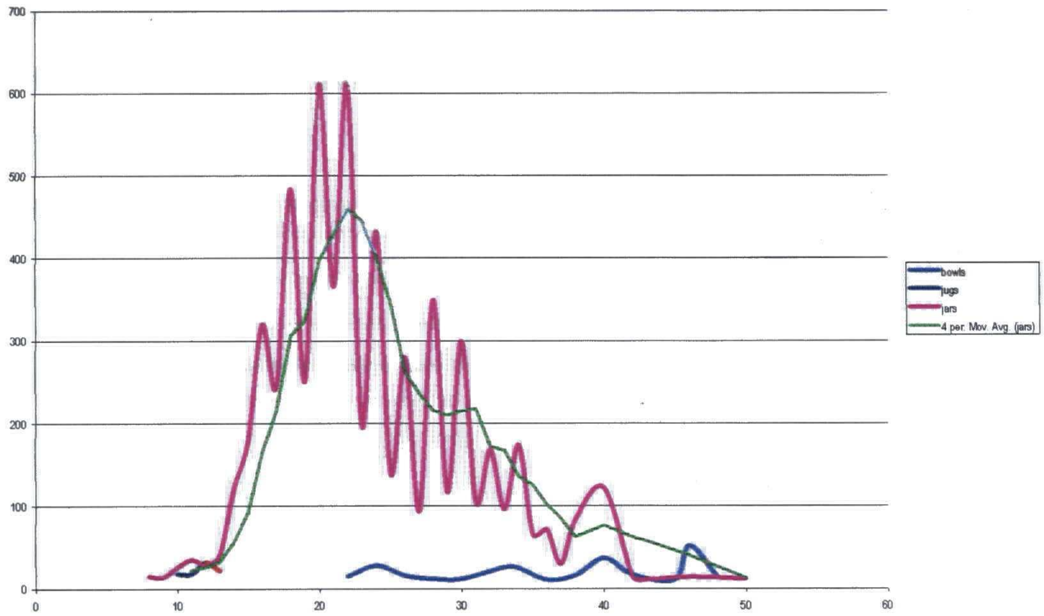
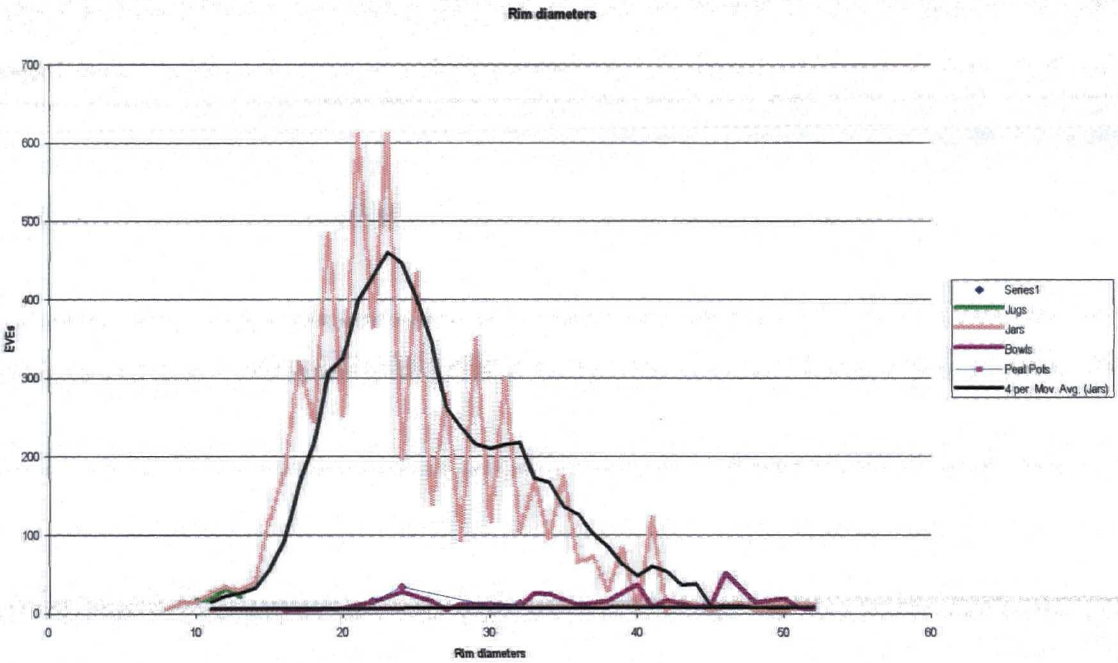
with a spigot hole close to the base and single examples of a possible *pedestal lamp* and an unidentified large vessel (perhaps a *storage jar*).

| Form | Sherds | Sherd Percent | Rim EVEs | Rim EVE % | Catalogue Nos. |
|---|---|---|---|---|---|
| Cistern | 3 | 0% | 0 | 0% | 97 |
| Curfew | 8 | 1% | 0 | 0% | 79, 106,108-11 |
| Large vess | 1 | 0% | 0 | 0% | |
| Pedestal lamp? | 1 | 0% | 0 | 0% | 112 |
| Jug | 18 | 2% | 90 | 1% | 92, 94, 98-100, 102, 104-5 |
| Bowl | 72 | 7% | 365 | 5% | 57-77 |
| Indet | 72 | 7% | 426 | 6% | |
| Jars and peat pots | 930 | 84% | 6339 | 88% | |
| Total | 1105 | 100% | 7220 | 100% | |






*Standardisation.*

The jars and peat pot rims appeared in the hand to occur in a set of standard sizes although when the data are plotted it is clear that there is a strong bias in recording towards assigning rims to an even diameter. If a trendline is used to smooth out this bias much of the distribution appears to be a normal curve. However there are inflexions at intervals which might indicate the intention to produce vessels with particular rim diameters. Because of the difficulty of determining rim diameters from small sherds the data were re-analysed using only rims with more than 10% of the circumference present. There is little difference in the overall pattern and we can conclude that the Staxton potters were producing their jars/peat pots with certain sizes in mind.

*Rim types.*

Previous studies of Staxton ware have demonstrated that there is a chronological progression in the form of rims used on jars although it was concluded that this general trend was difficult to employ on an individual basis (eg Le Patourel 1979). However, the current assemblage was sufficiently large and varied to justify employing a site-specific typology. Firstly, it would supply a means of testing the hypothesis arrived at by other means that the pottery originated in a single period production and was recycled into later deposits through a variety of mechanisms. Secondly, it should provide a fixed point for further studies of Staxton ware.

Accordingly, all 1071 Staxton ware rim sherds were examined and classified into fourteen major classes, which in some cases were subdivisable. Thus, all type 1 rims are from jars with thumbed rims which are everted and hollowed but these are then subdivided into three types, 1.1, 1.2 and 1.3. Some rims were classifiable only to major class level.

| Major Type | Form | Description | Number of specific types defined | No |
|---|---|---|---|---|
| 1 | Jar | Thumbed, hollow everted | 3 | 80 |
| 2 | Jar | Plain, hollow everted | 1 | 9 |
| 3 | Jar/peat pot | Flat everted rims | 13 | 478 |
| 4 | Jar | Flat everted with inner ledge | 2 | 2 |
| 5 | Small jar | Everted, rounded rim | 7 | 20 |
| 6 | Small jars | Inner ledge | 1 | 3 |
| 7 | Large jar or curfew | Thick, square rim | 1 | 1 |
| 8 | Jar | Thumbed rims, flat everted | 5 | 134 |
| 9 | Bowl | Everted plain | 1 | 26 |
| 10 | Bowl | Everted finger tipped | 1 | 25 |
| 11 | Bowl/jar | Everted rims | 2 | 63 |
| 12 | Jar | Collared rim | 6 | 135 |
| 13 | Bowl | Square rimmed, some thumbed | 5 | 21 |
| 14 | Jug | | 2 | 3 |

*Decoration.*

A restricted range of decorative techniques was used by the Staxton potters.

*White slip?* A single sherd (context 1001) had what might be white slip on the exterior.

*Applied strips (Nos. 74, 78, 96, 106, 111 and 114).* Thirty-eight sherds with applied strips of self-coloured clay were noted. Where the vessel form was determined they were the larger types, such as curfews, bowls and large vessels, although five sherds were jars/peat pots. The majority of these strips were decorated with finger-tip impressions.

*Combing (Nos. 69, 94, 108).* Nine sherds were decorated with combing. In two cases the comb was repeatedly stabbed into the surface of the vessel ('stabbed combing') and in one case - a jug or small jar - was applied as short strokes ('combed dashes'). The remainder (seven sherds) were decorated with combed lines, some of which were sinuous ('wavy combing').

