Ancient Monuments Laboratory
Report 3/2000

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Summary

This multi-period site produced small quantities (approx. 22.5kg) of debris from iron smithing and non-ferrous metalworking. There is evidence of hot and cold copper alloy and lead working, silver refining and gold melting.

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# The Assessment of Metalworking Debris from Norwich Millennium Library Excavation

Helen S. Bowstead Stallybrass

## Introduction

Excavation of the late Saxon to late medieval site of Norwich Millennium Library was undertaken by Norfolk Archaeological Unit. Six boxes of metalworking debris weighing approximately 22.5kg were sent to the English Heritage Centre for Archaeology for assessment.

## Background to the Excavation

The construction of the Norwich Millennium Library Building presented the opportunity for the archaeological investigation of a large area within Norwich's city centre. These excavations are the second largest, in area, undertaken within the historic core of Norwich and the first within the city quarter known - during the medieval period - as the French Borough (Hutcheson 1999).

## Dating

Dating for the site so far has been based on pottery, though it is hoped that other dating methods can be used to define these dates better at a later stage. Dates range from the 4$^{th}$/7$^{th}$ century through to the 19$^{th}$ century with material from the full range of dates sent to be assessed.

## Examination and interpretation of the metalworking debris

The material was visually examined and classified into the standard categories used by the English Heritage Centre for Archaeology. Classification can vary between specialists and the terms used are explained below. The weights of the fragments examined are listed in the table below. Details are given in a full listing of finds in Appendix 1.

| Table 1 Summary of metallurgical debris from Norwich Millennium | |
|---|---|
| **Interpretation** | **Weight (g)** |
| smithing hearth bottoms | 4680 |
| undiagnostic ironworking slag | 3776 |
| ferruginous concretion | 1166 |
| ?corroded iron object | 734 |
| hearth lining | 852 |
| crucible fragments | 784 |
| copper alloy concretions and waste | 976 |
| lead waste | 4585 |
| litharge cake | 318 |
| gold bar | 7 |
| fuel ash slag | 802 |
| fired clay | 4000 |
| Total | 22680 |

## Explanation of classification

Some types of slag are visually diagnostic, providing unambiguous evidence for a specific metallurgical process. Other debris is less distinctive and it is not possible to say which metallurgical, or other high temperature, process it derives from. At Norwich Millennium Library Site, diagnostic slags comprised about half of the assemblage. These included evidence of iron smithing (*i.e.* hot working) and a variety of non-ferrous metalworking. There was no clear evidence that iron, or any other metal, had been smelted (reduced from the ore) on the site.

Evidence for smithing may be recognised in two forms, as bulk slags and as micro slags. No micro slags were recovered from this site. **Smithing hearth bottoms** are the only bulk slags produced during smithing unlikely to be confused with the waste products of smelting. They are therefore considered diagnostic of smithing. Hearth bottoms are recognisable by their characteristic plano-convex form. Typically they have a rough convex base and a smoother, vitrified upper surface which is flat, or even slightly hollowed as a result of the downwards pressure of the air blast from the tuyère. The composition of smithing hearth bottoms are predominantly fayalitic (iron silicate) and are formed as a result of high temperature reactions between the iron, iron-scale and silica from either the clay hearth lining or sand used as a flux by the smith (Starley and Tulp 1998).

The debris classified as **undiagnostic ironworking slag** is also of fayalitic composition and can be formed during iron smelting or iron smithing. With no clear evidence of smelting on the site, it is likely that the undiagnostic slag also derives from iron smithing.

Another major component of the assemblage was **ferruginous concretions**. These are not indicators of metalworking. They form as a result of the re-deposition of iron

hydroxides, similar to the phenomenon of iron panning. Inclusions such as stones are bonded together with the iron compounds.

**Hearth lining** can be formed during iron smelting, iron smithing or non-ferrous metal working, as a result of a high temperature reaction between the clay lining of the hearth and the alkaline fuel ashes or fayalitic slag. The material usually shows a compositional gradient from unmodified clay on one surface to an irregular cinder or vitreous material on the other. Non-quantitative X-ray fluorescence (XRF) analysis has identified remains of hearths used for iron working, copper alloy working and lead working from this site.

Evidence for non-ferrous metalworking was provided by the finds of **crucible fragments**. The surfaces of these were analysed using XRF to identify the types of metal that had been melted in them. Crucibles for melting copper alloys and gold-silver alloys have been identified.

