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# STANWICK, NORTHAMPTONSHIRE ASSESSMENT OF INDUSTRIAL DEBRIS

David Dungworth

Discovery, Innovation and Science in the Historic Environment

Smithing Slag



Vitrified Fuel Ash



Research Report Series 010-2016

## STANWICK, NORTHAMPTONSHIRE

### ASSESSMENT OF INDUSTRIAL DEBRIS

David Dungworth

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## **SUMMARY**

The excavations at Stanwick recovered 97kg of slag and other industrial debris. The range of debris types identified indicates that smithing took place. The extent of the area excavated and the duration of past occupation suggest that this was a relatively minor activity. The ironworking residues are not uniformly distributed with a single context providing over 25% of all the ironworking residues. The vitrified fuel ash residues identified are not waste from an industrial process; however, the formation process(es) for this sort of material are not well understood.

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## INTRODUCTION

English Heritage undertook extensive excavations at Stanwick, Northamptonshire (1984 to 1991) ahead of gravel extraction. An assessment of the industrial debris carried out in 1995 (Starley 1995) identified evidence for iron smithing; however, this assessment did not provide a full quantification of the material. This report incorporates the results of Starley's (1995) assessment report and provides the full quantification of all industrial debris from Stanwick.

## METHODS

All of the retained industrial material from the 1984–1991 archaeological excavations at Stanwick, Northamptonshire was re-examined using the methods outlined in the relevant Historic England guidance (Historic England 2015). All material was examined visually, and in some cases the material was washed in water to remove adhering soil. Iron-rich corrosion products obscured the surfaces of the debris to varying degrees. In rare cases, the nature of the debris was further investigated by using a geological hammer to obtain a fresh fracture surface. A magnet was used to test the iron content of selected pieces of industrial debris and separate out iron objects. Several diagnostic categories of industrial debris were recognised during the assessment and the terms used are described in Table 1. All of the material was weighed: if >1g then to the nearest 1g, if 0.1–1g then to the nearest 0.1g, and if >0.1g then to the nearest 0.01g. No attempt was made to record the number of fragments due to the rather friable nature of some of the residues (*eg* VFA). Most of the residues examined could be easily assigned to one of the categories described in Table 1; however, some fragments displayed a range of characteristics typical of more than one category of residue. Some daub showed signs of having been heated and so resembled some VCL. Similarly some VFA clearly included fragments of partially vitrified ceramic which resembled VCL.

*Table 1. Types of industrial debris from Stanwick*

SHC	Smithing Hearth Cake Exemplary specimens are plano-convex (or concave-convex) and approximately 100–200mm across and 20–50mm deep. The upper (plane or concave) surface often shows more signs of vitrification than the lower (convex) surface. The latter surface often contains impressions of charcoal fuel. The slag is usually black in colour.
VCL	Vitrified Clay Lining Oxidised (red-orange) clay on one side (the exterior) with a black and vitrified surface on the other side (interior of the hearth).
HS	Hammerscale Small fragments of iron oxide formed during smithing. Hammerscale is usually black and plate-like, 1-5mm across and 0.1–0.2mm thick. Rarely spherical (1–3mm diameter).