*Finger-tip.* Finger-tip impressions were used in two ways:

a) around the edge of a rim (found on jars, bowls and peat pots). This is particularly common, occurring on 209 jar rims, 28 bowl rims and one definite peat pot *(Nos. 1-3, 6, 31-9, 50, 52-3, 68 and 71)*.

b) Around the shoulder, as a series of discrete 'dimples'. 34 examples have been recorded *(Nos. 18, 21)*.

*Grooved (No 92)* Three sherds were decorated with grooved lines (ie. Impressed into the clay surface with a round-tipped tool). One of these was identified as a jug sherd.

*Incised (Nos. 47, 59, 66, 79 and 95).* 25 sherds were decorated with incised lines (ie. Cut into the clay surface). Most of these lines (15 sherds) were wavy but two were horizontal and in eight this detail could not be determined.

*Pinching (No 110)* Two sherds had pinching of the base edge (a lid or curfew) or the rim edge (a bowl)

*Ribbing and ridging (Nos. 100 and 105).* Five sherds, one definitely from a jar, one from a small jar and two from jugs, were decorated with pronounced horizontal ridges.

*Slashing (No 60).* A jar or bowl rim was decorated with slashed lines, applied with a knife.

*Stabbing (Nos. 61, 64-5, 91, 93 and 107).* Twelve bowl rims were decorated with stabbed impressions, as were three jars and two small jars.

*Discussion.*

One of the questions posed of the Staxton pottery was 'does this waste represent a single phase of ceramic production?'. In order to test this the distribution of rim form classes was examined. The assemblages varied wildly in size, however. Twenty-nine contexts produced rim forms but of these all but all but ten of these produced ten or less rims. In such small assemblages the precise composition of the assemblage is likely to vary considerably as a result of the small sample size.

Consequently, data on the rim types present in the following contexts, deemed large enough for analysis, were examined using principal components analysis (PCA): 208, 1000, 1001, 1007, 1008, 1009, 1021, 1028, 1029, 1044 and 1051.

The results of this analysis show that the two components identified by the package are:

- component one - type 3 rims
- component two - type 12 rims

These two components allowed the ten contexts to be grouped into four:

| Group | Frequency of Type 12 | Frequency of Type 3 | Contexts |
|---|---|---|---|
| 1 | low or absent | 41 to 80% | 1007, 1044 and 1028 |
| 2 | 8-11% | 57-58% | 208, 1000 |
| 3 | 10-18% | 30-52% | 1001, 1009, 1021, 1051 |
| 4 | 50% | 3% | 1029 |

Since it seems that contexts 1029 and 1028 are in fact two samples of the same deposit and these two assemblages fall into the two extreme groups it is unlikely that the more subtle differences noted between the other three groups have any meaning.

The Staxton pottery industry is comparable with a number of others in which cooking wares (jars and bowls) formed the majority of the output but with unglazed jugs as a poor third. Examples of such industries are the Hertfordshire reduced ware industry which was to be found in a number of centres in Middlesex and Hertfordshire and the Newbury B industry which supplied a wide area around the Kennet valley in Berkshire. The potters in the former industry used the potters wheel and deliberately reduced their vessels and the comparison is therefore simply in terms of the range of vessels produced. The latter, however, is a much closer comparison: the vessels were handmade, were intended to have an oxidized surface and share the use of finger-tipped 'dimples' on jar shoulders.

As with the Hertfordshire industry, the Staxton ware pottery industry was spread across more than one centre. In this case, the neighbouring village of Potter Brompton supported a similar industry. Staxton wares (whether from Staxton or Potter Brompton) have been recorded on a number of sites in Yorkshire ranging from Hartlepool in the north to Beverley and Hull in the south with Wharram Percy in the middle. They are not, however, found in York, which seems to have always lain within a different ceramic tradition. Visual analysis of these traded Staxton wares casts some doubt over their identification and it is clear that the forms and typology employed by the Staxton ware potters was shared over a wider area - for example, some of the pottery produced at Hedon in the 12$^{th}$ century shares many Staxton ware features (eg McCarthy & Brooks 1988 Fig 137 illustrates dimple-decorated jars and peat pots). It is to be hoped, however that the analysis of Staxton ware carried out here will enable Staxton ware and Staxton-influenced wares to be distinguished in future.

### *10.2.2 Other Wares.*

Eighty-five sherds of other wares were recovered. Of these, all but 18 could be assigned a date range based on their occurrence on other Yorkshire sites.

| Cname | Full name | Date | Vessels |
|---|---|---|---|
| EYO | East Yorkshire Orangeware | mid 12$^{th}$ to 14$^{th}$ C | 5 |
| GYG | Splash glazed gritty ware | 12$^{th}$ to 13$^{th}$ C | 2 |
| HUM | Humber ware | 14$^{th}$ to 16$^{th}$ C | 1 |
| LERTH | Late earthenware (flowerpot) | 19$^{th}$/20$^{th}$ C | 1 |
| MISC | Miscellaneous | 12$^{th}$ to 14$^{th}$ C | 18 |
| MOD | Modern | 19$^{th}$/20$^{th}$ C | 1 |
| NYWW | North Yorkshire Whitewares | Late 13$^{th}$ to 15$^{th}$ C | 22 |
| SCAR | Scarborough ware | Late 12$^{th}$ to 13$^{th}$ C | 31 |
| YORK | York white/York glazed ware | Late 12$^{th}$ to 13$^{th}$ C | 4 |

Forty-two sherds were of later 12$^{th}$ to early 13$^{th}$-century types and twenty-two sherds are probably of late 13$^{th}$-century or later date (NYWW). Most of these later sherds were recovered during hand-cleaning of the site (context 1001) and the remainder were either associated with the rubble spread (1008 and 1009 - 7 sherds) or immediately below it (context 1011 - 1 sherd). A single sherd of late medieval Humber ware was found in context 1001.

*East Yorkshire Orangewares (EYO).*

This term has been used to describe fine-textured glazed redwares without obvious sand tempering. These wares are sometimes collectively termed Orangeware by Colin Hayfield and are included in Yorkshire Redwares in publications from the York Archaeological Trust. At least three sources are known: Beverley, Hedon and Little Kelk. The latter is by far the closest source to Staxton as the crow flies but both Beverley and Hedon could have greater claim to be the source of the Staxton sherds on economic grounds, in that Beverley was a major textile-production centre with connections by water to the Humber estuary whilst Hedon was a coastal port, of some importance before the rise of Kingston-upon-Hull in the later 13$^{th}$ century.

*Humber ware (HUM).*

Humber wares were produced at two main centres in the Humber estuary, West Cowick and Holme upon Spalding Moor. Their main floruit was the later 14$^{th}$, 15$^{th}$ and 16$^{th}$ centuries, although the later products are distinguishable by their dark glazes and purplish sheen. The single sherd from Staxton is not closely datable, although most likely to be of late medieval rather than post-medieval date.

*North Yorkshire whitewares (NYWW).*

A number of sherds of whiteware were found at Staxton. They have no clear typological features which would allow them to be assigned to a particular production centre but all probably come from kilnsites in the Hambleton Hills, of which the best known is Brandsby. A distinction is made at York between 'York ware' (see below) and 'Brandsby-type' ware on the grounds that the latter contains only scattered quartzose sand grains whereas York ware was probably deliberately tempered. Brandsby-type ware in York is thought to come into use in the mid 13$^{th}$-century, and there is a range of highly-decorated jugs produced in that ware which are very similar to York ware examples. Pottery manufacture continued in the Hambleton Hills into the post-medieval period (Ryedale ware) and it is unlikely that undiagnostic body sherds could be dated more closely than c.1250-1500.

*Scarborough ware (SCAR).*

The thirty-one sherds of Scarborough ware all come from glazed jugs. At least one sherd is from a tubular-spouted jug and two from highly-decorated 'knight jugs'. The precise chronology of Scarborough ware is unclear. The vessels were certainly still in use in the late 13$^{th}$ century since they are found in early levels in Kingston-upon-Hull but both the tubular-spouted vessels and highly-decorated types are probably of late 12$^{th}$ to mid 13$^{th}$-century date on typological grounds.

*York ware (YORK).*

Four sherds of York glazed ware were present. Two come from context 1009, one from context 1028 (the main deposit of Staxton ware waste) and one from context 1001.

Excavations at Lurk Lane, Beverley, have shown that highly-decorated York ware jugs were being made in the late 12$^{th}$ century and it seems from York that there is only a slight possible overlap with Brandsby-type ware in the mid 13$^{th}$ century.