The **copper alloy concretions** are likely to be formed from copper filings that have then corroded in the ground to form a copper-rich lump. The filings could be the result of either filing or trimming with a knife the edge of castings where a flash line from the mould could be seen.

The **copper alloy** and **lead waste** takes the form of offcuts and spillages and result from the working of solid and liquid metal respectively. The spillages may be formed either from splattering the metal whilst pouring or by solid metal being dropped by accident into a fire and then melted if the fire is hot enough (Bayley 1992, 778-9).

**Litharge cakes** are evidence of refining silver. They are essentially a block of bone ash hearth lining impregnated with litharge (lead oxide). The impure silver is melted with excess lead, which then oxidises to the litharge, which then acts as an oxidising agent causing the base metals within the silver to oxidise. The oxides either dissolve or volatilise into the litharge leaving pure silver (Bayley 1992, 748). This technique is known as cupellation.

A **gold bar** was found on the site and is thought to be "Viking" in style. The bar has been hammered into shape and is possible indication of gold working occurring on or close to the site.

**Fuel ash slag** is a lightweight material. It can, but need not, be produced during metalworking activities. Such slag can also be derived from accidental high temperature fires or processes such as cremation and firing ceramics.

**Fired clay** is clay that has been fired but shows no sign of being deliberately shaped. It is possible that the clay performed some function such as being part of a hearth or daub. It is equally possible that the clay has been accidentally fired.

## Conclusions

The assessment of the material from Norwich Millennium Library suggests that much it derives from metalworking. There are four major types of metal working debris represented. There is a relatively small quantity of iron smithing debris. There is also a small amount of non-ferrous working debris providing evidence for copper alloy working, lead working and gold working. Despite the large size of the site, all of the debris examined could have resulted from only a few days work.

The evidence for iron smithing is in the form of some diagnostic iron smithing slags. There are thirty fragments of smithing hearth bottoms, which formed in a blacksmith's hearth. The hearth bottoms fall into a range of dates from 11$^{th}$/12$^{th}$ century through to the 18$^{th}$ century. Most other iron slag from the site is undiagnostic, though it probably derived from smithing activities. If environmental samples have been taken from any of the contexts associated with smithing slags, the micro slags (hammerscale) should be looked for. If present, this would help add weight to the conclusion that smithing was occurring on the site and not at another location.

The non-ferrous metalworking debris from this site is of interest. The hearth linings are unusual; they are formed less often than ferrous hearth linings as non-ferrous metals were melted in crucibles. The presence of such hearth linings indicates that the skills of the metal workers was not high as these hearth linings are likely to have been formed by spilt metal reacting with the hearth lining. The metal spillages found on the site also lead to this conclusion.

The copper and lead working evidence from the site indicates both hot and possibly cold working of copper alloys. Splatters and spillages indicate hot metalworking. Cold working is evident from the copper alloy and lead offcuts and the possible copper alloy filings that have been found in the form of concretions. Similar concretions where seen in Iron Age contexts at Danebury (Northover 1991, 411-2). A minimum of ten crucibles have been used for copper alloy melting. The exact alloy composition of the melt is difficult to establish due to the difficulties of analysing crucibles. Some metals survive better within crucible walls than others (Dungworth and Bayley, forthcoming), causing analytical results to be misleading and difficult to interpret.

The remains of gold melting crucibles, confirmed by XRF analysis indicate the melting of precious metals occurred on the site. The gold bar also found on the site suggests gold working on or close to the site. Initial XRF analysis of the bar shows that it has been debased with silver and a small amount of copper. The presence of a litharge cake fragment indicates that refining by cupellation of silver was occurring. Similar cakes have been found on sites such as Coppergate in York, though the technique dates back to the first millennium BC (Bayley 1992, 748-9).

## Recommendations for further work

1. A sample of the copper alloy concretions should be examined in the SEM (Scanning Electron Microscope) to fully identify them and confirm the presence of filings.

2. The lead should be fully analysed to see if the remains are pure lead or an alloy. A small sample of material already analysed shows that there is a mixture of pure lead, lead-tin alloys and copper alloys currently identified as lead.

3. The non-ferrous artefacts (which are currently in Norwich) should be looked at and analysed to see if the alloys are similar to any of those found in the waste and spillages.

4. The gold analysis should be compared with known Viking gold to see if the debased nature is typical of Viking gold or not.

5. The spatial distribution of finds should be looked at to assess the role of metalworking on the site and identify any possible foci of metalworking.

Such work could be undertaken by English Heritage Centre for Archaeology if required.

