.013	0.161	0.000	0.000	0.000	0.000	0.000
	3310EH	1999	0.112	0.012	0.006	0.020	0.002	0.016	0.024	0.000	0.000	0.000	0.000	0.000
	3310EH	2000	0.002	0.035	0.004	0.003	0.006	0.010	0.031	0.050	0.001	0.000	0.001	0.000

Sample details	Oxford Lab ref.		Composition wt%											
	sample	spec.	Si	P	S	Mn	Co	Ni	Cu	As	Ti	V	Cr	Zn
960016 cont.	3310EH	2002	0.002	0.054	0.002	0.000	0.005	0.013	0.016	0.113	0.000	0.001	0.000	0.006
	3310EH	2003	0.005	0.046	0.005	0.000	0.001	0.013	0.040	0.067	0.000	0.001	0.000	0.000
	3310EH	2004	0.002	0.058	0.001	0.006	0.007	0.008	0.016	0.010	0.001	0.000	0.000	0.000
	3310EH	2005	0.002	0.048	0.003	0.000	0.006	0.022	0.019	0.000	0.004	0.000	0.001	0.000
	3310EH	2006	0.001	0.014	0.002	0.000	0.013	0.018	0.029	0.070	0.000	0.001	0.001	0.000
	3310EH	2007	0.003	0.038	0.002	0.002	0.005	0.014	0.023	0.096	0.000	0.000	0.000	0.000
	3310EH	2008	0.001	0.031	0.006	0.004	0.004	0.008	0.027	0.000	0.002	0.000	0.002	0.000
	3310EH	2009	0.009	0.023	0.003	0.006	0.006	0.008	0.027	0.034	0.004	0.000	0.000	0.000
	3310EH	2010	0.013	0.020	0.006	0.009	0.018	0.012	0.122	0.000	0.000	0.004	0.001	0.021
	3310EH	2011	0.036	0.039	0.015	0.023	0.014	0.014	0.139	0.014	0.000	0.000	0.000	0.003
	mean		0.015	0.040	0.007	0.007	0.011	0.012	0.085	0.028	0.001	0.001	0.000	0.002
960017 1 Bloomsbury St. Stair ballustrade 1770	EH23	2483	0.017	0.112	0.011	0.013	0.025	0.042	0.115	0.000	0.000	0.001	0.000	0.000
	EH23	2484	0.016	0.100	0.008	0.002	0.018	0.028	0.106	0.000	0.006	0.001	0.003	0.000
	EH23	2485	0.019	0.101	0.008	0.009	0.022	0.033	0.122	0.000	0.000	0.000	0.003	0.000
	EH23	2486	0.008	0.084	0.002	0.000	0.024	0.026	0.080	0.000	0.000	0.000	0.000	0.000
	EH23	2487	0.014	0.142	0.003	0.004	0.019	0.037	0.108	0.000	0.001	0.002	0.000	0.000
	EH23	2488	0.017	0.142	0.007	0.003	0.030	0.023	0.109	0.039	0.001	0.001	0.000	0.014
	EH23	2489	0.016	0.116	0.009	0.002	0.028	0.040	0.127	0.001	0.000	0.002	0.000	0.004
	EH23	2490	0.017	0.084	0.003	0.001	0.029	0.028	0.122	0.037	0.002	0.000	0.002	0.002
	EH23	2491	0.017	0.055	0.006	0.000	0.013	0.021	0.096	0.000	0.004	0.003	0.000	0.006
	EH23	2492	0.011	0.089	0.008	0.001	0.025	0.022	0.096	0.000	0.000	0.000	0.005	0.000
	mean		0.015	0.103	0.007	0.004	0.023	0.030	0.108	0.008	0.001	0.001	0.001	0.003
960020 143 Upper Picadilly balcolny railing 1775	3313EH	2031	0.005	0.027	0.005	0.006	0.000	0.017	0.021	0.041	0.000	0.000	0.000	0.005
	3313EH	2032	0.001	0.030	0.001	0.018	0.009	0.011	0.018	0.000	0.000	0.001	0.000	0.000
	3313EH	2033	0.002	0.021	0.004	0.007	0.016	0.012	0.024	0.000	0.000	0.000	0.000	0.000
	3313EH	2034	0.003	0.016	0.003	0.005	0.008	0.010	0.032	0.000	0.000	0.000	0.001	0.000