### *10.2.3 Post-medieval Pottery.*

Two modern sherds were recovered from the topsoil, context 1000.

## ***10.3 Acknowledgements.***

Peter Hill undertook the initial sorting and recording of the pottery. Illustrations are by Zoe Pattinson and the classification, analysis and report are the joint responsibility of the authors.

## ***10.4 Bibliography.***

McCarthy, M & Brooks, C 1988 *Medieval Pottery in Britain AD900-1600* Leicester University Press.

## *Appendix One*

| Rim form | 0 | 201 | 203 | 208 | 1000 | 1001 | 1003 | 1007 | 1008 | 1009 | 1011 | 1012 | 1013 | 1014 | 1021 | 1023 | 1027 | 1028 | 1029 | 1036 | 1038 | 1044 | 1046 | 1050 | 1051 | 1064 | 1068 | 1080 | 1081 | 1086 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | | | 3 | | | | 1 | | | | | | | 1 | 4 | | | | | | | | | | | | |
| 1.1 | | | | | | | | | 2 | | | | | | | | | 14 | | | | | | | 1 | | | | | |
| 1.2 | | | | | 3 | 14 | | | 1 | | | | | | 1 | | | 4 | | | | | 1 | | | | | | | |
| 1.3 | 2 | | | | | 14 | | | 1 | | | | | | | | | 13 | | | | | | | | | | | | |
| 2.1 | | | | | 1 | 4 | | | 1 | | | | | | | | | 2 | | | | 1 | | | | | | | | |
| 3 | | 1 | | 1 | 3 | 29 | | | 2 | 7 | | 1 | | | | | | 10 | 1 | | | | | | | | | | | |
| 3.1 | 2 | | | 10 | 2 | 26 | | 4 | 2 | 7 | | | 1 | | 1 | | | 11 | 2 | | | | | | | | | 1 | | |
| 3.11 | | | | 3 | 2 | 2 | | 1 | 2 | 4 | | | | | | | | | | | | 1 | | 1 | | | | 1 | 1 | |
| 3.12 | | | | | | 1 | | | | | 1 | | | | | | | | | | | 1 | | | | | 2 | | | |
| 3.13 | | | | | 1 | 1 | | | 1 | | | | | | | 1 | | | | | | | | | | | | | | |
| 3.2 | 1 | | 1 | 16 | 4 | 27 | | 3 | 14 | 11 | 1 | 3 | 2 | | | 2 | | 3 | 1 | | | 1 | | | 1 | | | | | 1 |
| 3.3 | | | 3 | 16 | 4 | 17 | 1 | | 4 | 3 | | | | | 1 | 1 | | 7 | | | | 1 | | | 1 | | | 1 | | |
| 3.4 | 2 | | | 4 | 2 | 16 | | 6 | 2 | 6 | | | | | | | | 8 | 1 | | | 7 | | | 2 | | | | | 1 |
| 3.5 | 1 | | | 2 | | 15 | | | | 6 | | | | | | | 1 | 11 | | | | | | | | | 1 | | | |
| 3.6 | | | | 1 | | 26 | | 1 | 2 | 8 | | | 3 | | | | | 3 | | | | | | | | | | | | |
| 3.7 | | 2 | | 2 | | 6 | | | 4 | | | | | 1 | | | | | | | 1 | | | | | | | | | |
| 3.8 | | | | | | 1 | | | | | | | | | | | | | | | | | | | | | | | | |
| 3.9 | 1 | | | 2 | 2 | 3 | | | 4 | 4 | 1 | | | | 1 | | | | | 1 | | | | | | | | | 1 | |
| 4.1 | | | | | | | | | | | | | | | | | | 1 | | | | | | | | | | | | |
| 4.6 | | | | | | 1 | | | | | | | | | | | | | | | | | | | | | | | | |
| 5 | | | | | | | | | | | | | | | | | | | 1 | | | | | | | | | | | |
| 5.1 | | | | | | 2 | | | | | | | | | | | | 1 | | | | | | | | | | | | |
| 5.2 | | | | | 1 | 1 | | 1 | | | | | | | | | | | | | | | | | | | | | | |
| 5.3 | | | | | | 1 | | | 1 | | | | | | | | | | | | | | | | | | | | | |
| 5.4 | | | | | | 2 | | | | 1 | | | | | | | | | | | | | | | | | | | | |
| 5.5 | | | | | | 1 | | | | | | | | | | | | | | | | | | | | | | | | |
| 5.6 | | | | | | 2 | | | | | | | | | | | | | | | | | | | | | | | | |
| 5.7 | | | | | | 2 | | | | 3 | | | | | | | | | | | | | | | | | | | | |
| 6.1 | | | | | | | | | | | | | 1 | | | | | 1 | | | | | | | | 1 | | | | |

| Rim form | 0 | 201 | 203 | 208 | 1000 | 1001 | 1003 | 1007 | 1008 | 1009 | 1011 | 1012 | 1013 | 1014 | 1021 | 1023 | 1027 | 1028 | 1029 | 1036 | 1038 | 1044 | 1046 | 1050 | 1051 | 1064 | 1068 | 1080 | 1081 | 1086 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 7.1 | | | | | | | | | | | | | | | | | | 1 | | | | | | | | | | | | |
| 8 | | | | 1 | | | | | | | | | | | | | | | 1 | | | 1 | | | | | | | | |
| 8.1 | | | | | | 3 | | | | | | | | | | | | 5 | | | | | | | | | | | | |
| 8.2 | | | | 17 | 1 | 27 | | 12 | 1 | 2 | 1 | 1 | | | 1 | 1 | | 10 | 1 | | | | | | 2 | | | 1 | | |
| 8.3 | | | | | 1 | 5 | | | 2 | 1 | | | | | | | | 8 | | | 1 | | | | 1 | | | | | |
| 8.4 | | | | 8 | | 4 | | 2 | 1 | | | | | | | | 1 | 3 | | | | 1 | | | | | | | | |
| 8.5 | 1 | | | | 1 | 1 | | | | 2 | | | | | | | | 1 | | | | | | | | | | | | |
| 9.1 | | | | 1 | 1 | 8 | | | 3 | 5 | | 1 | | 1 | | | | 4 | | | | | | | | | 1 | 1 | | |
| 10.1 | 1 | | | 2 | | 15 | | 1 | 2 | 1 | | | 1 | | 1 | | | 1 | | | | | | | | | | | | |
| 11.1 | | | | 2 | | 13 | | 3 | | 3 | 1 | | | | | | | 2 | | | | | | | | | | | | |
| 11.2 | | | | 1 | 2 | 16 | | 2 | 6 | 7 | | | | | 2 | 1 | | 1 | | | 1 | | | | | | | | | |
| 12 | | | | | 2 | 3 | | | | | | | | | | | | | | | 1 | | | | | | | | | |
| 12.1 | 1 | | | 5 | | 38 | | | 2 | 3 | | | | | | | | | 4 | | | | 1 | | 2 | | | | | |
| 12.2 | 7 | | | 2 | 2 | 23 | | | 10 | 13 | | | | | | | | 1 | 4 | | 1 | | | 1 | | | | | | |
| 12.3 | | | | | | 1 | | | | | | | | | | | | | | | | | | | | | | | | |
| 12.4 | | | | | | 3 | | | | | | | | | | | | | | | | | | | | | | | | |
| 12.5 | | | | | | 2 | | | 1 | | | | | | | | | | | | | | | | | | | | | |
| 12.6 | | | | 1 | | | | | | | | | | | 1 | | | | | | | | | | | | | | | |
| 13.1 | | | | | | 4 | | | | | | | | | | | | | | | | | | | | | | | | |
| 13.2 | | | | | | 4 | | | 1 | | | | | | | | | | | | | | | | | | | | | |
| 13.3 | | | | 1 | | 2 | | | 2 | 2 | | | | | 1 | | | | | | | | | | 1 | | | | | |
| 13.4 | | | | | | | | | | 2 | | | | | | | | | | | | | | | | | | | | |
| 13.5 | | | | | | | | | | 1 | | | | | | | | | | | | | | | | | | | | |
| 14.1 | | | | | | | | | | 2 | | | | | | | | | | | | | | | | | | | | |
| 14.2 | | | | | | | | | | 1 | | | | | | | | | | | | | | | | | | | | |
| 32 | | | | 1 | | 1 | | | | | | | | | | | | | | | | | | | | | | | | |
| 36 | | | | | | | | | | 1 | | | | | | | | | | | | | | | | | | | | |
| 82 | | | | | | | | | | 1 | | | | | | | | | | | | | | | | | | | | |