## Time requirements

The completion of recommended work 1, 2, 4 and 5 would take 3 days. Recommended work 3 would be dependent on the number of artefacts sent from Norwich.

## Storage of material

All slag should be saved. Most metalworking slag, being predominantly fayalitic, is not prone to deterioration and requires no special storage treatment. The copper alloy waste should be stored like copper alloy objects.

## References

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Dungworth, D. and Bayley, J. (forthcoming) The Use of EDXRF for the Examination of Crucibles and Moulds. In Crucibles, moulds and tuyères from Mucking, Essex. Ancient Monuments Laboratory Report, 3-6.

Hutcheson, A. (1999) Contribution to the Annual Review. In Shepherd E. (*Ed*) *Annual Review for Norfolk Archaeological Unit 1998-9.* Field Archaeology Division, Norfolk Museums Service, Norwich.

Northover, J.P. (1991) Non-ferrous metalwork and metallurgy. In Cunliffe, B. and Poole, C. *Danebury an Iron Age hillfort in Hampshire. Volume 5 The Excavations, 1979-88: the finds.* CBA Research Report **73**. Council for British Archaeology, London.

Starley, D. and Tulp, C. (1998) The assessment of Metalworking Debris from Covert Farm (Dirft East), Crick, Northamptonshire. Ancient Monuments Laboratory Report 54/98.

| Appendix 1 | Metalworking debris from Norwich Millennium Library | | | | |
|---|---|---|---|---|---|
| **Context** | **Small Find NO/ Metal detector NO** | **Material** | **Debris type (no of fragments)** | **Weight (g)** | **Comments** |
| 10076 | | concretion | Fe concretion (1) | 16 | |
| 10145 | | concretion | Fe concretion (1) | 182 | |
| 10511 | | concretion | Fe concretion (1) | 6 | |
| 10794 | | concretion | Fe concretion (2) | 66 | |
| 13986 | | concretion | Fe concretion | 162 | |
| 12955 | | concretion, metalworking debris | Fe concretion (3), Fe hearth lining (1) | 234 | |
| 10020 | | crucible | Cu alloy and Au | 42 | |
| 10020 | | crucible | Cu alloy | 24 | Sample 121 |
| 10781 | | crucible | Cu alloy | 12 | |
| 11046 | | crucible | Cu alloy | 2 | |
| 11813 | | crucible | Cu alloy | 6 | Sample 270 |
| 12425 | | crucible | Cu alloy | 70 | Sample 282 |
| 12427 | | crucible | Cu alloy | 166 | Sample 283 |
| 12427 | | crucible | Cu alloy | 94 | |
| 12514 | | crucible | Cu alloy | 16 | |
| 10020 | | fired clay | | 7 | |
| 10104 | | fired clay | | 6 | Sample 113 |
| 10255 | | fired clay | | 6 | |
| 10255 | | fired clay | | 64 | Sample 125 |
| 10694 | | fired clay | | 8 | |
| 10732 | | fired clay | | 40 | |
| 10807 | | fired clay | | 8 | Sample 139 |
| 11011 | | fired clay | | 4 | |
| 11277 | | fired clay | | 8 | |
| 11309 | | fired clay | | 12 | |
| 11310 | | fired clay | | 26 | |
| 11626 | | fired clay | | 38 | |
| 11631 | | fired clay | | 1 | |
| 11750 | | fired clay | | 6 | |
| 11750 | | fired clay | | 1 | |
| 11787 | | fired clay | | 8 | |
| 12221 | | fired clay | | 12 | |
| 12270 | | fired clay | tile | 84 | |
| 12381 | | fired clay | | 1 | |
| 12396 | | fired clay | | 7 | |
| 12425 | | fired clay | | 4 | Sample 282 |
| 12427 | | fired clay | | 1 | Sample 283 |
| 12528 | | fired clay | | 30 | |
| 12529 | | fired clay | | 6 | |
| 12756 | | fired clay | | 2 | Sample 267 |
| 12787 | | fired clay | | 149 | |
| 12840 | | fired clay | | 10 | |
| 12861 | | fired clay | | 6 | |
| 12884 | | fired clay | | 42 | |
| 12957 | | fired clay | | 34 | |
| 13124 | | fired clay | | 4 | |
| 13183 | | fired clay | | 2 | |
| 13206 | | fired clay | | 4 | |
| 13298 | | fired clay | | 30 | Sample 308 |