	3313EH	2035	0.000	0.029	0.005	0.006	0.009	0.014	0.014	0.002	0.000	0.000	0.000	0.012
	3313EH	2036	0.005	0.012	0.004	0.007	0.001	0.008	0.024	0.029	0.002	0.000	0.000	0.000
	3313EH	2037	0.004	0.021	0.002	0.025	0.006	0.012	0.020	0.000	0.001	0.000	0.001	0.000
	3313EH	2038	0.003	0.020	0.001	0.013	0.007	0.008	0.018	0.000	0.001	0.000	0.006	0.000
	mean		0.003	0.022	0.003	0.011	0.007	0.012	0.021	0.009	0.001	0.000	0.001	0.002
960002 Bedford Square Gardens fireplate 1779	3316	2368	0.064	0.055	0.030	0.004	0.029	0.065	0.033	0.000	0.000	0.000	0.000	0.007
	3316	2369	0.047	0.157	0.009	0.001	0.032	0.059	0.019	0.000	0.000	0.001	0.000	0.000
	3316	2370	0.065	0.170	0.015	0.002	0.027	0.053	0.029	0.000	0.000	0.000	0.000	0.004
	3316	2371	0.080	0.108	0.052	0.000	0.032	0.044	0.046	0.000	0.003	0.000	0.000	0.000
	3316	2372	0.072	0.163	0.026	0.000	0.030	0.043	0.043	0.086	0.000	0.000	0.002	0.011
	3316	2374	0.139	0.101	0.016	0.002	0.020	0.040	0.044	0.032	0.000	0.000	0.002	0.000
	3316	2375	0.058	0.103	0.008	0.003	0.024	0.057	0.015	0.054	0.002	0.000	0.002	0.000
	3316	2376	0.075	0.150	0.016	0.000	0.034	0.060	0.048	0.005	0.003	0.000	0.002	0.009
	3316	2377	0.060	0.107	0.016	0.000	0.033	0.049	0.044	0.000	0.001	0.001	0.000	0.007
	3316	2379	0.109	0.121	0.023	0.002	0.023	0.045	0.028	0.000	0.001	0.003	0.000	0.006
	mean		0.077	0.124	0.021	0.001	0.028	0.052	0.035	0.018	0.001	0.001	0.001	0.004
960004 Portsmouth Dockyard fireplate 1779		2410	0.021	0.067	0.015	0.000	0.013	0.037	0.034	0.029	0.000	0.002	0.000	0.013
		2411	0.016	0.044	0.021	0.004	0.030	0.063	0.074	0.108	0.001	0.002	0.000	0.014
		2412	0.005	0.038	0.019	0.000	0.027	0.062	0.038	0.000	0.000	0.000	0.001	0.000
		2413	0.005	0.130	0.014	0.000	0.008	0.015	0.025	0.029	0.000	0.000	0.001	0.000
		2414	0.006	0.056	0.039	0.000	0.021	0.063	0.143	0.065	0.000	0.000	0.000	0.000
		2416	0.013	0.038	0.012	0.002	0.008	0.033	0.028	0.012	0.000	0.000	0.000	0.000
		2417	0.008	0.061	0.010	0.000	0.024	0.065	0.019	0.059	0.000	0.003	0.001	0.000
		2418	0.053	0.210	0.015	0.010	0.026	0.075	0.032	0.106	0.000	0.000	0.000	0.000
		2419	0.030	0.182	0.012	0.005	0.022	0.080	0.045	0.034	0.000	0.000	0.000	0.000
		2420	0.018	0.108	0.014	0.003	0.012	0.050	0.041	0.001	0.003	0.001	0.000	0.010
		2421	0.008	0.052	0.020	0.000	0.006	0.019	0.028	0.000	0.000	0.002	0.000	0.000

Sample details	Oxford Lab ref.		Composition wt%											
	sample	spec.	Si	P	S	Mn	Co	Ni	Cu	As	Ti	V	Cr	Zn
960004 cont.		2422	0.004	0.077	0.008	0.000	0.007	0.046	0.021	0.043	0.000	0.002	0.000	0.000
		2423	0.008	0.062	0.009	0.000	0.010	0.053	0.024	0.075	0.002	0.000	0.000	0.005
	mean		0.015	0.087	0.016	0.002	0.016	0.051	0.042	0.043	0.000	0.001	0.000	0.003