## *Catalogue of illustrated sherds.*

| No | DN | Cont | form | Rim form | Decoration | Use | Comments | Sherd link |
|---|---|---|---|---|---|---|---|---|
| 1 | 137 | 1028 | jar | 1.1 | f-t rim edge | | four sherds | |
| 2 | 22 | 1028 | jar | 1.1 | f-t rim edge | | | |
| 3 | 36 | 1028 | jar | 1.1 | f-t rim edge | | | |
| 4 | 12 | 1028 | jar | 1.1 | | | | |
| 5 | 13 | 1028 | jar | 1.2 | | | | |
| 6 | 301 | 1001 | jar | 1.3 | f-t rim edge | | | |
| 7 | 16 | 1028 | jar | 1.3 | | | | vess3 |
| 8 | 17 | 1028 | jar | 2.1 | | | | |
| 9 | 20 | 1028 | jar | 3.01 | | | | |
| 10 | 272 | 1001 | jar | 3.01 | | | | |
| 11 | 428 | 1001 | jar | 3.01 | | | | |
| 12 | 20 | 1028 | jar | 3.01 | | | | |
| 13 | 530 | 1001 | jar | 3.01 | | | | |
| 14 | 31 | 1028 | jar | 3.01 | | | | |
| 15 | 395 | 1001 | jar | 3.02 | | | | |
| 16 | 573 | 1001 | jar | 3.02 | | | | |
| 17 | 26 | 1028 | jar | 3.03 | | | | vess2 |
| 18 | 1295 | 1028 | jar | 3.04 | f-t shoulder | | | |
| 19 | 25 | 1028 | jar | 3.04 | | ?soot | | |
| 20 | 141 | 1028 | jar | 3.05 | | | | |
| 21 | 587 | 1001 | jar | 3.05 | f-t shoulder | | firing cracks | |
| 22 | 145 | 1028 | jar | 3.05 | | | | |
| 23 | 218 | 1001 | jar | 3.06 | | | | vess8 |
| 24 | 311 | 1001 | jar | 3.07 | | | | |
| 25 | 263 | 1001 | jar | 3.08 | | | | |
| 26 | 514 | 1001 | jar | 3.09 | | | | |
| 27 | 432 | 1001 | jar | 3.11 | | | | |
| 28 | 477 | 1001 | jar | 3.12 | | | | |
| 29 | 556 | 1001 | jar | 3.13 | | | | |
| 30 | 14 | 1028 | jar | 4.1 | | | | |
| 31 | 82 | 1028 | jar | 8.2 | f-t rim edge | | | |
| 32 | 143 | 1028 | jar | 8.2 | f-t rim edge | | | |
| 33 | 214 | 1001 | jar | 8.2 | f-t rim edge | | | |
| 34 | 310 | 1001 | jar | 8.3 | f-t rim edge | | | |
| 35 | 265 | 1001 | jar | 8.3 | f-t rim edge | | | |
| 36 | 66 | 1028 | jar | 8.3 | f-t rim edge | | | |
| 37 | 942 | 208 | jar | 8.4 | f-t rim edge | | | |
| 38 | 83 | 1028 | jar | 8.4 | f-t rim edge | | | |
| 39 | 237 | 1001 | jar | 8.5 | f-t rim edge | | | |
| 40 | 580 | 1001 | jar | 12.1 | | | | |
| 41 | 287 | 1001 | jar | 12.1 | | | | |
| 42 | 1026 | 1008 | jar | 12.2 | | | | |
| 43 | 331 | 1001 | jar | 12.2 | | | distorted | |
| 44 | 498 | 1001 | jar | 12.2 | | | | |
| 45 | 313 | 1001 | jar | 12.3 | | | | |
| 46 | 307 | 1001 | jar | 12.4 | | soot | | |
| 47 | 409 | 1001 | jar | 12.5 | incised | soot | | |
| 48 | 582 | 1001 | jar | 12.5 | | | | |
| 49 | 918 | 208 | jar | 12.6 | | | | |
| 50 | 182 | 1028 | peat pot | 1.2 | f-t rim edge | | full profile | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 51 | 34 | 1028 | peat pot | 3.02 | | | | |
| 52 | 956 | 208 | peat pot | 8.2 | f-t rim edge | | firing cracks | |
| 53 | 955 | 208 | peat pot | 8.4 | f-t rim edge | | | |
| 54 | 215 | 1001 | peat pot | 12.1 | | | | |
| 55 | 136 | 1028 | peat pot | 12.2 | | | two sherds | |
| 56 | 1153 | 1007 | peat pot (pierced) | | | | pierced 2 holes, 4mm | |
| 57 | 19 | 1028 | jar/bowl | 11.1 | | | | |
| 58 | 800 | 1009 | jar/bowl | 11.2 | | | folded rim | |
| 59 | 1070 | 1008 | jar/bowl | 11.2 | incised wavy dec | | | |
| 60 | 72 | 1028 | jar/bowl | 11.2 | slashed diagonal lines | | | |
| 61 | 269 | 1001 | jar/bowl | 11.2 | stabbed | | | |
| 62 | 366 | 1001 | jar/bowl | 11.2 | | | ? Wear mark inner rim | |
| 63 | 1033 | 1008 | bowl | 9.1 | | | folded rim | |
| 64 | 391 | 1001 | bowl | 9.1 | stabbed | | | |
| 65 | 18 | 1028 | bowl | 9.1 | stabbed dashes | | | Vess 17 |
| 66 | 193 | 1001 | bowl | 9.1 | incised wavy dec | | | |
| 67 | 1061 | 1008 | bowl | 9.1 | | | firing cracks | |
| 68 | 23 | 1028 | bowl | 10.1 | f-t rim edge | | | |
| 69 | 583 | 1001 | bowl | 10.1 | combed stabbed | | | |
| 70 | 725 | 0 | bowl | 10.1 | f-t rim edge; incised wavy dec | | | |
| 71 | 199 | 1001 | bowl | 10.1 | f-t rim edge | | | |
| 72 | 216 | 1001 | bowl | 13.1 | | | | Vess1 8 |
| 73 | 257 | 1001 | bowl | 13.2 | | | | Vess9 |
| 74 | 1262 | 1051 | bowl | 13.3 | f-t applied strip | | worn | |
| 75 | 384 | 1001 | bowl | 13.3 | | | | Vess1 0 |
| 76 | 841 | 1009 | bowl | 13.3 | | | distorted | |
| 77 | 783 | 1009 | bowl | 13.4 | f-t rim edge; incised wavy dec | | | |
| 78 | 1227 | 1021 | | | f-t applied strip | | very thick, two sherds | |
| 79 | 825 | 1009 | bowl/curfew | 13.5 | incised wavy dec | | dec on inside and rim | |
| 80 | 1112 | 1001 | small jar | 5.1 | | | | |
| 81 | 117 | 1028 | small jar | 5.1 | | | | |
| 82 | 289 | 1001 | small jar | 5.2 | | | | |
| 83 | 1031 | 1008 | small jar | 5.3 | | | | |
| 84 | 780 | 1009 | small jar | 5.4 | | | | |
| 85 | 398 | 1001 | small jar | 5.4 | | | ? Same vess as DN380 | |
| 86 | 447 | 1001 | small jar | 5.5 | | | | |
| 87 | 544 | 1001 | small jar | 5.6 | | | | |
| 88 | 533 | 1001 | small jar | 5.7 | | | | Vess1 6 |
| 89 | 801 | 1009 | small jar | 5.7 | | soot | | |
| 90 | 64 | 1028 | small jar | 6.1 | | | | |
| 91 | 1291 | 1064 | small jar | 6.1 | stabbed rim & inner wall | | | |
| 92 | 1204 | 1011 | jug? | | grooved | | | |
| 93 | 1209 | 1013 | small jar | 6.1 | stabbed | | | |
| 94 | 640 | 1001 | jug/small jar | | combed dashes | | | |
| 95 | 600 | 1001 | | | incised wavy dec | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 96 | 11 | 1028 | jar | | f-t applied strip | | | |
| 97 | 605 | 1001 | cistern? | | | | pierced bunghole? | |
| 98 | 1281 | 1046 | jug | | | | rod; uhj with thumbing | Vess1 5 |
| 99 | 110 | 1028 | jug? | 3.03 | | | | |
| 100 | 912 | 1009 | jug | 14.2 | ridged body | | lip | |
| 101 | 167 | 1028 | jar | | | | fragment | |
| 102 | 699 | 203 | jug? | | f-t edges | | thick strap | Vess2 6 |
| 103 | 598 | 1001 | | | | | ?part of applied bung/handle | |
| 104 | 243 | 1001 | jug? | 5.3 | | | | |
| 105 | 878 | 1009 | jug | 14.1 | ridged | | | Vess1 3 |
| 106 | 738 | 1000 | curfew/bowl | 9.1 | f-t applied strip | int soot | | |
| 107 | 1 | 1028 | | | stabbed, wavy combed | | | |
| 108 | 181 | 1028 | curfew? | | combed wavy dec | | | vess2 1 |
| 109 | 1277 | 1046 | lid/curfew | | | soot (inside) | thick | |
| 110 | 676 | 1001 | lid/curfew | | pinched basal edge | | | |
| 111 | 61 | 1028 | large jar/curfew | 7.1 | f-t applied strip around neck | | | |
| 112 | 914 | 1009 | pedestal lamp? | | | | | |
| 113 | 621 | 1001 | lid/kfurn | | | | 10mm thick | |
| 114 | 1292 | 1064 | | | f-t applied strip | Reused | soot; trimmed to disc; post-fire perforation | |
| 115 | 1232 | 1014 | | | | Reused | trimmed to disc; post-fire perforation; soot | |

