

# GeoArch

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Assessment of materials from TSSF23  
(part 2), Pocklington, East Yorkshire

Dr Tim Young  
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Dr T.P. Young

## Abstract

*The materials from this phase comprised approximately 178 pieces with a total weight of 206kg from 33 archaeological contexts from 21 trenches, plus unstratified material from one trench. Of this total, 155kg was a single very large intact furnace bottom from context (85010) that has not yet been examined in full detail.*

*The largest class of materials by weight were iron smelting slags produced in non-slag tapping furnaces with wood packed basal pits which certainly provided 197kg of the assemblage and probably provided all the metallurgical residues except for 584g (this being a single smithing hearth cake). These fragments of iron smelting slags probably derive from furnace bottoms similar to the intact example.*

*Furnaces of this type were employed both in the pre-Roman Iron Age and the early medieval periods. These examples are most likely to be Iron Age in date. The intact 'furnace bottom' (FB) from context (85010) is an important find and has the potential to reveal details of the particular form of furnace employed – details that are not currently known for the E Yorkshire Iron Age. The overall shape of the FB resembles a 4<sup>th</sup> to 2<sup>nd</sup> century BC example from Tolgarrick Farm near Truro that weighed approximately 100kg. Larger FBs than the Tolgarrick Farm example have been recorded, for instance in the Wokingham area, where a 148kg furnace bottom was found at Folly Court. The large furnaces of the Wokingham area appear to have had a flatter floor than either at Tolgarrick Far or the present site.*

*The widespread distribution of fragments of all parts of the furnace bottoms suggests that they were intended to be removed from the furnace after each smelt (a process that usually requires breaking-up the FB). The survival of an intact furnace bottom that was not in a furnace may possibly indicate that slag was removed from an abandoned furnace, perhaps even as part of post-medieval field clearance.*

*The single smithing hearth cake (SHC) was of a form compatible with also being of Iron Age date.*

*The materials also included a single concretion with an unknown core.*

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## Methods

All materials were examined visually, using a low-powered binocular microscope where required. The identifications of materials in this report, as an assessment during which no instrumental analysis was undertaken, are necessarily limited and must be regarded as provisional.

This assessment was conducted in October 2023 and was commissioned by Julie Franklin of Headland Archaeology. The materials derive from a field evaluation undertaken near Pocklington, E Yorkshire, (TSSF23) centred on NGR [SE7646]. An earlier phase of work on the same site produced residues assessed previously (Young 2023).

## Results

### *General nature of the assemblage*

The materials from this phase comprised approximately 178 pieces with a total weight of 206kg from 33 archaeological contexts from 21 trenches, plus unstratified material from one trench. Of this total, 155kg was a single very large intact furnace bottom from context (85010) that has not yet been examined in full detail.

The largest class of materials by weight were iron smelting slags produced in non-slag tapping furnaces with wood packed basal pits which certainly provided 197kg of the assemblage and probably provided all the metallurgical residues except for 584g (this being a single smithing hearth cake). These fragments of iron smelting slags probably derive from furnace bottoms similar to the intact example.

The materials also included a single concretion with an unknown core.

### *Iron smelting residues*

The iron smelting residues are similar to those previously described from the site (Young 2023). The present material includes a very large, intact furnace bottom (from context (85010)).

The comminuted FB material includes almost the whole suite of textures to be found within such a large FB.

There are freely-flowed lobed flow-slugs that have cooled near to the furnace arch. Some pieces show secondary reddening, and a tiny proportion of the flow slugs resemble tapslugs in having a maroon sheen to their uppermost flows. Such slags were also recorded at Folly Court (Young 2018; Young & Anelay in press), where it was believed that they had not been tapped but had superficially oxidised under the influence of air drawn in through the furnace arch.

Amalgamated flow slags with large moulds of wood probably formed in the base of the furnace. The wood moulds suggest the use of roundwood (up to 40mm diameter) and split wood (up to 70mm diameter) as a packing of the furnace pit or basal chamber.

Above these residues formed a layer that appears as more massive, but which displays internal flow lobes near the furnace walls.

The upstanding furnace walls were represented by 2823g of furnace wall material (mostly as blocks of highly indurated sloughed wall material that was probably cleared from the furnace between smelts). A further 1006g of residue were slags that had probably formed on or against the furnace wall above the level of the FB. In one case the wall ceramic was strongly altered to a vesicular fuel ash slag.

3205g of slag were of indeterminate origin, but most was probably from iron smelting.

### *Iron smithing residues*

Iron smithing is represented by a single intact SHC (from context (243018)) that weighed 598g. The preservation of this piece matches that of the smelting slag and an Iron Age date seems likely.

A 108g piece from context (273006) is just possibly a fragment of a coal-fuelled smithing slag, which would indicate a later, possibly post-medieval age, but the identification is far from certain (possible residues from coal-fuelled smithing were also noted from the first phase of the project).

### *Other materials*

The materials also include a single small iron-rich concretion of unknown core (but probably either slag or iron).

## Interpretation

The residues appear to be concentrated in a few areas.

The very large, intact furnace bottom (from context (85010)) is a very significant find as it provides a key by which to interpret the fragmented slags of both this and the previous phase of investigation.