950012 Norbury Park fireplate 1779	3329	2380	0.002	0.070	0.005	0.002	0.051	0.089	0.025	0.000	0.000	0.005	0.000	0.000
	3329	2381	0.006	0.036	0.008	0.000	0.066	0.091	0.194	0.088	0.000	0.002	0.000	0.000
	3329	2382	0.001	0.104	0.005	0.002	0.023	0.089	0.050	0.011	0.003	0.000	0.001	0.000
	3329	2383	0.004	0.081	0.007	0.001	0.049	0.093	0.038	0.013	0.003	0.004	0.000	0.000
	3329	2384	0.002	0.030	0.005	0.000	0.050	0.030	0.172	0.000	0.004	0.000	0.001	0.001
	3329	2385	0.005	0.041	0.005	0.000	0.020	0.054	0.015	0.055	0.003	0.003	0.004	0.003
	3329	2386	0.003	0.040	0.005	0.002	0.012	0.057	0.000	0.000	0.000	0.006	0.001	0.005
	3329	2387	0.008	0.107	0.008	0.000	0.038	0.089	0.047	0.029	0.000	0.001	0.004	0.000
	3329	2388	0.003	0.109	0.006	0.000	0.034	0.084	0.028	0.051	0.000	0.000	0.001	0.000
	3329	2389	0.005	0.036	0.003	0.001	0.088	0.085	0.205	0.012	0.000	0.000	0.002	0.012
	3329	2390	0.003	0.019	0.009	0.000	0.062	0.114	0.174	0.044	0.000	0.004	0.002	0.000
	3329	2391	0.014	0.234	0.005	0.000	0.016	0.045	0.030	0.000	0.002	0.000	0.000	0.000
	3329	2392	0.005	0.031	0.004	0.000	0.108	0.229	0.076	0.092	0.000	0.000	0.001	0.006
	3329	2393	0.004	0.031	0.007	0.000	0.078	0.168	0.050	0.000	0.000	0.004	0.000	0.003
	3329	2394	0.001	0.140	0.005	0.004	0.025	0.064	0.038	0.034	0.000	0.002	0.001	0.011
	3329	2395	0.005	0.069	0.007	0.005	0.011	0.033	0.049	0.023	0.002	0.000	0.000	0.007
	3329	2396	0.003	0.052	0.007	0.002	0.036	0.083	0.037	0.000	0.000	0.004	0.000	0.000
	3329	2398	0.004	0.086	0.014	0.000	0.006	0.029	0.051	0.013	0.000	0.004	0.003	0.001
	mean		0.004	0.073	0.006	0.001	0.043	0.085	0.071	0.026	0.001	0.002	0.001	0.003
960018 50 Portland Place stair balustrade 1782	3311EH	2012	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.001	0.000	0.074	0.000	0.000
	3311EH	2013	0.007	0.141	0.003	0.002	0.008	0.022	0.005	0.000	0.003	0.000	0.001	0.000
	3311EH	2014	0.005	0.073	0.003	0.003	0.005	0.018	0.024	0.000	0.000	0.000	0.000	0.002
	3311EH	2015	0.004	0.049	0.008	0.000	0.010	0.032	0.020	0.000	0.000	0.000	0.001	0.000
	3311EH	2016	0.010	0.024	0.003	0.000	0.016	0.029	0.036	0.000	0.000	0.002	0.001	0.000
	3311EH	2017	0.002	0.070	0.003	0.000	0.011	0.027	0.024	0.000	0.000	0.000	0.000	0.004
	3311EH	2018	0.007	0.027	0.003	0.007	0.004	0.022	0.025	0.000	0.000	0.000	0.000	0.000
	3311EH	2019	0.004	0.038	0.003	0.002	0.012	0.033	0.088	0.002	0.000	0.000	0.000	0.000
	3311EH	2020	0.006	0.031	0.002	0.009	0.009	0.034	0.028	0.000	0.003	0.002	0.000	0.000
	mean		0.005	0.050	0.003	0.003	0.008	0.024	0.028	0.000	0.001	0.009	0.000	0.001
960021 Lindsay House upright 1799	EH24	2493	0.006	0.039	0.005	0.000	0.002	0.005	0.018	0.034	0.003	0.000	0.000	0.007