# 11.0 Appendix 3 ~ Metal-working debris and metal registered finds.



## *11.1 Introduction.*

An excavation was undertaken by On-Site Archaeology at a housing development site in Staxton. A north-south ditch crossed the site dividing it into two plots. On the western side quantities of pottery wasters were found from a local kiln while to the east were the remains of building [1088], a number of other structures, pits and a cobbled surface. All the metal-working debris came from the eastern area. The main occupation sequence at the site is dated to the 12th – 13th centuries.

## *11.2 Recording Methodology For The Metal-Working Debris.*

A total of 32.57 kg of slag and associated materials (666 pieces) were submitted for recording. The slag was brushed clean with a toothbrush and identified solely on morphological grounds by visual examination, sometimes with the aid of a x10 binocular microscope. They were recorded on *pro forma* recording sheets and the information entered into a Microsoft Access database using the following encoded fields: Context; Material; Type; Count; Weight; Comments. A note of probable fuel type has been recorded when fragments or imprints were incorporated within the slag.

## *11.3 The Iron-Smithing Slags And Associated Debris.*

All of the 32.57 kg of slag and associated debris were generated by iron smithing, the fabrication of bar iron into objects and the recycling of iron. The assemblage from the site is consistent in character and could all have been produced by a single smith working within, or near to, the excavated area, it is therefore discussed below as a single assemblage. The types of debris are presented below; for an explanation of the terms used also see below.

The categories of iron-smithing debris by weight and count.

| Type | Quantity | Weight (g) |
|---|---|---|
| Blast furnace slag | 1 | 119 |
| Cinder | 83 | 565 |
| Fired clay | 41 | 213 |
| Fuel ash slag | 2 | 12 |
| Hammerscale | * | * |
| Hearth Bottoms | 87 | 25984 |
| Unspecified slag | 247 | 1775 |
| Smithing-slag lumps | 145 | 2993 |
| Slagged stone | 7 | 110 |
| Tuyere | 1 | 123 |
| Vitrified hearth lining | 52 | 680 |

*** Present but not recorded**

The plano-convex hearth bottoms form in the hearth just below, or attached to, the tuyere and not actually in the base of the hearth. The ones from Staxton are very variable in size and weight, ranging from as little as 67g (length: 35mm; width: 55mm; height: 40mm) to a very large example 1.43 kilograms in weight (150mm x 140mm x 50mm). There are a total of five that weigh over 1 kilogram while three weigh under 100 grams. The diversity possibly suggests that the smith undertook a wide range of smithing tasks requiring different temperatures and different levels of cleanliness within the hearth. It probably also reflects the density of the slag and the quantity of glassy inclusions. Most of the hearth bottoms are quite compact and dense but a number have glassy tops or side extensions (recorded as eared in the catalogue) formed of a silicate rich slag. The sources of the silicate would have been the tuyere and/or hearth wall, sand in the fuel and possibly from fluxing the iron prior to welding. Some smiths flux iron, ie sprinkle the surface of the white hot iron with sand, to remove the oxidised surfaces of the iron to ensure a clean weld.

Many of the hearth bottoms have rust coloured surfaces, or are partially encrusted with iron and some are actively corroding. A few pieces have started to crack. These features indicate that the slags probably have a high iron content, possibly some in the form of small waste pieces of iron that have become separated from the iron being worked. The greatest loss of iron occurs when smithing at high temperatures, particularly the white heat (1350°C) needed for welding when some of the iron can 'burn' or melt in the hearth. It is important to keep the hearth as clean as possible during these operations and in modern practice all slag would be removed from the hearth before making a weld.

With such a large number of well preserved hearth bottoms (particularly from pit [1039]) another feature of the slag is noticeable, namely that many have a domed upper surface not the flat or slightly hollowed face that is more usual. This must relate to the usage of the bellows because it is the air draught that causes the flat or often hollowed upper surface. The reason for this feature, however, is far from clear.

Some of the hearth bottoms have a layered structure indicating that they have been left in the hearth for more than one smithing episode. Although it is now considered bad practice to do this it is not an uncommon feature of medieval slags.

The majority of the hearth bottoms are covered in minerally-preserved organics that resemble straw, wood and/or reeds. This type of material was evidently discarded with the slags and has been preserved by the iron within them. The only exceptions are the pieces from the cobbled surface [1027] which has none of this material attached. A piece of copper alloy was incorporated into one of the hearth bottoms from fill [1050]; another piece is also visible on a smithing-slag lump from the same context. Clearly the smith was producing – or recycling – iron objects with a copper alloy component. The slags from pit [1039] had modern plant roots growing through them.

Smithing-slag lumps are technically the fayalitic slags ($2FeO.SiO_2$) that move freely within the fire zone before coalescing to form the hearth bottom. These slags from Staxton are almost indistinguishable from the cinder – a silicate rich iron slag – and although in compositional terms they do form a continuum these are glassier than normal. The most likely explanation is that the smith was fluxing his iron or possibly the charcoal fuel had sand mixed in with it (which would suggest it was being produced on sandy soils). The use of peat for fuel (or peat charcoal?) combined with wood charcoal is another possibility because a fine white ash was found adhering to many of the slags. Peat can have a high silica content if it is composed of sedges and reeds. Peat is a slow burning, low temperature smouldering fuel and therefore not suited for iron smithing on its own. Peat charcoal can be made in clamps by building blocks of peat into a dome or in pits. The fierce heat produced by this fuel is apparently comparable to that of wood charcoal and has been produced in some treeless areas (eg Ireland, Orkney and Shetland) specifically for smithing iron (Estyn Evans 1957, 186; Fenton 1978, 237 - 8).

For the purpose of this catalogue the cinder is generally the small more rounded glassy pieces of slag whereas the smithing slag lumps are the more irregular and generally larger pieces, although some overlap will have occurred. Stone inclusions were uncommon in the hearth bottoms but they are fairly frequent in these two types and indeed in a few instances they may be slag coated stones. The presence of stones in blacksmiths' hearths is not uncommon throughout the medieval period which is bemusing because they will explode in the fire causing a severe risk to the smiths eyesight.

The small quantity of soil that was attached to the slag was brushed off and checked with a magnet for hammerscale. Large uncrushed pieces of plate scale were recovered from contexts [1011] (the layer under the collapsed building [1088]), the cobbled surface [1027] and from the three fills in pit [1039]. Spheroidal scale, which is probably produced during welding, was only noted in the pit [1039] contexts. This type of scale is, however, always much less common than the plate variety. The size and freshness of the scale are again good indicators that the smithing occurred on, or very close to, the site.

Most of the pieces of vitrified hearth lining are probably tuyere fragments (the cylinder or block of clay that protected the bellow nozzle from the heat of the fire) but no pieces include the remains of a tuyere hole. A probable cylindrical tuyere from pit [1039] lower fill [1050] has an external diameter of *c.* 260mm, is slightly chinned, and has a lip of slag attached that is not a true hearth bottom. The remains of another possible tuyere are attached to a hearth bottom from cobbled surface [1027]. This appears to be the curved lower edge of another cylindrical tuyere with a diameter of *c.* 200mm. A strange piece of vitrified hearth lining, unfortunately broken and only partially recovered, was also found in fill [1050]. It may be the remains of a tuyere but it has evidently been repaired (there is a sequence of at least four vitrified surfaces) suggesting that it may be part of the hearth. It has a right-angled section with one face being severely vitrified and slag attacked while the 'base' is sandier and less highly fired. Although about 250 grammes of this piece survives too much is missing for an interpretable reconstruction.