ND	<p>Non-diagnostic ironworking slag</p> <p>The black colour of this slag suggests that it was almost certainly produced during the working of iron; however, the small size of many pieces (and their highly fractured state) prevents the identification of the exact process which produced them (smelting or smithing).</p>
TAP	<p>Tap slag</p> <p>Ironworking slag (black) with a smooth, flowed upper surface. Usually formed during iron smelting and allowed to flow from the base of a bloomery iron smelting furnace.</p>
BFS	<p>Blast furnace slag</p> <p>Usually pale blue or green with a vitreous fracture. Produced during iron smelting but using a blast furnace (cAD1500+).</p>
Cu slag	<p>Copper (alloy) slag</p> <p>Small amorphous lumps of slag coloured green by the corrosion of copper (alloys). Probably formed during the melting and casting of copper alloy objects.</p>
Cu spill	<p>Copper (alloy) spillage</p> <p>Small amorphous lumps of copper (alloys). Probably formed during the melting and casting of copper alloy objects.</p>
Cu conc	<p>Copper alloy concretion</p> <p>Small amorphous lumps of soil partially concreted with copper (alloy) corrosion products. Such concretions often represent no more than the corroded remains of a copper (alloy) object.</p>
Pb spill	<p>Lead spillage</p> <p>Small amorphous lumps of lead. The surfaces of these lumps are routinely covered in creamcoloured lead corrosion products. Probably formed during the melting and casting of lead objects (confirmed with EDXRF).</p>
DAUB	<p>Daub</p> <p>Clay-based material used for constructing ovens, hearths, furnaces and buildings. Unlike VCL, daub is usually oxidised fired (red-orange) throughout. Most pieces are too small to allow the form of the structure to be reconstructed.</p>
VFA	<p>Vitrified Fuel Ash</p> <p>The vitrified remains of burning non-mineral fuels (especially wood). This material is characterised by its light weight and the high degree of porosity. Fresh fracture surfaces are usually vitreous and black or green in colour. The surfaces have usually weathered to a cream colour. Vitrified fuel ash is usually amorphous and shows signs of partial fusion but no flow. The examples from Stanwick sometimes occur as quite large masses (&gt;100g) and fresh fracture surfaces reveal a grey colour. Some larger pieces appear to have a texture similar to over-fired and partially vitrified ceramic.</p>
PBC	<p>Partially burnt coal</p> <p>Black, vitreous and porous, slag-like material which forms when coal is incompletely burnt (the organic content and the presence of sulphur confirmed with EDXRF).</p>
GEOL	<p>Naturally-occurring geological materials</p> <p>Rocks and other geological materials, some of which can be mistakenly identified as slags or other residues. In some cases (<i>ie</i> smelting sites) these materials can include specimens of ore and/or gangue (waste rock).</p>
HMR	<p>Heat-magnetised residues</p> <p>Small &lt;5mm pieces of soil, ceramic and geological materials which have become partially magnetised as a result of heat (including possibly a domestic fire). HMR is often found in sieved residues from environmental samples — it usually has very limited significance for understanding past industrial processes.</p>

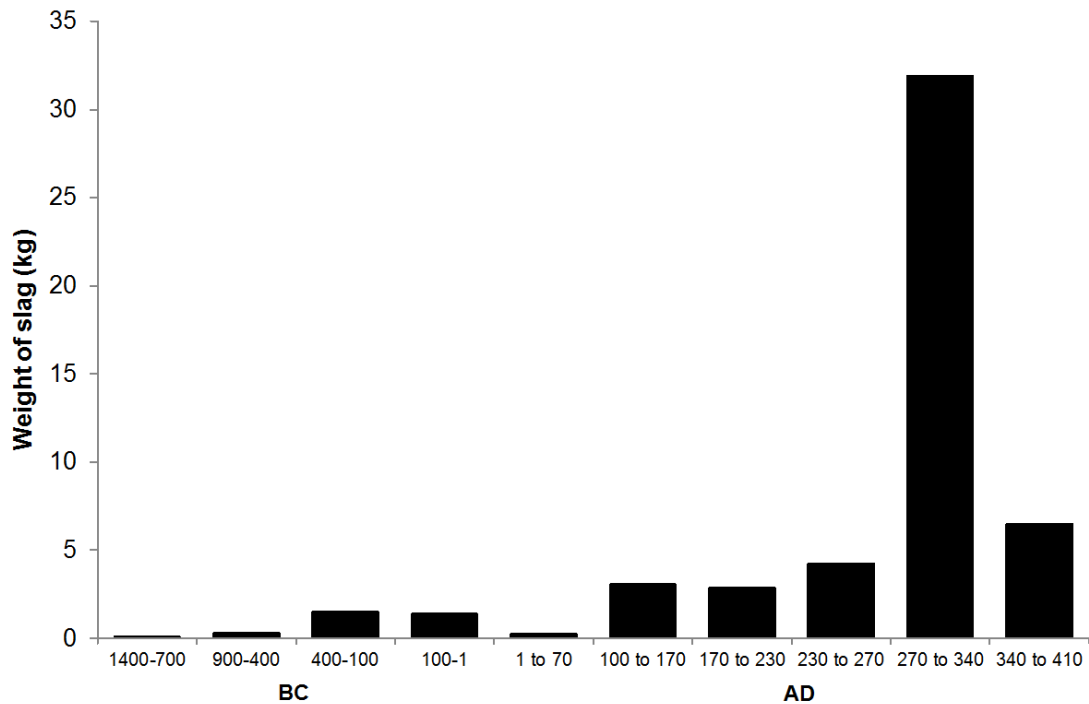
- ? Unidentifiable  
Some of the very smallest fragments of slag recovered archaeologically (especially from sieved environmental samples) are so small and/or fractured that they might not be identified at all.