	EH24	2494	0.010	0.031	0.006	0.006	0.000	0.011	0.032	0.000	0.000	0.000	0.001	0.013
	EH24	2495	0.015	0.032	0.003	0.000	0.006	0.009	0.021	0.000	0.000	0.000	0.000	0.007
	EH24	2496	0.023	0.025	0.002	0.006	0.001	0.016	0.026	0.000	0.001	0.002	0.000	0.000
	EH24	2497	0.004	0.029	0.002	0.000	0.007	0.013	0.003	0.000	0.000	0.002	0.000	0.000
	EH24	2498	0.011	0.013	0.007	0.007	0.003	0.011	0.008	0.038	0.000	0.000	0.000	0.004
	EH24	2499	0.008	0.022	0.005	0.000	0.002	0.012	0.020	0.000	0.000	0.004	0.000	0.002
	EH24	2500	0.028	0.029	0.009	0.003	0.000	0.013	0.025	0.000	0.001	0.000	0.000	0.000
	EH24	2501	0.037	0.039	0.007	0.000	0.001	0.007	0.018	0.010	0.002	0.004	0.001	0.000
	EH24	2502	0.010	0.020	0.005	0.007	0.000	0.014	0.021	0.000	0.000	0.000	0.003	0.000
	mean		0.015	0.028	0.005	0.003	0.002	0.011	0.019	0.008	0.001	0.001	0.001	0.003
960003 Quarry Bank Mill fireplate 1799	3317	2399	0.014	0.111	0.011	0.008	0.002	0.016	0.018	0.011	0.002	0.000	0.000	0.000
	3317	2400	0.123	0.162	0.009	0.061	0.006	0.025	0.012	0.000	0.007	0.006	0.002	0.000
	3317	2401	0.256	0.135	0.035	0.016	0.006	0.027	0.021	0.000	0.004	0.001	0.000	0.005
	3317	2402	0.002	0.147	0.007	0.079	0.007	0.012	0.023	0.007	0.000	0.000	0.006	0.000
	3317	2403	0.266	0.077	0.005	0.028	0.012	0.029	0.019	0.000	0.001	0.004	0.002	0.000
	3317	2404	0.026	0.182	0.011	0.005	0.000	0.017	0.013	0.041	0.005	0.003	0.002	0.011
	3317	2405	0.069	0.119	0.004	0.014	0.005	0.020	0.008	0.000	0.000	0.000	0.001	0.001
	3317	2406	0.006	0.149	0.003	0.008	0.006	0.021	0.004	0.000	0.000	0.002	0.001	0.000
	3317	2407	0.004	0.038	0.001	0.001	0.013	0.028	0.023	0.000	0.000	0.000	0.004	0.000
	3317	2408	0.106	0.094	0.003	0.088	0.009	0.033	0.019	0.000	0.009	0.009	0.002	0.001

Sample details	Oxford Lab ref.		Composition wt%											
	sample	spec.	Si	P	S	Mn	Co	Ni	Cu	As	Ti	V	Cr	Zn
960003 cont.	3317	2409	0.028	0.125	0.007	0.018	0.008	0.017	0.014	0.000	0.007	0.001	0.000	0.004
	mean		0.082	0.122	0.009	0.030	0.007	0.022	0.016	0.005	0.003	0.002	0.002	0.002
960019 5 Knightsbridge railing 1799	3312EH	2021	0.051	0.074	0.008	0.021	0.021	0.040	0.025	0.028	0.000	0.000	0.000	0.000
	3312EH	2022	0.035	0.119	0.008	0.002	0.009	0.029	0.008	0.000	0.001	0.001	0.000	0.002
	3312EH	2023	0.018	0.136	0.006	0.004	0.011	0.035	0.018	0.000	0.003	0.004	0.000	0.011
	3312EH	2024	0.027	0.057	0.004	0.002	0.017	0.027	0.031	0.000	0.000	0.000	0.000	0.000
	3312EH	2025	0.018	0.146	0.010	0.006	0.015	0.027	0.028	0.000	0.002	0.001	0.001	0.003
	3312EH	2026	0.016	0.125	0.007	0.001	0.006	0.034	0.022	0.013	0.002	0.001	0.000	0.000
	3312EH	2027	0.054	0.162	0.010	0.017	0.010	0.033	0.033	0.000	0.003	0.000	0.000	0.000
