Report on the slag and associated finds from Sprotbrough Gardens, Near Doncaster (OSA01 EX03.Doncaster Museum No 2001.8)

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Introduction

A number of medieval and post-medieval features were excavated by On Site Archaeology, and some of these cut a buried soil horizon in which some Romano-British and prehistoric features were identified.

Methodology

A total of 3769g (36 pieces) of slag and associated finds were submitted for recording (Table 1). The slag was 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: Site; Context; Type; Count; Weight; Craft; Fuel; Condition; Comments. A note of probable fuel type has been recorded when fragments or imprints were incorporated within the slag. The soil in the associated bags, that had been scrapped of the slag before it was washed, was checked with a magnet for hammerscale but none was noted. The catalogue forms Appendix 1.

Description of the slag

This is a perplexing assemblage that includes some distinctly odd and unusual slags. There is also no obvious evidence for iron smithing although there are some definite iron smelting (production) slags (Table 1). These are in the form of pit-furnace block slags, a type of slag rarely encountered and at present poorly dated. The best examples from Sprotbrough are from Context 3087, a buried soil horizon.

Table 1. Summary of the slags and associated finds from the site.

Craft	Type	No	Weight
Iron smelting	Block (pit-furnace slag)	2	1508g
Iron smelting	Slag (block fragment?)	1	75g
Iron smelting	Tap	3	21g
Iron smelting?	Slag	1	123g
Iron smelting?	Tap	5	162g
Iron smelting or smithing	Slag	7	1043g
Iron smelting or smithing?	Slag	4	276g

	Cinder	6	237g
	Iron object	1	15g
	Slag	3	271g
	Vitrified hearth lining	3	38g

The largest block fragment (weight 1158g), like all slags of this type, possibly formed in a shallow pit below the furnace (the traditional interpretation based on later Continental examples), but it is also possible that they formed in a pit alongside it or even within the actual furnace. Very little is known about this technology and no British furnaces have been found associated with this type of slag. The base of the feature that moulded this example appears to have been square or rectangular in shape with rounded corners as the form of one corner and portions of the straight sides survives on this piece. The base is covered in reduced fired clay from the pit/ furnace lining. The slag is densest towards the base while the slag above contains a mass of small charcoal imprints. Patches of the slag is slightly magnetic. The maximum surviving height is 90mm and this could be the actual height of the block, but on one section towards the original centre of the piece it is only *c*. 10mm thick between the flat base and flowed top. The top of the highest part has an angular crystalline structure and has probably never been hot enough to be liquid. This factor suggests that it either formed in a pit below the furnace or within it. The slag could be the by-product of a single smelt because it was probably never particularly large.

The smaller block from the same context (weight 350g) has frequent massive charcoal imprints, a common characteristic of this type. The largest measures *c*. 50 x 40 x 30mm. There is a small surface area, probably part of a side and occasional grey and pinkish fired clay inclusions.

Other pieces that are block fragments come from Context 3140 (fill of Pit 3139 dated Mid-Late 12th Century) and 2118 (fill of Mid-Late 12th Century Robber Trench 2119). Another possible piece is also from 2118 - although this could be a strange proto-hearth bottom and Context 3127 (fill of Linear Feature 3132 below 3087) unless these two pieces are fragments of exceptionally large hearth bottoms.

The slag from this site that is most likely to be a by-product of iron smithing is the possible hearth bottoms from Context 3080 (the Mid-Late 12th Century Ditch Recut 3218). It is large, slightly magnetic and has a distinct L-shaped profile. A large quantity of hearth lining is attached to the back. It is possible that this is again a block fragment because it does not have the classic plano-convex shape. Another possibility is the very dense fragment from Context 4110, the Mid-Late 12th century fill of Pit 4111. This piece has multiple fresh breaks but part of a side or basal surface survives with rare charcoal imprints and parts of other crystalline or slightly flowed surfaces. The surfaces are very unlike those usually found on hearth bottoms but the lack of charcoal imprints or inclusions does not make it an obvious candidate for a slag block. The other possible smithing slags are all very abraded and partially encrusted with soil. They are from Contexts 3080 and 3043, the latter a Post-Medieval levelling layer or buried soil.

There is a group of odd slags from the site that are black and tap-like in form but have a distinctive metallic sheen on their surfaces. Some lead-production slags are similar in appearance. Both lead and iron smelting slags are primarily

composed of fayalite ($2FeO.\ SiO_2$). These slags, from Contexts 2055 (Post-Medieval dump), 2118 and 3042, may be by-products of a non-ferrous industry (smelting lead is unlikely given the site location) or iron-smelting slags affected by some post-depositional process.