The main evidence for the fuel used for the iron smithing at Staxton is the large amount of charcoal incorporated within and adhering to the slag, the hearth bottoms in particular. Charcoal is a clean, high temperature fuel and is therefore ideally suited for this purpose. Whether peat or peat charcoal was also used is more problematical. Only certain peats would be suitable for smithing – those used in Orkney are described as black and oily (Fenton 1978, 237) – whether any were available near Staxton in the 12th – 13th century is unknown to the author.

### *11.4 Site Discussion.*

The slag assemblage discussed here represents only a small proportion of the slag that actually existed on the site because, in accordance with current excavation techniques, only a small section across most features was excavated. The site information used here is taken from an initial draft report written by Guy Hopkinson of On-Site Archaeology.

Romano-British and medieval slags are very different to those produced by smiths today (on account of the type of iron, fuel and hearth used) so it is difficult to estimate the amount of iron working a slag assemblage represents. This group is, however, likely to be the results of more than a short visit to the settlement by an itinerant smith and on a rough basis the production of one hearth bottom a day (Cowgill, McDonnell and Mills 1997) represents an absolute minimum of 59 days work. A built smithy structure would therefore be anticipated within which this work would have been undertaken.

The contexts that produced metal-working debris.

| Context | Description | Count | Weight (g) |
|---|---|---|---|
| 201 | Fill of pit 200 | 1 | 171 |
| 1001 | Spit hand cleaned | 5 | 1932 |
| 1008 | Building collapse | 3 | 490 |
| 1009 | Dark soil around rubble | 3 | 93 |
| 1011 | Foundation material under western extension | 29 | 4263 |
| 1027 | Cobbled surface | 58 | 1309 |
| 1028 | Layer | 1 | 19 |
| 1038 | Fill of pit 1039* | 2 | 124 |
| 1049 | Fill of pit 1039* | 69 | 4033 |
| 1050 | Fill of pit 1039* | 495 | 20140 |

*** Pit half sectioned.**

The majority of this material (24.3 kg) comes from pit [1039] located in the northern part of the eastern area of excavation. There are also large assemblages from layer [1011] and the cobbled surface [1027] (Table 2). Each of these groups differs slightly in character, although this may be due to the level of retrieval on site in the case of the assemblages from [1039] and [1011] (Most of the pieces from [1011] are large (mean weight 147g) while many smaller, almost crumb size pieces of slag and fired clay was collected from fill [1050] (mean weight 43g). It is difficult to establish where the focus of the smithing activity was because it may well have lain below the level that excavation was permitted because, in theory, the layers were not threatened by the development.

Two potential *foci* can be suggested: immediately to the east of the excavated area perhaps within part of building [1088] or to the west of building [1088] below the extension represented by walls [1034], [1035] and [1072]. Within this latter area existed what was tentatively described during excavation as a stone hearth or anvil setting [1074] surrounded by burnt material [1080] and [1081]. A smithing hearth by this date would have been a waist-high structure, probably rectangular in shape but not necessarily set against a wall. The iron anvil could have been set into a block made from a range of materials including an old tree stump. It is suggested in the report that the hearth and associated debris were external, however, this is extremely unlikely if this was indeed a smithy. One of the most important factors in iron smithing is good fire control and a knowledge of the temperature of the iron being worked and both are achieved to some degree by subtle changes in colour (Rural Development Commission 1995,14 – 20). This is why smithies are often quite dark places. It is certainly not desirable to smith in the open air unless circumstances demand it eg military campaign smiths had mobile forges that could, weather permitting, function without shelter. A wooden lean too would be sufficient, possibly supported by wall [1076], immediately to the west of building [1088]. If this was the case the purpose of the 0.5m wide passage is unclear unless it was solely for access. A smithy is not a noxious place or a fire risk, however, it could be noisy! If samples were taken from [1080] and/or [1081] it is important to check these for the presence of hammerscale and prills because they may resolve whether this area did indeed function as a smithy (Mills and McDonnell 1992).

Pit [1039] was cut into the cobbled surface [1027]. The pit fills contain no pottery (A. Vince, *pers. comm.*) and seems to have been backfilled almost exclusively with slag (particularly the lowest fill [1050]) and organic debris. Possibly the pit was dug to dispose of an unwanted quantity of slag (perhaps a slag heap) when a building changed use or the smithy went out of operation. The actual size of the pit was not established during the excavation. The few medieval smithies that have been adequately recorded appear generally to have localised heaps of slag 'out the back', with some material being used locally for road surfacing (McDonnell 1992, 4 – 6).

The cobbled surface [1027], through which pit [1039] was cut, butts onto the northern wall of building [1088]. Some of the slag is described as being fused onto these cobbles. The majority of the slag from this layer is cinder and is therefore small and light in weight (mean weight 24g) and most is fairly glassy. The heaviest piece weighs only 253 grammes. This is the type of material that may be found outside a smithy and much of it could have been distributed by the wind and trampling. For the slag to be fused onto the stones, however, must mean that it was deposited when hot. Slag is not usually removed from the hearth until it has cooled and solidified, for the main practical purpose that it is a semi-liquid 'black treacle' when the fire is hot. It therefore needs to be clarified whether the cobble stones themselves had slag fused onto them or if there were slagged stones from the hearth amongst them.

### *11.5 The Registered Finds Catalogue (In Context Order).*

Context 1000; RF 35. IRON NAIL, Post-medieval? Large rectangular slightly domed head measuring 28 x 15mm. The complete shank is 70mm long.

Context 1001; RF 37. IRON AWL. Square-sectioned shaft with round-sectioned tip; length 87mm.

Context 1001; RF 38. IRON FOLDING KNIFE OR RAZOR. Probably post-medieval. An almost complete blade with only the tip and part of the blade edge near the pivotal hole missing. Length (including thumb piece) 110mm; maximum blade width 22mm.

Context 1001; RF39. IRON HORSESHOE. Only the calkin and a short section of the end survives; no holes are present.

Context 1001; RF 40. COPPER ALLOY. Modern. A piece of waste or just possibly the remains of a simple crude buckle-plate. Surviving piece of sheet measures 18 x 15mm.

Context 1008; RF 15. IRON HORSESHOE. Post medieval. The calkin and two rectangular holes survive, through one of which protrudes a rectangular-headed nail.

Context 1011; RF 33. IRON PADLOCK SLIDE KEY. 13th century? The bit is too corroded to determine its form but it lies at a right angle to the shaft. The bow is circular with a central hole for suspension. The shank and bow have a combined length of 105mm. Hammerscale is present in the corrosion products and is clearly visible on the x-radiograph (BCR268).

Context 1011; RF 34. COPPER ALLOY WIRE. A 65mm long piece of wire with a circular section but of irregular thickness.

Context 1027; RF 3. IRON STAPLE. Approximately half survives; the arm measures 65mm.

Context 1050; RF 32. COPPER ALLOY SPUR ROWEL. 13th century -. A cast six-pointed star rowel with round sectioned points. There is no evidence for plating. Diameter 23mm.

Context 1080; RF 16. IRON OBJECT. Rod c. 85mm long; possibly a flattened staple?

## *11.6 Conclusions.*

It is likely that there was a smithy on or very close to this site at Staxton. A medieval village smith was usually a Jack-of-all-Trades, repairing and manufacturing goods to serve the local population and travellers passing by on the main road, from Scarborough and Filey to York, just to the north of the site. The presence of copper alloy in some of the slag indicate that the smith probably made composite objects or decorated some of those made principally from iron.

The small contemporary finds assemblage includes an iron padlock key from layer [1011], which has hammerscale within and adhering to its corrosion products. The short piece of copper-alloy wire from the same context maybe waste from the smithy because of its irregular thickness. Many iron objects at this date have decorative copper alloy inlays. There is also a hearth bottom from [1011] with copper-alloy inclusions.

The spur rowel that was found amongst the slag in pit [1039] fill [1050] is unfortunately not a closely datable type. A similar rowel was found at the Billingsgate, London excavations and although it is from a context dated 1200 – 1230 it is suggested that these small rowels are more likely to date from the mid 13th century (Ellis 1995,127 – 148). Although no pottery was found in this pit this rowel would suggest a mid to late 13th century date for the deposition of the slag and organic material in this pit.