	3312EH	2028	0.035	0.114	0.004	0.002	0.006	0.030	0.041	0.000	0.004	0.000	0.001	0.005
	3312EH	2029	0.030	0.099	0.012	0.000	0.005	0.025	0.031	0.000	0.000	0.001	0.000	0.007
	3312EH	2030	0.053	0.151	0.015	0.002	0.014	0.031	0.017	0.000	0.005	0.001	0.000	0.000
	mean		0.034	0.118	0.008	0.006	0.011	0.031	0.025	0.004	0.002	0.001	0.000	0.003
960022 Coventry Hall stair upright 1800	3314EH	2039	0.007	0.054	0.009	0.001	0.025	0.037	0.047	0.000	0.000	0.000	0.000	0.000
	3314EH	2040	0.011	0.091	0.011	0.005	0.008	0.045	0.042	0.032	0.000	0.000	0.002	0.020
	3314EH	2041	0.002	0.058	0.007	0.007	0.025	0.028	0.015	0.027	0.001	0.003	0.004	0.004
	3314EH	2042	0.005	0.070	0.007	0.000	0.003	0.048	0.048	0.000	0.002	0.000	0.001	0.001
	3314EH	2043	0.002	0.081	0.007	0.005	0.011	0.039	0.042	0.008	0.000	0.001	0.004	0.000
	3314EH	2044	0.006	0.061	0.004	0.000	0.012	0.042	0.050	0.007	0.004	0.000	0.001	0.008
	3314EH	2045	0.003	0.057	0.004	0.001	0.021	0.045	0.035	0.000	0.000	0.001	0.000	0.000
	3314EH	2046	0.006	0.062	0.003	0.001	0.014	0.041	0.044	0.008	0.001	0.000	0.003	0.001
	3314EH	2047	0.013	0.038	0.008	0.002	0.028	0.037	0.100	0.029	0.000	0.002	0.000	0.000
	mean		0.006	0.064	0.007	0.002	0.016	0.040	0.047	0.012	0.001	0.001	0.002	0.004
960023 St. Mary at Hill Church washer 1822	EH2	2503	0.006	0.114	0.013	0.005	0.007	0.027	0.029	0.025	0.000	0.001	0.002	0.000
	EH2	2504	0.000	0.255	0.010	0.000	0.017	0.024	0.014	0.023	0.000	0.005	0.000	0.000
	EH2	2505	0.004	0.359	0.019	0.001	0.017	0.035	0.025	0.000	0.000	0.001	0.003	0.003
	EH2	2506	0.004	0.228	0.012	0.000	0.000	0.035	0.035	0.000	0.000	0.000	0.000	0.000
	EH2	2507	0.009	0.038	0.010	0.000	0.054	0.115	0.090	0.000	0.000	0.000	0.002	0.015
	EH2	2508	0.005	0.067	0.010	0.000	0.020	0.040	0.051	0.000	0.000	0.001	0.002	0.000
	EH2	2509	0.036	0.297	0.020	0.013	0.008	0.027	0.021	0.013	0.000	0.002	0.002	0.008
	EH2	2510	0.011	0.353	0.020	0.004	0.016	0.029	0.024	0.000	0.002	0.002	0.001	0.006
	EH2	2511	0.016	0.217	0.026	0.008	0.009	0.032	0.023	0.002	0.000	0.000	0.000	0.000
	EH2	2512	0.037	0.429	0.025	0.019	0.010	0.019	0.013	0.000	0.000	0.000	0.003	0.004
	EH2	2513	0.066	0.288	0.025	0.011	0.014	0.022	0.016	0.000	0.007	0.000	0.000	0.000
	EH2	2515	0.003	0.477	0.041	0.003	0.002	0.023	0.025	0.024	0.000	0.003	0.001	0.000
	EH2	2516	0.002	0.286	0.021	0.003	0.000	0.035	0.029	0.013	0.000	0.000	0.005	0.008
	EH2	2517	0.003	0.376	0.023	0.005	0.015	0.017	0.008	0.002	0.000	0.002	0.000	0.001
	mean		0.014	0.270	0.020	0.005	0.014	0.034	0.029	0.007	0.001	0.001	0.002	0.003
960024 Morden Grange dog (staple) 1825	EH2	2518	0.008	0.055	0.009	0.009	0.004	0.019	0.016	0.073	0.000	0.000	0.000	0.000