| Appendix 1 | Metalworking debris from Norwich Millennium Library | | | | |
|---|---|---|---|---|---|
| **Context** | **Small Find NO/ Metal detector NO** | **Material** | **Debris type (no of fragments)** | **Weight (g)** | **Comments** |
| 13305 | | fired clay | | 42 | |
| 13328 | | fired clay | | 386 | |
| 13349 | | fired clay | | 24 | |
| 13350 | | fired clay | | 26 | |
| 13351 | | fired clay | | 132 | |
| 13353 | | fired clay | | 2 | |
| 13356 | | fired clay | | 234 | |
| 13390 | | fired clay | | 54 | |
| 13427 | | fired clay | | 12 | |
| 13519 | | fired clay | | 2 | |
| 13524 | | fired clay | | 2 | |
| 13683 | | fired clay | | 2 | |
| 13696 | | fired clay | | 382 | |
| 13840 | | fired clay | | 8 | |
| 13903 | | fired clay | | 18 | |
| 13929 | | fired clay | | 48 | |
| 13992 | | fired clay | | 230 | |
| 13993 | | fired clay | | 164 | |
| 14001 | | fired clay | | 1246 | |
| 14003 | | fired clay | | 42 | |
| 14014 | | fired clay | | 360 | |
| 14028 | | fired clay | | 4 | |
| 14098 | | fired clay | | 10 | |
| 14117 | | fired clay | | 16 | |
| 14166 | | fired clay | | 10 | |
| 14384 | | fired clay | | 4 | |
| 14583 | | fired clay | | 24 | |
| 10591 | | fired/burnt clay | | 8 | |
| 10008 | | metalworking debris | ? cast iron | 734 | |
| 10116 | | metalworking debris | Cu alloy concretion (1) | 12 | |
| 10120 | | metalworking debris | Cu alloy concretion (1) | 2 | |
| 10329 | | metalworking debris | Cu alloy concretion (1) | 6 | Sample 128 |
| 10513 | | metalworking debris | Cu alloy concretion (1) | 16 | |
| 10747 | | metalworking debris | Cu alloy concretion (1) | 12 | |
| 13206 | | metalworking debris | Cu alloy concretion (1) | 18 | |
| 11366 | | metalworking debris | Cu alloy concretion (2) | 4 | |
| 12425 | | metalworking debris | Cu alloy concretion (5) | 24 | Sample 282 |
| 10173 | | metalworking debris | Cu alloy hearth lining (1) | 20 | |
| 12427 | | metalworking debris | Cu alloy hearth lining (7) | 56 | |
| 12959 | | metalworking debris | Cu alloy hearth lining (8) | 18 | |
| 10007 | | metalworking debris, slag | fuel ash slag (5), Fe hearth lining (1) | 216 | |
| 10058 | | metalworking debris, concretion | Fe concretion (3), Fe hearth lining (1) | 148 | |
| 10014 | | metalworking debris, slag, concretion | Fe concretion (3), fuel ash slag (9), Cu alloy concretion (3) | 412 | |
| 13411 | | metalworking debris | Fe hearth bottom (12), Fe hearth lining (2) | 1836 | |
| 10256 | | metalworking debris | Fe hearth bottom (1) | 210 | |
| 10321 | | metalworking debris | Fe hearth bottom (4) | 270 | |