The final group are the cindery slags from Contexts 3123 and 3125, both Mid-Late 12th Century fills of Pit 3124. These are too large to be ordinary fuel ash slags but they have been produced at high temperatures. These may have been generated accidentally and need not necessarily be associated with any 'industrial' process. There is a piece of cinder that could belong to this group but stratigraphically it is from the buried soil 4006 (the same horizon 3087) and therefore is much earlier in date. It is a fairly dense fused mass of sand and perhaps hearth lining and again the event that caused its generation may have been accidental.

Discussion of the pit-furnace slag blocks

A small group of slag blocks have been identified at West Moor Park, Armthorpe near Doncaster (Cowgill 2001a) only five miles to the east of Sprotbrough. Another group of seven pieces are from the Teeside to Saltend Ethylene Pipeline (TSEP) Site 238, near Bolton, just to the east of York (Cowgill, Godfrey and McDonnell 2003) and *c*. 36 miles north of Sprotbrough. Further single examples have been identified at TSEP Site 908 (near High Catton, east of York), Pocklington, East Yorkshire (Cowgill 2000) and Nunthorpe, Teeside (Cowgill 2001b). All these pieces have similar characteristics: flat tops and straight moulded sides although the quantity and size of the charcoal imprints within them tends to vary. Unfortunately all these sites are poorly dated but it is thought probable that the technology was Late Iron Age to transitional Romano-British in date. Much larger block slags have also been found at Welham Bridge, North Humberside, (dated to the Mid-Late Iron Age) and these have a mean weight of 12.7kg, with the lightest recorded piece being 8.75kg and the heaviest complete piece a massive 74kg (Clogg 1999). These slags are found as identifiable heaps (the total quantity from Welham Bridge weighed 5400kg), whereas it is noticeable that the other slag blocks were found in secondary contexts (usually ditches) and often as single examples.

The slag from the TSEP Sites, West Moor Park and Nunthorpe have been analysed by the Ancient Metallurgy Research Group, University of Bradford, and compared to those from Welham Bridge (Godfrey and McDonnell 2001 and 2002, summarized in Cowgill, Godfrey and McDonnell 2003). It concluded that the slags were similar in composition and were evidently remnants from an early pit-furnace iron-smelting process but they did not, although comparable in morphology, match the Welham Bridge material. The analysis suggests that not only was a different ore used but also different operating conditions and that the slags from these sites appear to form a technological tradition that produced smaller blocks than those found around the River Foulness.

It is possible that pit-furnace smelting may have been more widespread and persistent in Britain than previously recognised. Very little is known about the early pit-furnace technologies but these were developed and became the main form of iron production in northern Continental Europe during the 2nd - 5th centuries AD, where thousands of these pit-furnaces have been excavated at hundreds of sites from the Holy Cross Mountains in Poland (Bielenin 1987) to Snorup in Denmark (Voss 1995). As this slag is always found *in situ* it means that after each pit was filled with slag a new furnace would have to be constructed over a newly excavated pit, a factor that was evidently not deemed problematical to the smelters. In contrast in Britain no pit slags have been found *in situ*, they are always recovered from secondary contexts, which suggests that they had been purposely removed from the pits. It is possible, therefore, that

the pits were alongside and not below the furnace, that access was available to the below furnace pit and that the blocks could be regularly removed without causing substantial damage to it or that they actually formed within the furnace. This technology probably also meant that a new furnace would not be needed at the commencement of each smelting episode. It appears that while in Northern Europe the pit-furnace technology was developed, in Britain sometime in the Late Iron Age – Early Romano-British period, it was replaced by slag tapping furnaces. In terms of date, the British examples are earlier, and therefore care must be taken when comparing the late European examples with the British ones.

Summary

The presence of pit-furnace block slags on this site is important because it adds another reference point to our gradually expanding distribution map of this slag type. The majority of sites that have been identified with these slags have been around the Humber and in Yorkshire. It is too early to know whether this was a distinct regional type of iron smelting or whether we should find them across the country.