	EH2	2519	0.013	0.052	0.009	0.004	0.005	0.010	0.019	0.073	0.001	0.003	0.003	0.000
	EH2	2520	0.009	0.054	0.011	0.002	0.013	0.018	0.023	0.000	0.000	0.000	0.001	0.000
	EH2	2521	0.013	0.042	0.006	0.009	0.003	0.015	0.031	0.034	0.002	0.002	0.001	0.000
	EH2	2522	0.026	0.040	0.010	0.018	0.006	0.007	0.017	0.005	0.000	0.005	0.000	0.000
	EH2	2523	0.025	0.028	0.007	0.013	0.005	0.008	0.017	0.036	0.001	0.005	0.000	0.000
	EH2	2524	0.014	0.060	0.008	0.009	0.009	0.015	0.017	0.034	0.005	0.000	0.001	0.000
	EH2	2525	0.017	0.056	0.015	0.004	0.011	0.004	0.034	0.057	0.000	0.002	0.000	0.002
	EH2	2526	0.008	0.053	0.011	0.003	0.000	0.007	0.018	0.041	0.002	0.000	0.001	0.000
	EH2	2527	0.006	0.044	0.006	0.004	0.005	0.007	0.023	0.080	0.000	0.003	0.002	0.000
	EH2	2528	0.009	0.056	0.008	0.009	0.006	0.009	0.027	0.046	0.000	0.000	0.000	0.005
	EH2	2529	0.011	0.044	0.009	0.008	0.000	0.014	0.027	0.038	0.003	0.000	0.000	0.002
	EH2	2530	0.016	0.069	0.010	0.010	0.003	0.011	0.013	0.086	0.001	0.004	0.001	0.005
	EH2	2531	0.016	0.043	0.016	0.012	0.009	0.015	0.026	0.025	0.000	0.004	0.002	0.004
	mean		0.014	0.050	0.010	0.008	0.006	0.011	0.022	0.045	0.001	0.002	0.001	0.001

Sample details	Oxford Lab ref.		Composition wt%											
	sample	spec.	Si	P	S	Mn	Co	Ni	Cu	As	Ti	V	Cr	Zn
960025 23 Onslow Gardens balcony rail leaf 1872	EH27	2532	0.013	0.141	0.009	0.001	0.012	0.039	0.035	0.000	0.001	0.003	0.001	0.011
	EH27	2533	0.014	0.041	0.006	0.002	0.009	0.028	0.029	0.015	0.001	0.000	0.000	0.000
	EH27	2534	0.051	0.055	0.009	0.014	0.009	0.026	0.013	0.000	0.000	0.000	0.002	0.003
	EH27	2535	0.006	0.145	0.003	0.001	0.007	0.026	0.027	0.021	0.000	0.000	0.000	0.013
	EH27	2536	0.009	0.147	0.010	0.001	0.003	0.041	0.036	0.000	0.000	0.000	0.000	0.005
	EH27	2537	0.006	0.183	0.006	0.003	0.005	0.028	0.026	0.000	0.000	0.000	0.001	0.000
	EH27	2538	0.005	0.114	0.003	0.000	0.015	0.028	0.016	0.001	0.000	0.001	0.000	0.000
	EH27	2539	0.010	0.113	0.008	0.002	0.011	0.030	0.024	0.002	0.002	0.004	0.000	0.009
	EH27	2540	0.008	0.090	0.012	0.004	0.012	0.033	0.061	0.000	0.000	0.000	0.000	0.000
	mean		0.014	0.114	0.007	0.003	0.009	0.031	0.030	0.004	0.000	0.001	0.000	0.005
950006 Albert Memorial bolt 1876	3301EH	1884	0.004	0.195	0.010	0.002	0.009	0.034	0.008	0.000	0.000	0.000	0.000	0.003
	3301EH	1885	0.001	0.229	0.013	0.000	0.020	0.043	0.030	0.007	0.000	0.000	0.000	0.007
	3301EH	1886	0.005	0.274	0.014	0.002	0.008	0.039	0.016	0.052	0.000	0.003	0.001	0.009
	3301EH	1887	0.003	0.108	0.004	0.001	0.018	0.048	0.023	0.033	0.000	0.000	0.003	0.000
	3301EH	1888	0.005	0.113	0.008	0.002	0.012	0.046	0.018	0.000	0.000	0.000	0.003	0.006