| Appendix 1 | Metalworking debris from Norwich Millennium Library | | | | |
|---|---|---|---|---|---|
| **Context** | **Small Find NO/ Metal detector NO** | **Material** | **Debris type (no of fragments)** | **Weight (g)** | **Comments** |
| 10810 | | metalworking debris | Fe hearth bottom (2) | 260 | |
| 10924 | | metalworking debris | Fe hearth bottom (1) | 172 | |
| 11157 | | metalworking debris | Fe hearth bottom (1) | 462 | |
| 12598 | | metalworking debris | Fe hearth bottom (2) | 166 | |
| 12838 | | metalworking debris | Fe hearth bottom (1) | 94 | |
| 13479 | | metalworking debris | Fe hearth bottom (3) | 304 | |
| 13597 | | metalworking debris | Fe hearth bottom (1) | 186 | |
| 14403 | | metalworking debris | Fe hearth bottom (1) | 638 | |
| 14450 | | metalworking debris | Fe hearth bottom (1) | 182 | |
| 10526 | | metalworking debris | Fe hearth lining (1) | 120 | |
| 11750 | | metalworking debris | Fe hearth lining (1) | 172 | |
| 12518 | | metalworking debris | Fe hearth lining (1) | 16 | |
| 12977 | | metalworking debris | Fe hearth lining (1) | 222 | |
| 13122 | | metalworking debris | Fe hearth lining (1) | 6 | |
| 13183 | | metalworking debris | Fe hearth lining (1) | 62 | |
| 13265 | | metalworking debris | Fe hearth lining (1) | 12 | |
| 13703 | | metalworking debris | Fe hearth lining (30+) | 78 | Sample 298 |
| 13060 | | metalworking debris | Pb hearth lining (1) | 118 | |
| 10090 | | metalworking debris | undiagnostic Fe slag (14) | 540 | |
| 10162 | | metalworking debris | undiagnostic Fe slag (1) | 24 | |
| 10228 | | metalworking debris | undiagnostic Fe slag (1) | 14 | Sample 109 |
| 10230 | | metalworking debris | undiagnostic Fe slag (18) | 406 | Sample 107 |
| 10230 | | metalworking debris | undiagnostic Fe slag (30+) | 1726 | |
| 10329 | | metalworking debris | undiagnostic Fe slag (1) | 10 | |
| 10475 | | metalworking debris | undiagnostic Fe slag (1) | 124 | |
| 11190 | | metalworking debris | undiagnostic Fe slag (1) | 4 | |
| 11229 | | metalworking debris | undiagnostic Fe slag (1) | 4 | |
| 11240 | | metalworking debris | undiagnostic Fe slag (2) | 54 | |
| 11470 | | metalworking debris | undiagnostic Fe slag (3) | | |
| 11553 | | metalworking debris | undiagnostic Fe slag (1) | 4 | |
| 11627 | | metalworking debris | undiagnostic Fe slag (1) | 36 | |
| 11825 | | metalworking debris | undiagnostic Fe slag (1) | 14 | |
| 11835 | | metalworking debris | undiagnostic Fe slag (1) | 28 | |
| 12419 | | metalworking debris | undiagnostic Fe slag (1) | 60 | |
| 12580 | | metalworking debris | undiagnostic Fe slag (2) | 22 | |
| 12684 | | metalworking debris | undiagnostic Fe slag (4) | 390 | |
| 12786 | | metalworking debris | undiagnostic Fe slag (1) | 36 | |
| 13152 | | metalworking debris | undiagnostic Fe slag (4) | 92 | |
| 13193 | | metalworking debris | undiagnostic Fe slag (1) | 24 | |
| 13209 | | metalworking debris | undiagnostic Fe slag (1) | 56 | |
| 13586 | | metalworking debris | undiagnostic Fe slag (1) | 110 | |
| 14447 | | metalworking debris | undiagnostic Fe slag (6) | 374 | |
| 10013 | | slag | fuel ash slag (7) | 222 | |
| 10427 | | slag | fuel ash slag (30+) | 264 | |
| 10433 | | slag | fuel ash slag (1) | 16 | |
| 10555 | | slag | fuel ash slag (1) | 18 | Sample 136 |
| 10681 | | slag | fuel ash slag (3) | 8 | |
| 10732 | | slag | fuel ash slag (1) | 10 | |
| 10816 | | slag | fuel ash slag (1) | 2 | Sample 138 |
| 11555 | | slag | fuel ash slag (1) | 12 | |