## RESULTS

The Stanwick industrial residues (summarised in Table 2) include almost 97kg of material (not all of which was certainly produced by an industrial process). The single most abundant category of industrial residue is non-diagnostic ironworking slag (almost 62%). While individual examples of this material cannot be identified as the result of iron smelting or iron smithing, when considered in relation to the assemblage as a whole it is usually possible to suggest how most was produced. The second most abundant category is smithing hearth cakes (almost 23%) which indicate that iron smithing took place. The very small amount of iron smelting (TAP) slag (0.3%) suggests that no iron smelting took place within the areas excavated. Most of the early iron smelting sites in Northamptonshire are found further north of Stanwick, especially within the Forest of Rockingham (Condron 1997). The low levels of smelting slag and the presence of a substantial proportion of SHC suggests that most (if not all) of the ND slag was formed during iron smithing.

*Table 2. Proportions of different categories of industrial material*

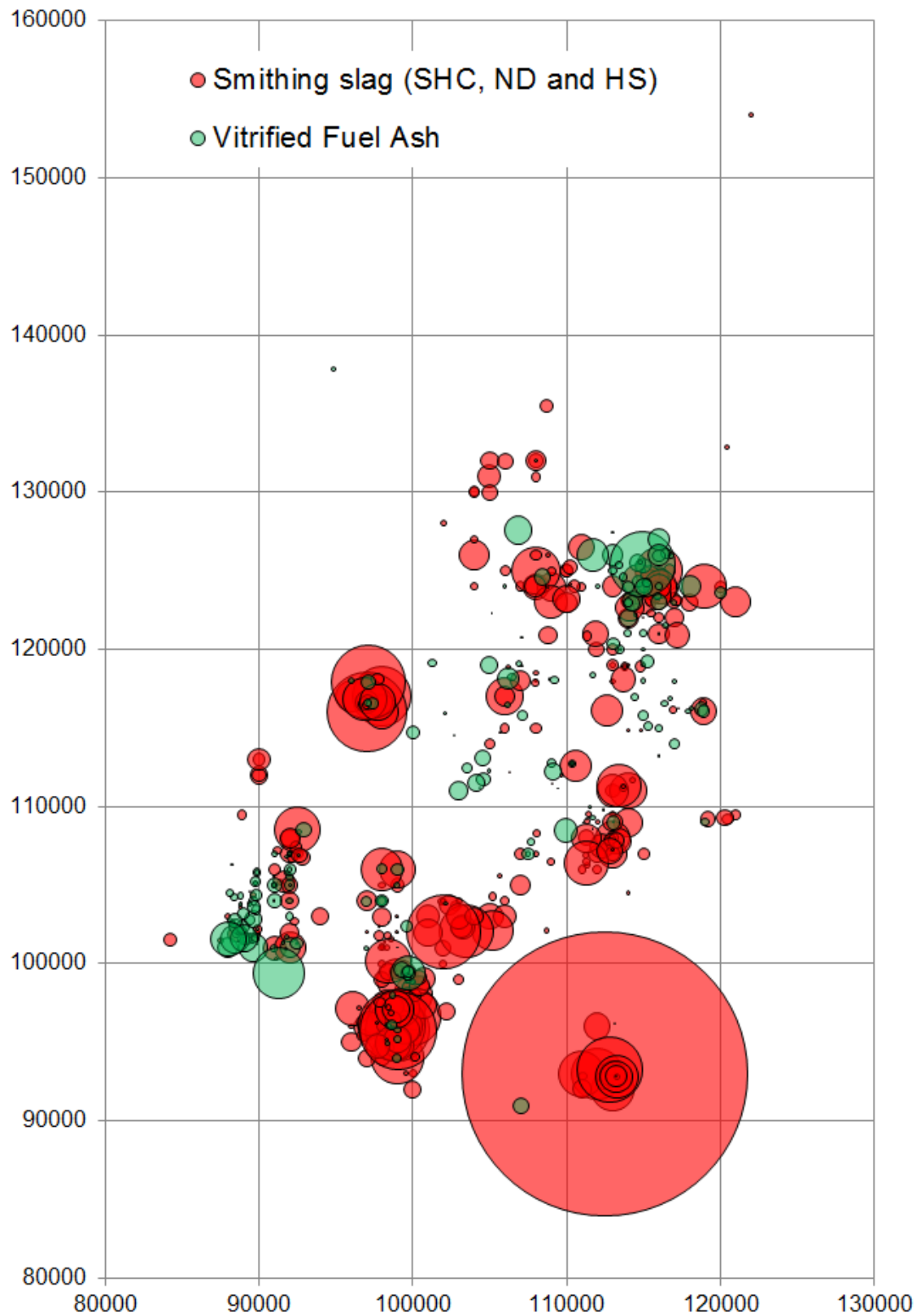
<b>Type</b>	<b>Weight (g)</b>	<b>Proportion (%)</b>
SHC	22,030.0	22.8
VCL	1,347.5	1.39
HS	76.8	0.079
ND	59,534.8	61.6
TAP	242.0	0.25
BFS	137.0	0.14
Cu slag	24.0	0.025
Cu spill	34.0	0.035
Cu conc	5.0	0.005
Pb spill	951.0	0.98
DAUB	1,436.1	1.49
VFA	9,480.4	9.8
PBC	2.3	0.002
GEOL	1,125.0	1.16
HMR	0.3	0.0003
?	240.9	0.25
<b>Total</b>	<b>96,667.2</b>	