## *11.7 Bibliography.*

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## *The Bulk Finds In Context Order*

## *Abbreviations Used In The Catalogue*

| | |
|---|---|
| BLAST | Blast furnace slag |
| CIND | Cinder |
| CHARC | Charcoal |
| FAS | Fuel ash slag |
| FIRE | Fired clay |
| HAMMS | Hammerscale |
| HB | Plano-convex hearth bottom |
| HL | Hearth lining |
| LGE | Large |
| MPOS | Minerally preserved organics |
| RF | Registered find number |
| SSL | Smithing slag lump |
| TUY | Tuyere |
| V | Very |
| VHL | Vitrified hearth lining |
| VIT | Vitrified |
| 75 x 50 x 22 | Hearth bottom length x width x height |

*Glossary Of Iron Working Terms And Codes.*

*Jane Cowgill.*

It is important to note that the slags generated by the same process form a continuum and that each type is not necessarily distinct from any other. There are, however, a number of types of slag that can confidently be assigned to a specific type of metal-working process and these are explained below followed by the more general forms and related debris. The codes used in the catalogue are in bold.

A wide range of factors concerning iron production and smithing are not yet understood and much misleading and over simplified information has been published. Fundamental aspects concerning the techniques, such as slag formation, is still poorly understood. Experimental archaeology and more informed excavations are gradually improving the situation.

It is recommended that the Historical Metallurgy Society Datasheets on metal-working are obtained from D Starley (Ancient Monuments Laboratory, English Heritage, Fortress House, 23 Savile Row, London) for the price of £1 made payable to Historical Metallurgy Society.

Unlike all other metals, before AD1500, iron was produced and worked only in the solid state; this technology is known as the Direct Process. The processes involved using this direct or bloomery technology are the extraction of the metal from the ore in a furnace, the compaction and purification of the metal to produce a bar during primary smithing and the working of the iron to an object in secondary smithing. Primary smithing is usually discussed with the smelting/ iron production because it is only after this stage that a saleable and workable piece of iron has been produced.

*Iron Production.*

Iron ores are commonly found throughout Britain, often in the form of iron oxide bog ores. For the early technologies to succeed it was essential that this ore was as rich as possible, over 70% iron oxide. (Iron slags commonly contain over 50% Fe). All ores were probably washed, bonfire roasted and crushed before being fed into the furnace. (McDonnell 1995a).

The basic furnace structure was a cylindrical shaft built of clay, between 1 and 2m high, with an internal diameter of 0.3 to 1m with an air hole through the furnace wall for the supply of the air draught (produced by bellows). At the base was an arch through the wall to allow the removal of the slag. Each furnace could have been reused for numerous smelts. The furnaces would have been covered by some sort of structure although the evidence seldom survives. When excavated the furnace remains can be very difficult to identify and often survive as little more than a reddened scoop in the ground (Crew 1995).

The most common form of fuel was charcoal (coal was never used for this technology) which was consumed in very large quantities (Crew 1991). The availability of this resource was probably the most important factor in determining the location of the smelting sites, available ores and clays for furnace building are usually more freely available.

To smelt iron the furnace has to be preheated and then the ore and further charcoal would be fed into it; the bellows meanwhile producing the draught. Two equally important operations occurred inside the furnace, the production of iron and the removal of the gangue (impurities within the ore *etc*) as liquidated slag. The slag collected at the bottom of the furnace and was often tapped off into a pit or hollow in the ground (**TAP**); some of the slag sometimes solidified in the channel connecting the furnace to the pit (**CHAN**). At the end of a smelt some slag may remain inside the furnace and allowed to cool there, this is known as furnace slag; it often has the imprints of the large pieces of charcoal used as fuel (**FURN**). The iron formed as a bloom (thus the term bloomery) attached to the inside wall of the furnace just below the air hole. When the bloom reached a large enough size to impede the air hole the smelt stops and the soft spongy bloom, a mixture of slag and iron, is extracted for refining and smithing to make it into a workable bar. This initial working of the iron is the primary smithing stage but the slags produced are similar to those generated by secondary smithing. Blooms are extremely rare archaeological finds because they can always be re-smelted if they are failures or shatter while being worked. (Crew 1996.)

*Secondary Smithing.*

This is the term used to describe the manufacture or repair of objects. Although this can be undertaken almost anywhere, permanent forges were often built. The main features of a forge are the hearth, often built waist high, a bosh or water container, the anvil and a pair of bellows. There was usually a tuyere on the hearth to protect the bellows' nozzle from the heat of the fire. This often took the form of a perforated cylinder or plate of clay or even a reused piece of tile. The most common fuel was charcoal although from the Romano-British period coal was occasionally used.

Iron smiths had a range of irons available to them varying from pure ferritic iron (relatively soft), iron containing phosphorus (relatively harder) to steels (potentially very hard, but more brittle) and were also probably involved in re-cycling broken and damaged artefacts of varied iron composition (McDonnell 1988, McDonnell 1989). Steel is the best material for use in the production of cutting or working tools, since it can be heat treated to produce the optimum toughness.

Secondary smithing produces a range of waste products, slag being the most common. The classic form is a 'plano-convex accumulation of slag', commonly called a 'hearth bottom', which is formed in the hottest part of the hearth just below the tuyere (**HB**). The terminology is incorrect, although it persists, in that it does not necessarily form in the base of the hearth. The usual shape is a convex base with a flattish top often with a shallow depression formed by the blast of air from the bellows. Another common waste product is termed 'smithing slag lumps' (**SSL**). These develop as free slag within the fuel filling the hearth. They are randomly shaped pieces of iron silicate generated during the smithing process which have failed to coalesce with the 'hearth bottom'. During formation the slag would be in a plastic, or semi-molten state and would need to cool before the smith could remove it from the hearth. The high temperatures produced in the hearth can lead to considerable quantities of the clay wall and the tuyere melting, leading to the formation of vitrified hearth lining and cinder, the latter a silica rich slag (**VHL**, **CIND**). The above slags would all have formed in the hearth.

The processes involved in the formation of these hearth slags are not completely understood. The possible 'ingredients' include ash, sand, impurities in the fuel, hammerscale and any iron that 'burns' (melts) in the fire. Free iron oxide is extremely reactive with silicates and therefore the hearth wall or tuyere will be attacked leading to the combining of the sand in the clays with the slags. A result is that the hearth wall and/or the tuyere may have to be repaired or replaced between smithing operations. In the final stages of formation the 'hearth bottoms' may be attached to the tuyere or hearth wall and can threaten, by their increasing size, to block the tuyere hole and thereby lessen the air draught into the hearth. When removed they are snapped off the wall, which usually removes a certain amount of the structure, again necessitating repair.

When the hot iron is hammered another waste product, hammerscale, is produced the presence of which may help in locating the anvil within a smithy archaeologically (**HAMM**) (McDonnell 1992b and 1992c). When heated by the smith the surface of iron oxidises and this oxidised layer flakes off when beaten producing thin flat plates of scale debris (plate hammerscale). Surface oxidisation can be avoided by careful placement of the iron within the fire (in a reducing zone) and by fluxing. Fluxing involves covering the metal surface with a thin layer of sand. Spheroidal hammerscale, small droplets of slag that have solidified and may be either hollow or solid, are also produced and is again created when the hot iron is hammered (Starley 1995). Hammerscale is easily trampled and can form a concreted layer that may be mistaken for iron pan. The significance of such deposits may not be recognised. Hammerscale is seldom recognised during excavations, indeed many archaeologists are unaware of its existence.

Unfortunately there is nothing that easily characterises a smithy archaeologically. An essential feature is the hearth, but these may have often been constructed at waist height and therefore little or nothing that is 'fired' and definable survives. Anvils and other tools are portable and valued objects and the water bosh need not be a sunken feature. The most important form of evidence is therefore the hammerscale and slag (McDonnell 1992b and 1992c). The presence of hammerscale in quite large quantities is thought to be a significant indicator of the presence of a smithy and in most circumstances this material will be found in an uncorroded state and is easily retrieved with a magnet (though often difficult to see when mixed with soils). Occasionally, however, hammerscale does corrode and resembles a type of 'loose' iron-pan (the circumstances when this occurs are not well understood). The presence of tuyeres and hearth lining is also important because it is thought that they remain close to their origins, namely the hearth. Another important part of the finds assemblage that is frequently overlooked are the iron fragments. Amongst these are often the bars, off cuts and general detritus of a smiths' waste products (see for example Ottaway 1992). Frequently they appear to be amorphous lumps, particularly if the iron is badly corroded.

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# 12.0 Appendix 4 ~ The Plates.