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|---|---|---|---|---|---|
| **Context** | **Small Find NO/ Metal detector NO** | **Material** | **Debris type (no of fragments)** | **Weight (g)** | **Comments** |
| 12049 | | slag | fuel ash slag (1) | 24 | |
| 12887 | | slag | fuel ash slag (1) | 14 | |
| | MD2 | ?Pb | | | |
| | MD391 | ?Pb/Sn scrap | | | |
| | MD11 | Cu alloy | | | |
| | MD147 | Cu alloy | | | |
| | MD277 | Cu alloy | | | |
| | MD336 | Cu alloy | | | |
| | MD502 | Cu alloy | | | |
| | MD141 | Cu alloy fragment | | | |
| | MD13 | metalworking debris | Cu alloy droplet | | |
| | MD220 | metalworking debris | Cu alloy concretion | | |
| | MD23 | metalworking debris | Cu alloy concretion | | |
| | MD25 | metalworking debris | Cu alloy concretion | | |
| | MD281 | metalworking debris | Cu alloy concretion | | |
| | MD352 | metalworking debris | Cu alloy concretion | | |
| | MD413 | metalworking debris | Cu alloy concretion | | |
| | MD8 | metalworking debris | Cu alloy concretion | | |
| | MD87 | metalworking debris | Cu alloy concretion | | |
| | MD22 | metalworking debris | Cu alloy spillage | | |
| | MD451 | metalworking debris | Cu alloy spillage | | |
| | MD339 | metalworking debris | Pb droplet | | |
| | MD415 | metalworking debris | Pb droplet | | |
| | MD49 | metalworking debris | Pb droplet | | |
| | MD67 | metalworking debris | Pb droplet | | |
| | MD10 | metalworking debris | Pb spillage | | |
| | MD120 | metalworking debris | Pb spillage | | |
| | MD134 | metalworking debris | Pb spillage | | |
| | MD146 | metalworking debris | Pb spillage | | |
| | MD168 | metalworking debris | Pb spillage | | |
| | MD183 | metalworking debris | Pb spillage | | |
| | MD19 | metalworking debris | Pb spillage | | |
| | MD191 | metalworking debris | Pb spillage | | |
| | MD219 | metalworking debris | Pb spillage | | |
| | MD280 | metalworking debris | Pb spillage | | |
| | MD289 | metalworking debris | Pb spillage | | |
| | MD295 | metalworking debris | Pb spillage | | |
| | MD311 | metalworking debris | Pb spillage | | |
| | MD340 | metalworking debris | Pb spillage | | |
| | MD358 | metalworking debris | Pb spillage | | |
| | MD387 | metalworking debris | Pb spillage | | |
| | MD418 | metalworking debris | Pb spillage | | |
| | MD428 | metalworking debris | Pb spillage | | |
| | MD430 | metalworking debris | Pb spillage | | |
| | MD434 | metalworking debris | Pb spillage | | |
| | MD501 | metalworking debris | Pb spillage | | |
| | MD503 | metalworking debris | Pb spillage | | |
| | MD506 | metalworking debris | Pb spillage | | |
| | MD6 | metalworking debris | Pb spillage | | |
| | MD86 | metalworking debris | Pb spillage | | |

| Appendix 1 | Metalworking debris from Norwich Millennium Library | | | | |
|---|---|---|---|---|---|
| **Context** | **Small Find NO/ Metal detector NO** | **Material** | **Debris type (no of fragments)** | **Weight (g)** | **Comments** |
| | MD102 | metalworking debris | Pb waste | | |
| | MD112 | metalworking debris | Pb waste | | |
| | MD116 | metalworking debris | Pb waste | | |
| | MD12 | metalworking debris | Pb waste | | |
| | MD127 | metalworking debris | Pb waste | | |
| | MD130 | metalworking debris | Pb waste | | |
| | MD138 | metalworking debris | Pb waste | | |
| | MD140 | metalworking debris | Pb waste | | |
| | MD145 | metalworking debris | Pb waste | | |
| | MD15 | metalworking debris | Pb waste | | |
| | MD154 | metalworking debris | Pb waste | | |
| | MD162 | metalworking debris | Pb waste | | |
| | MD163 | metalworking debris | Pb waste | | |
| | MD177 | metalworking debris | Pb waste | | |
| | MD184 | metalworking debris | Pb waste | | |
| | MD188 | metalworking debris | Pb waste | | |
| | MD194 | metalworking debris | Pb waste | | |
| | MD201 | metalworking debris | Pb waste | | |
| | MD218 | metalworking debris | Pb waste | | |
| | MD237 | metalworking debris | Pb waste | | |
| | MD240 | metalworking debris | Pb waste | | |
| | MD245 | metalworking debris | Pb waste | | |
| | MD262 | metalworking debris | Pb waste | | |
| | MD264 | metalworking debris | Pb waste | | |
| | MD273 | metalworking debris | Pb waste | | |
| | MD285 | metalworking debris | Pb waste | | |
| | MD287 | metalworking debris | Pb waste | | |
| | MD297 | metalworking debris | Pb waste | | |
| | MD304 | metalworking debris | Pb waste | | |
| | MD33 | metalworking debris | Pb waste | | |
| | MD332 | metalworking debris | Pb waste | | |
| | MD343 | metalworking debris | Pb waste | | |
| | MD377 | metalworking debris | Pb waste | | |
| | MD399 | metalworking debris | Pb waste | | |
| | MD403 | metalworking debris | Pb waste | | |
| | MD42 | metalworking debris | Pb waste | | |
| | MD441 | metalworking debris | Pb waste | | |
| | MD45 | metalworking debris | Pb waste | | |
| | MD53 | metalworking debris | Pb waste | | |
| | MD68 | metalworking debris | Pb waste | | |
| | MD78 | metalworking debris | Pb waste | | |
| | MD79 | metalworking debris | Pb waste | | |
| | MD80 | metalworking debris | Pb waste | | |
| | MD9 | metalworking debris | Pb waste | | |
| | MD90 | metalworking debris | Pb waste | | |
| | MD98 | metalworking debris | Pb waste | | |
| | MD308 | Pb | | | |
| | MD359 | Pb | | | |
| | MD187 | Pb bar | | | |
| | MD328 | Pb bar | | | |