*Figure 1. Chronological distribution of iron smithing slags (SHC, HS and ND). Nearly 80% of the smithing evidence from contexts dated to 240 to 340AD came from a single context: 85207*

The identification of smithing as the most significant metalworking activity at Stanwick is further strengthened by the recovery of small amounts of hammerscale (0.1%). The relatively small amounts of hammerscale recovered probably reflect the fact that the sampling strategy was not aimed to recover hammerscale.

Ironworking slags were recovered from 376 contexts but 33% of the ND and 20% of the SHC came from a single context: 85207, dated to 270 to 340AD (this context also provided over 60% of the hammerscale recovered). Context 85207 is a fill of a feature within an enclosure (LE192058). Other contexts with at least 1kg of ironworking slag include: 2 (undated), 65514 (undated), 65518 (undated), 67408 (100 to 170AD), 84995 (340 to 410AD), 84300 (undated), 88003 (220 to 270AD) and 89518 (undated). Most of the contexts from which industrial residues were recovered could be dated (Figure 1) and from this it is clear that iron smithing was a minor activity (less than 0.4kg of iron smithing slag came from prehistoric contexts). Within the Roman period there appears to be a peak of smithing activity within the late third century and early fourth century; however, most of this peak comes from a single context (85207).



*Figure 2. Spatial distribution of the iron working slags (red) and the vitrified fuel ash (green). The area of each circle is proportional to the weight of material recovered. The grid is based on the site coordinates*

The iron working slags (Figure 2) are found in most areas excavated at Stanwick, although three possible foci can be recognised:

1. Associated with a late third- and early fourth-century enclosure (LE192058, includes contexts 85207, 88003 and 88109),
2. A series of ashy and stony layers within the later fourth-century villa (especially contexts 84723, 84995, 86282, 86376 and 86394) and
3. The second-century fill of a ditch (especially context 67408, fill of 67407).

The third most abundant residue is VFA which is found in higher proportions than is common for this sort of material. Nevertheless, this phenomenon is shared by a number of sites with Iron Age occupation (Andrews 2009; Cowgill *et al* 2006; Grimes and Close-Brooks 1993; McDonnell 1986; Salter 1991; Young 2011). It is possible that the VFA described here corresponds to the 'Iron Age Grey' proposed by Cowgill and colleagues (Cowgill *et al* 2001). The Stanwick VFA was recovered from all contexts spanning the late Bronze Age to the end of the Roman period (Figure 3); however, 3.4kg was recovered from prehistoric contexts and 3.1kg from Roman contexts (with another 3kg from undated/unphased contexts). It is likely that the VFA from Stanwick derives from a non-metallurgical process. VFA was abundant (>200g) in the following contexts: 4557 (undated), 4709 (220 to 270AD), 4873 (Iron Age), 8759 (400 to 100BC), 9023 (Iron Age), 9426 (170 to 230AD), 48102 (220 to 270AD), 84603 (340 to 410AD) and 87210 (100 to 1BC). These nine contexts contained 42% of all of the VFA from Stanwick. The idea that this material is not related to metallurgical activities is strengthened by the fact that these same contexts contained no metallurgical slags. This separation can also be seen in the different spatial distribution of iron working slags and VFA (Figure 2).