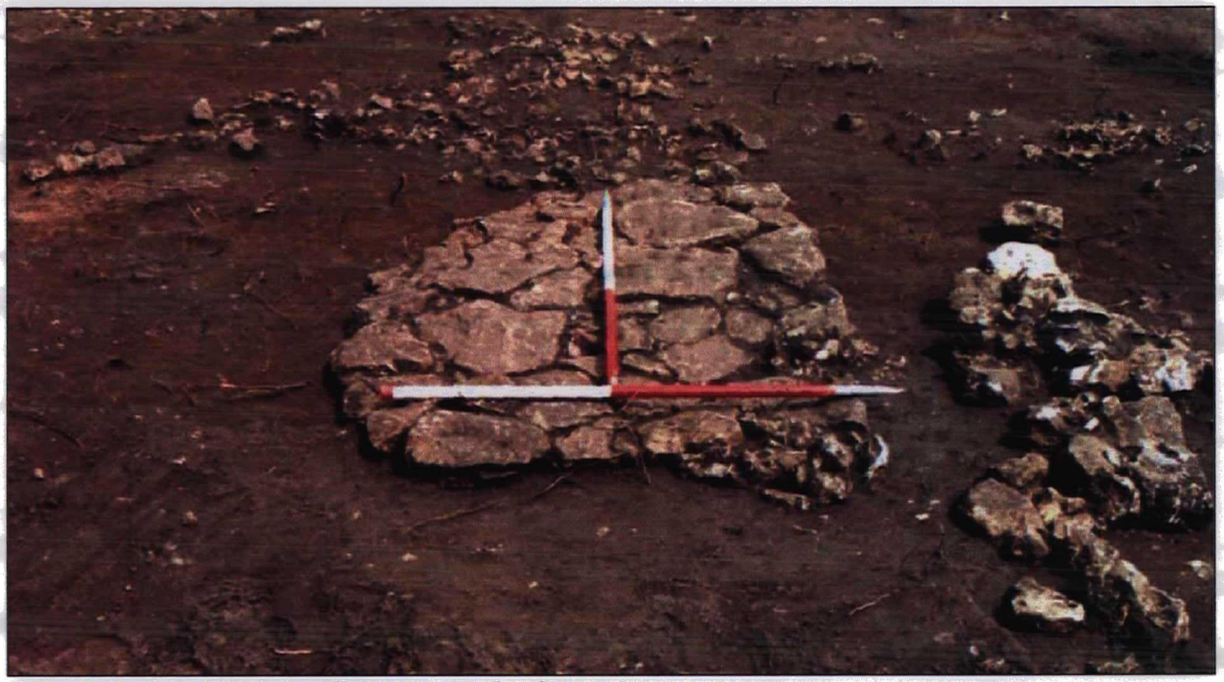

*Plate 1. Surface (1015) & wall (1017). (Scale of 2 x 1m).*

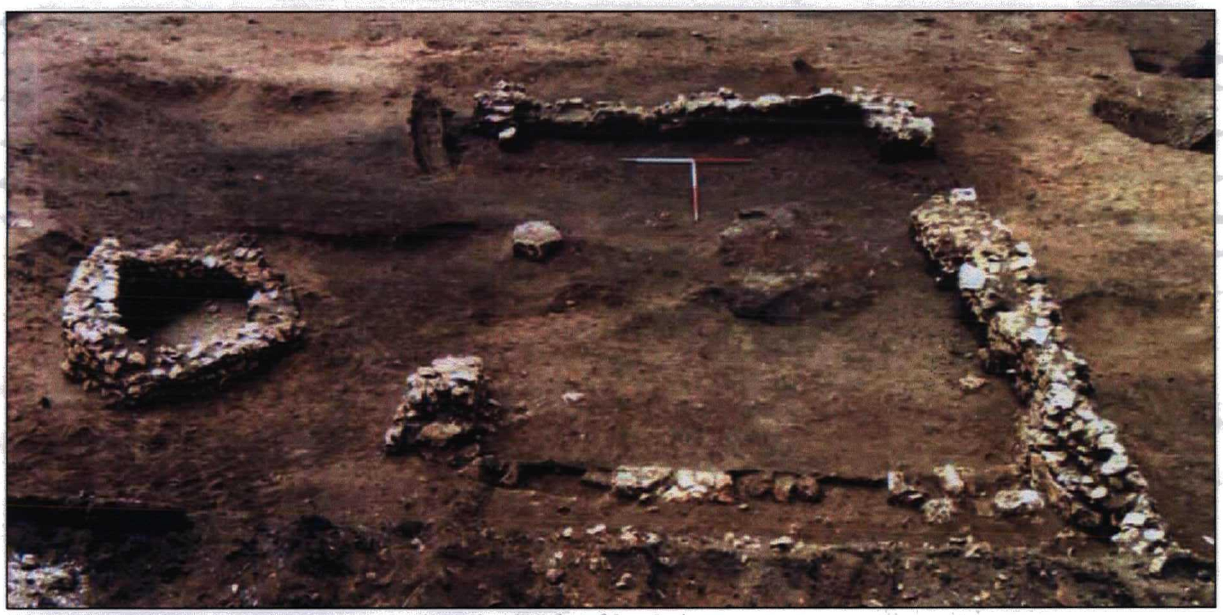

*Plate 2. Building (1088) & structure (1073). (Scale of 2 x 1m).*

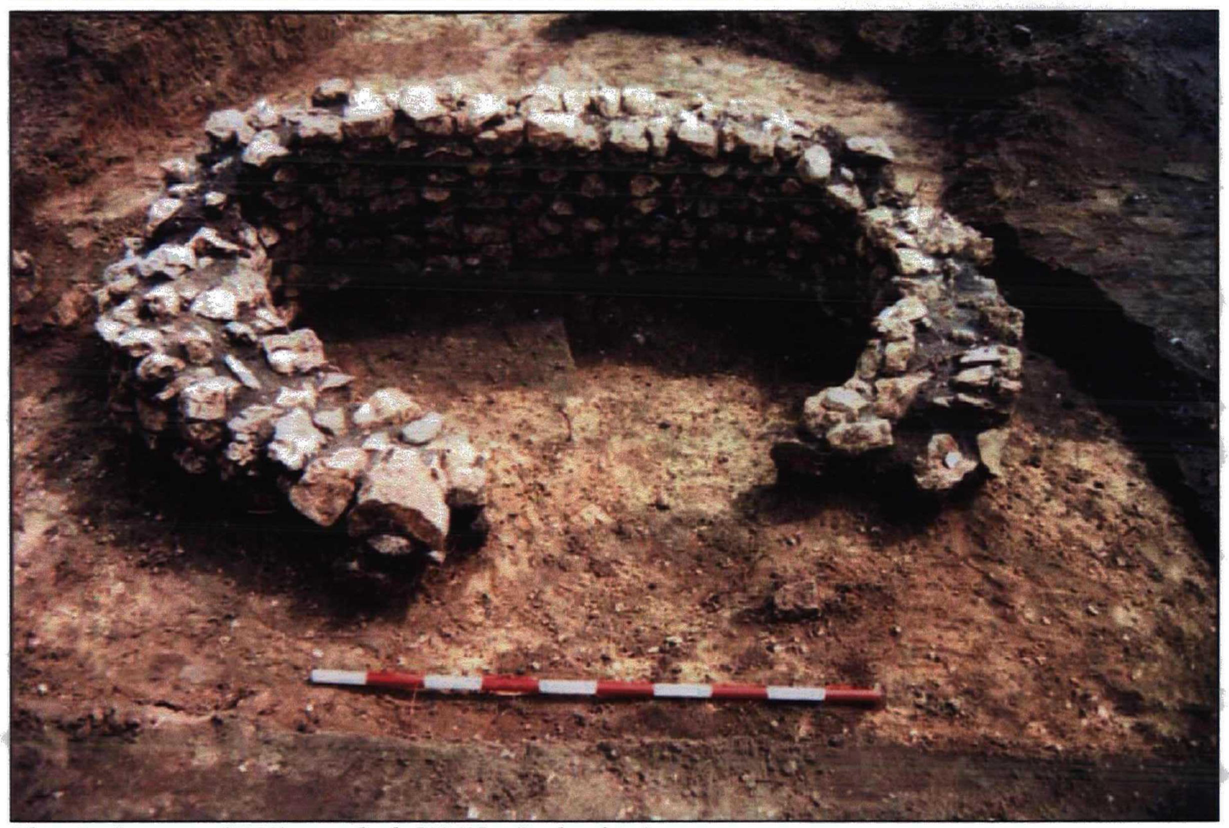

*Plate 3. Structure (1073) over ditch [1063]. (Scale of 1m).*