| Appendix 1 | Metalworking debris from Norwich Millennium Library | | | | |
|---|---|---|---|---|---|
| **Context** | **Small Find NO/ Metal detector NO** | **Material** | **Debris type (no of fragments)** | **Weight (g)** | **Comments** |
| | MD41 | Pb bar | | | |
| | MD88 | Pb bar | | | |
| | MD70 | Pb fragment | | | |
| | MD71 | Pb fragment | | | |
| | MD252 | Pb object | | | |
| | MD31 | Pb object | | | |
| | MD342 | Pb object | | | |
| | MD214 | Pb sheet | | | |
| | MD257 | Pb sheet | | | |
| | MD271 | Pb sheet | | | |
| | MD272 | Pb sheet | | | |
| | MD279 | Pb sheet | | | |
| | MD290 | Pb sheet | | | |
| | MD291 | Pb sheet | | | |
| | MD298 | Pb sheet | | | |
| | MD324 | Pb sheet | | | |
| | MD326 | Pb sheet | | | |
| | MD330 | Pb sheet | | | |
| | MD331 | Pb sheet | | | |
| | MD338 | Pb sheet | | | |
| | MD350 | Pb sheet | | | |
| | MD351 | Pb sheet | | | |
| | MD363 | Pb sheet | | | |
| | MD37 | Pb sheet | | | |
| | MD382 | Pb sheet | | | |
| | MD396 | Pb sheet | | | |
| | MD410 | Pb sheet | | | |
| | MD414 | Pb sheet | | | |
| | MD424 | Pb sheet | | | |
| | MD425 | Pb sheet | | | |
| | MD429 | Pb sheet | | | |
| | MD440 | Pb sheet | Perforated | | |
| | MD452 | Pb sheet | Perforated | | |
| | MD54 | Pb sheet | | | |
| | MD7 | Pb sheet | | | |
| | MD99 | Pb sheet | | | |
| | MD137 | Pb strip | | | |
| | MD159 | Pb strip | | | |
| | MD199 | Pb strip | | | |
| | MD286 | Pb strip | Perforated | | |
| | MD3 | Pb strip | | | |
| | MD4 | Pb strip | | | |
| | MD72 | Pb strip | | | |
| | MD77 | Pb strip | | | |
| | MD92 | Pb strip | | | |
| | MD95 | Pb strip | | | |
| 99999 | 19 | metalworking debris | Pb lump | | |
| 99999 | 32 | metalworking debris | Pb spillage | | |
| 99999 | 34 | metalworking debris | Cu alloy concretion | | |
| 99999 | 35 | metalworking debris | Pb spillage | | |