	3301EH	1889	0.005	0.148	0.010	0.000	0.010	0.038	0.025	0.000	0.000	0.005	0.000	0.000
	3301EH	1890	0.007	0.245	0.016	0.006	0.015	0.037	0.016	0.000	0.000	0.000	0.002	0.005
	3315	2350	0.009	0.155	0.010	0.007	0.014	0.021	0.007	0.000	0.000	0.000	0.000	0.006
	3315	2351	0.010	0.117	0.015	0.000	0.000	0.025	0.016	0.008	0.004	0.000	0.002	0.004
	3315	2352	0.012	0.060	0.007	0.013	0.018	0.031	0.016	0.000	0.002	0.000	0.000	0.010
	3315	2353	0.012	0.088	0.009	0.005	0.022	0.024	0.015	0.000	0.000	0.004	0.001	0.007
	3315	2354	0.013	0.098	0.008	0.003	0.017	0.030	0.016	0.000	0.003	0.002	0.000	0.012
	3315	2355	0.018	0.105	0.007	0.011	0.012	0.026	0.011	0.038	0.000	0.001	0.000	0.000
	3315	2356	0.010	0.177	0.010	0.000	0.012	0.031	0.031	0.000	0.002	0.000	0.000	0.012
	3315	2357	0.010	0.153	0.010	0.008	0.012	0.024	0.022	0.000	0.004	0.000	0.001	0.000
	3315	2358	0.023	0.112	0.007	0.001	0.006	0.019	0.021	0.000	0.000	0.003	0.000	0.000
	3315	2359	0.010	0.074	0.006	0.000	0.013	0.018	0.034	0.000	0.000	0.000	0.000	0.014
	3315	2360	0.011	0.189	0.022	0.004	0.010	0.022	0.027	0.000	0.000	0.001	0.000	0.000
	3315	2361	0.012	0.094	0.007	0.006	0.025	0.034	0.022	0.015	0.000	0.000	0.000	0.000
	3315	2362	0.049	0.127	0.014	0.028	0.011	0.023	0.016	0.000	0.000	0.000	0.002	0.000
	3315	2363	0.010	0.113	0.010	0.007	0.008	0.025	0.012	0.000	0.000	0.002	0.001	0.000
	3315	2364	0.011	0.115	0.006	0.000	0.012	0.020	0.017	0.014	0.000	0.000	0.001	0.009
	3315	2365	0.021	0.146	0.012	0.016	0.014	0.034	0.013	0.000	0.000	0.000	0.002	0.000
	3315	2366	0.009	0.105	0.007	0.002	0.015	0.023	0.024	0.053	0.001	0.000	0.000	0.003
	mean		0.012	0.139	0.010	0.005	0.013	0.030	0.019	0.009	0.001	0.001	0.001	0.004
960026 Avery Hill College water leaf from gates 1891	EH28	2541	0.011	0.061	0.058	0.362	0.004	0.017	0.054	0.001	0.005	0.000	0.003	0.000
	EH28	2542	0.076	0.053	0.085	0.317	0.000	0.014	0.042	0.102	0.005	0.001	0.006	0.000
	EH28	2543	0.014	0.058	0.085	0.408	0.000	0.025	0.052	0.035	0.000	0.000	0.003	0.001
	EH28	2544	0.011	0.065	0.083	0.402	0.005	0.025	0.048	0.017	0.000	0.000	0.003	0.006
	EH28	2545	0.013	0.050	0.043	0.368	0.008	0.020	0.044	0.003	0.000	0.001	0.004	0.002
	EH28	2546	0.013	0.049	0.038	0.331	0.009	0.009	0.030	0.000	0.000	0.000	0.003	0.000
	EH28	2547	0.007	0.055	0.040	0.340	0.003	0.016	0.037	0.019	0.000	0.001	0.000	0.000
	EH28	2548	0.009	0.050	0.044	0.377	0.004	0.021	0.047	0.017	0.002	0.003	0.000	0.000
	EH28	2549	0.015	0.050	0.060	0.388	0.001	0.018	0.026	0.037	0.002	0.000	0.002	0.000
	EH28	2550	0.013	0.072	0.080	0.375	0.000	0.020	0.035	0.070	0.000	0.000	0.003	0.000
	mean		0.018	0.056	0.062	0.367	0.003	0.019	0.042	0.030	0.001	0.001	0.003	0.001