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Appendix 1. Catalogue of the slag and associated finds from Sprotbrough

Context	Type	No	Weight	Craft	Fuel	Condition	Comments
US	CIND	2	42				1 X TOTALLY VITRIFIED CLAY?
US	SLAG	2	8	FEWKING?			1 X TAP? 1 X CIND/IRON CIND?
US	TAP	1	6	FESMELT			
US	TAP	1	11	FESMELT			+ REDU HL
2055	SLAG	1	6	FEWKING?			TAP? VERY SHINEY + GLOSSY = NOT FEWKING?
2118	SLAG	1	41	FEWKING	CHARC		SMITH OR SMELT? COULD BE PROTO-HB BUT FORM ETC NOT RIGHT
2118	SLAG	1	123	FESMELT?	CHARC		RARE CHARC IMPRINTS; SIMILAR TO 3087 BLOCK; MAX TH 25MM; OCCASIONAL REDU HL INCLUSIONS
2118	TAP	2	71	FESMELT?	CHARC		RARE CHARC IMPRINTS; GLOSSY
3042	SLAG	1	35	FEWKING		VERY ABRADED	CORRODED; MID-GREY COLOUR; MAGNETIC
3042	SLAG	2	29			ABRADED	1 X LIGHT GREY COLOUR; GRAINY; 1 X CIND?
3042	TAP	1	31	FESMELT?	CHARC		CHARC IMPRINTS; GLOSSY
3042	VITHL	1	13				REDU FABRIC; OCCASIONAL ORGANIC INCLUSIONS
3080	SLAG	1	38	FEWKING	CHARC	ABRADED	MAGNETIC; OXID HL ATTACHED
3080	SLAG	1	559	FEWKING	CHARC		RECTANGULAR HB? L-SHAPED SECTION; 110 X 80 X 80MM; LOTS HL ON BACK; MAGNETIC
3087	BLOCK	1	1158	FESMELT	CHARC		WEST MOOR PARK, NR DONCASTER, PARALLEL; IMPORTANT PIECE; SEE REPORT

3087	BLOCK	1	350	FESMELT	CHARC		PART OF PIT BLOCK; FREQUENT MASSIVE CHARC IMPRINTS - LARGEST 50 X 40 X 30MM; SEE REPORT
3087	TAP	1	4	FESMELT			FRAGMENT OF ABOVE
3123	CIND	1	7				WHITE/BLACK FUSED SAND/HL
3123	IRON	1	15				OBJECT?
3123	SLAG	1	29	FEWKING	CHARC		IRREGULAR PIECE
3123	SLAG	1	242				V GLASSY + GLOSSY TOP; CINDERY MID-LIGHT GREY NEAR TOP; SANDY HL? ON BASE; MAX TH 25MM
3123	TAP	2	60	FESMELT?	CHARC		NOT NORMAL FLOWS; CHARC IMPRINTS
3123	VITHL	1	10				OXID/PURPLE BACK; BLACK/WHITE VITRIFIED FACE
3123	VITHL	1	15				REDU FABRIC; SOME ORGANIC INCLUSIONS ON ROUGH SURFACE ON BACK; MAX TH 20MM
3127	SLAG	2	341	FEWKING	CHARC	ABRADED	FRAGMENTS V LARGE HBS? SANDY BASES, MAX TH 45MM; FAIRLY DENSE; SMITH OR SMELT?
3135	CIND	1	44				ASSOCIATED SLAGS 3123; GLOSSY + GLASSY; COLOURFUL; V SANDY PATCHES; PMED
3135	CIND	1	118				ASSOCIATED SLAGS 3123; GLOSSY + GLASSY CIND; SAND ON SURFS; SOME BLACK/WHITE; PMED
3140	SLAG	1	75	FESMELT	CHARC		LARGE CHARC IMPRINTS; PROBABLY PART OF A BLOCK; 1 SIDE MAGNETIC
4006	CIND	1	26				V GLASSY; QUITE DENSE; FUSED SAND AND HL?
4110	SLAG	1	262		CHARC		V DENSE; RARE CHARC ON BASE/SIDE; FRESH BREAKS; PARTS OF CRYSTALLINE AND ?FLOWED SURFS

Appendix 2: Codes used in Appendix 1

Code	Description
CHARC	Charcoal.
CIND	Cinder. A denser and larger form of fuel ash slag that is not necessarily generated by iron working.
FESMELT	Iron smelting slag.
FESMITH	Iron smithing slag.
FEWKING	Iron smelting or smithing.
HB	Plano-convex slag accumulation (commonly known as hearth bottom).
HL	Hearth lining.
MAX TH	Maximum thickness.
OXID	Fired/burnt in an oxidizing environment.
REDU	Fired/burnt in a reducing environment.
TAP	Smelting tapped slag.
US	Unstratified
V	Very.
VITHL	Pieces of vitrified clay, possibly hearth lining.