| Appendix 1 | Metalworking debris from Norwich Millennium Library | | | | |
|---|---|---|---|---|---|
| **Context** | **Small Find NO/ Metal detector NO** | **Material** | **Debris type (no of fragments)** | **Weight (g)** | **Comments** |
| 99999 | 36 | metalworking debris | Cu alloy concretion (1) | | |
| 99999 | 41 | metalworking debris | Cu alloy concretion (5) | | |
| 10008 | 45 | metalworking debris | Cu alloy concretion (1) | | |
| 10067 | 62 | metalworking debris | Pb strip | | |
| 10173 | 94 | metalworking debris | Cu alloy spillage (1), Cu alloy concretion (2) | | |
| 10143 | 97 | metalworking debris | Pb spillage (4) | | |
| 10286 | 140 | metalworking debris | Pb offcut | | |
| 10697 | 175 | gold bar | Small slightly curved bar of gold, with one hammered face. The ends are rounded. | | |
| 10529 | 206 | metalworking debris | Pb offcut | | |
| 10020 | 231 | metalworking debris | Cu alloy Spillage | | |
| 10208 | 274 | metalworking debris | Pb spillage | | |
| 10329 | 277 | metalworking debris | Cu alloy concretion (1) | | |
| 10020 | 278 | crucible | Cu alloy | | |
| 11129 | 283 | metalworking debris | Cu alloy concretion (1) | | |
| 10792 | 299 | metalworking debris | Cu alloy fragments (2) | | |
| 10857 | 301 | metalworking debris | Pb spillage | | MD |
| 10747 | 308 | metalworking debris | Cu alloy concretion (1) | | |
| 10803 | 314 | metalworking debris | Cu alloy concretion (1) | | |
| 11277 | 387 | metalworking debris | Cu alloy concretion | | |
| 10513 | 389 | metalworking debris | Pb offcut | | |
| 10109 | 400 | metalworking debris | Pb Weight or ingot? (markings on one side) | | |
| 10513 | 412 | metalworking debris | Pb scrap | | |
| 10228 | 420 | metalworking debris | Cu alloy concretion (1) | | |
| 10219 | 421 | metalworking debris | Litharge cake | | |
| 10219 | 422 | metalworking debris | Pb spillage (1) | | |
| 10627 | 423 | metalworking debris | Pb spillage | | |
| 10876 | 424 | metalworking debris | Cu alloy concretion (1) | | |
| 10076 | 429 | metalworking debris | Cu alloy concretion (1) | | |
| 10038 | 430 | metalworking debris | Cu alloy fragment | | |
| 10020 | 435 | metalworking debris | Cu alloy concretion (6) | | |
| 11397 | 448 | metalworking debris | Cu alloy concretion (1) | | |
| 11050 | 467 | metalworking debris | Pb waste | | |
| 11458 | 472 | metalworking debris | Pb sheet with Fe encrustation | | |
| 11313 | 489 | metalworking debris | Cu alloy fragment (1), Cu alloy concretion (3) | | |
| 11447 | 501 | metalworking debris | Pb spillage | | MD |
| 11707 | 502 | metalworking debris | Pb scrap | | MD |
| 11717 | 507 | metalworking debris | Folded lead strip. | | |
| 11543 | 508 | metalworking debris | Cu alloy concretion (1) | | |
| 11717 | 520 | metalworking debris | Cu alloy fragment | | |
| 11712 | 524 | metalworking debris | Bent Pb strip forming a ring. | | MD |
| 11447 | 525 | metalworking debris | Pb waste | | MD |
| 11355 | 529 | metalworking debris | Pb bar | | |
| 10549 | 531 | metalworking debris | Pb offcut | | |
| 11069 | 551 | metalworking debris | Cu alloy concretion (1) | | |
| 10988 | 562 | metalworking debris | Cu alloy concretion (8) | | |

| Appendix 1 | Metalworking debris from Norwich Millennium Library | | | | |
|---|---|---|---|---|---|
| **Context** | **Small Find NO/ Metal detector NO** | **Material** | **Debris type (no of fragments)** | **Weight (g)** | **Comments** |
| 12314 | 623 | metalworking debris | Pb spillage | | |
| 12425 | 624 | metalworking debris | Cu alloy concretion (2), Cu alloy hearth lining (1) | | |
| 11860 | 627 | metalworking debris | Cu alloy fragment (2) | | |
| 12428 | 631 | metalworking debris | Cu alloy concretion (2) | | |
| 12514 | 635 | metalworking debris | Cu alloy concretion | | |
| 12427 | 642 | metalworking debris | Cu alloy concretion (2), Cu alloy offcut (1) | | |
| 12427 | 643 | metalworking debris | Pb scrap (2) | | |
| 11458 | 707 | metalworking debris | Pb strips (3) | | MD |
| 10549 | 712 | metalworking debris | Pb offcut | | |
| 11712 | 727 | metalworking debris | Pb waste | | |
| 10420 | 737 | metalworking debris | Pb scrap | | |
| 13305 | 891 | metalworking debris | Cu alloy (5) | | |
| 12741 | 953 | metalworking debris | Twisted and bent Pb strip. | | |
| 11207 | 989 | metalworking debris | Cu alloy concretion (1) | | |
| 13302 | 990 | metalworking debris | Cu alloy concretion | | |
| 11790 | 1004 | metalworking debris | Pb scrap | | |
| 11712 | 1057 | metalworking debris | Pb Offcut. | | MD |
| 13060 | 1218 | metalworking debris | Cu alloy concretion | | |
| 13683 | 1224 | metalworking debris | Pb folded strip | | |
| 14049 | 1225 | metalworking debris | Pb offcuts (2) | | |
| 10000 | 2005 | metalworking debris | Pb strip. | | MD 206 |
| 14388 | 2174 | metalworking debris | Cu alloy | | |

Key to abbreviations used in table.

Au Gold
Cu Copper
Fe Iron
Pb Lead
Sn Tin
MD Metal Detected Finds