The VFA is found in most areas excavated at Stanwick (Figure 2), although two possible prehistoric foci can be recognised:

1. Associated with roundhouse 87210, the fill of a pit 4873 (which also contained pot boilers), and the fill of ditches 4766 and 8759) in the south-western part of the site, and
2. A cluster of features (such as the fill of a pit 9023 and the fill of a ditch 8759) in the north-western part of the site.

The remaining material makes up a very small proportion of the residues examined and it is unlikely that it represents any other significant metalworking at Stanwick. Blast furnace slag was found in two contexts (45017 and 45026) and both of these (undated/unphased) contexts are likely to have been deposited after cAD1500. Copper (alloy) slag/spillages and lead spillages were found in a few contexts (81800, 82000, 82001, 82002 and 82003) but these were unstratified contexts (and in one case used to record material from a spoil heap).

The assessment of the industrial residues from Stanwick included material recovered as bulk finds and material recovered during the sieving of environmental soil samples. The residues were recovered from a total of 793 contexts: material was collected as bulk material only from 507 of these contexts, while 39 contexts had material collected both as bulk finds and material from environmental samples and 247 contexts provided material only from environmental samples. The environmental samples provided 5.3kg of material while the bulk samples provided 93kg. The residues from the environmental samples made a relatively small contribution to the industrial residues assemblage but required a disproportionate amount of time to examine and record (Table 3). In most cases the residues from the environmental samples comprised material 1–4mm across and this made material identifications difficult — just over 95% of all of the unidentifiable (?) material came from the environmental samples.

*Table 3. Rates of recording material from bulk finds and environmental samples*

	<b>Weight (g)</b>	<b>No. of bags</b>	<b>Time (mins)</b>	<b>Weight (g) per minute</b>	<b>No. of bags per minute</b>
Bulk	93236	716	985	95	0.7
Environmental	5332	560	388	14	1.4

## SUMMARY

The industrial residues recovered from Stanwick indicate that smithing of iron took place; however, the quantities of material recovered (82kg), the extent of the area excavated (30ha) and the duration of past occupation (500? years) suggest that this was a relatively minor activity (cf Hatton 2004). The ironworking residues represent the accumulation of just over 5g per year per hectare. The ironworking residues are not uniformly distributed. Context 85207 provides over 25% of all the ironworking residues and probably relates to the operation of a smithy. The vitrified fuel ash residues are not waste from an industrial process; however, the formation process(es) for this sort of material are not well understood.

## FUTURE RESEARCH

There are two elements of the Stanwick industrial residue assemblage which could fruitfully be investigated in the future.

The first topic covers iron smithing in a rural context in Roman Britain. The fairly large assemblage from context 85207 probably represents the output of a single workshop over a limited period of time. The detailed examination of a range of smithing slags from this context using metallographic examination and chemical analysis (cf Anderson *et al* 2004; Mangin *et al* 2000; Serneels 1993; Soullignac and Serneels 2013) would improve our understanding of iron smithing and the formation of smithing slags (McDonnell 1991).

The second topic covers the formation and significance of vitrified fuel ash. This porous, light-weight material is evidence for the combustion of organic materials and fusion of the remaining ash. Some of the processes which may have produced fuel ash slag include the burning of:

- 1) haystacks (Biek 1977; Nickolls 1977),
- 2) animal dung (Evans and Tylecote 1967), and
- 3) wattle and daub (Biek 1978; Salter 2005).

The detailed examination of such material from Beckford (Dungworth and McDonnell forthcoming) suggests that the vitrified material from that site was produced by reactions between wood ash and soil and/or ceramic material (possibly daub) at temperatures between 850°C and 1150°C. Mack and McDonnell rule out a metallurgical association but suggest a slightly higher temperature of formation (Mack and McDonnell 2006). Detailed metallographic analysis combined with chemical and mineralogical analysis could establish the formation process(es) for the Stanwick VFA.

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