The size and shape of the intact FB indicate it is almost certainly of Iron Age date. The overall shape of the FB resembles a 4th to 2nd century BC example from Tolgarrick Farm near Truro (Young 2016) that weighed approximately 100kg. Larger FBs than the Tolgarrick Farm example have been recorded, for instance in the Wokingham area, where a 148kg furnace bottom was found at Folly Court. The large furnaces of the Wokingham area appear to have had a flatter floor than either at Tolgarrick Farm or the present site (Lewis *et al.* 2013; Young 2018; Young & Anelay in press).

Very large Iron Age furnace bottoms have been reported in the area previously (Clogg 1999; Halkon 1997) but have not however been examined in detail and no details of the technology are yet known.

## Further work

This material is an indication of Iron Age smelting and smithing activity in the vicinity of the test trenches. Detailed analytical examination of the intact furnace bottom is recommended since such materials have not been analysed from this region before, despite its enormous significance to the regional Iron Age economy (Halkon 2007, Halkon & Starley 2011).

Such analysis could help clarify the technology, the nature of the ore and the yield of the process.

## Glossary

**Blacksmithing:** the working of iron and steel. Often restricted to the secondary smithing – i.e. the smithing of iron to produce or repair artefacts, as opposed to the smithing involved in the production of billets or bar iron from raw iron blooms.

**Bloomery:** a furnace for smelting iron from ore in which iron is produced as a solid material. The bloomery process was employed mainly prior to the introduction of the later blast furnace from the late 15th century.

**Bloomsmithing:** The process of reworking a raw bloom, through repeated reheating and hammering, to reduce its content of slag, to remove unwanted inclusions and to draw out the remaining slag into elongate inclusions. The end product may be a bar or billet. Usually taken as an alternative term for bloom-refining.

**Coke:** a dark, highly vesicular material that is an organic material formed from the incomplete combustion of coal (compare **clinker**, which is the inorganic slaggy material remaining after the combustion of impure coal). Coke may be either a material produced incidentally during the combustion of coal, or a material produced deliberately to produce a high temperature industrial fuel.

**Flow slag:** slag that had flowed before it chilled into a usually elongate prill, demonstrating its flow. Tapslag is a particular form of flow slag in which the slag flows out of the furnace and chills in the air. Bloomery tapslags typically generate a thin veneer of oxides with a maroon colour on their surface because of oxidation

**Furnace bottom (FB):** a slag block that accumulates during a smelt in a non-slag tapping furnace in its basal pit or chamber. The pit is typically filled with a packing of green wood or grass/cereal before the smelt and the furnace bottom replaces this, but often incorporates moulds where the organic matter had been.

**Non-slag tapping furnace:** a bloomery furnace in which the slag does not run out of the furnace during the smelt, but downwards to a pit or chamber below the shaft.

**Olivine:** a group of silicate minerals of the form  $(M^{2+})_2SiO_4$  where M can commonly be iron, magnesium, calcium (up to half the  $M^{2+}$  ions) or manganese.

**Smelting:** a process involving the reaction of raw ore to produce a metal,

**Smithing:** the activity involved in forming a metal object, including, but not limited to, forging metal and joining metal by welding.

**Smithing hearth cake (SHC):** a slag mass that grows just in front of and below the blowhole in a smithing hearth, from the reaction of iron and iron oxides from the workpiece with melted ceramic from the hearth wall.

**Vesicle:** a void or pore, usually rounded and formed as a preserved gas bubble in a solidified melt.

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Table 1: summary catalogue, weights in g.

context	bag wt	item wt	item no.	notes
74004	4790	3405	1	extremely dense rectangular block; surface rather worn, probably blowing wall below burr, but way up not entirely clear
		1330	1	dense upper part of FB, contains small fuel moulds and hints of wood, but voids largely seem occluded by later fine prills
		50	6	fragments probably broken from larger piece in transit
74004	4070	2850	1	large and complex block from foot of wall - hints at generation of second dense crust 100mm or so in front of first, but interpretation by no means certain; grades from reduced fired indurated wall into flow slags with wood moulds, maybe second crust is a filling into a mould?
		228	1	fragment of dense slag from near wall
		526	1	dense and complexly shaped block, possibly passing into burr type development with failure in front??
		432	1	large cuboidal block of thickly vitrified wall - apparently with convex front face, probably just badly sloughed
76005	286	286	2	pale highly vesicular blocks of FAS, highly vesicular, locally greenish, both show passage into simple grey ceramic; unclear if these are genuine FAS or highly altered furnace wall
81005	3870	2490	1	large block of amalgamated flow slag, with clear lobes; one sandy contact face; large, but rather crude moulds
		1085	1	200mm long composite flow; presumably a distinct flow towards distal margin of furnace; from near base
		64	1	dark fresh slag in composite stalactite formed of very small individual prills (8mm diameter?)
		220	1	fragment showing stalactite like forms in sand covered FB fragment; unclear if they descend off the wall or a clast
85009	14340	3615	13	flow slags with good free surfaces (cf tapslag) and large wood moulds; 30-45mm diameter roundwood and half roundwood to 60/70mm diameter
		1795	1	large block of prilly slag with only small voids, very dense and strong
		1240	1	180x130mm; indurated to 40mm depth; large block of reduced fired wall, mostly strongly indurated; fissured face
		258	1	semi-circular sheet of slag, appears to be a 'pull'; now concave with slight lip (from below blowhole??)
		2505	1	large and very dense block from near floor - lots of spilt wood with splits 60-70mm across
		1630	1	large block of more finely prilly slag with small voids; at base is poorly preserved round wood mould; perhaps small prills still somewhat fluid?
		680	1	coarse tapslag-like flow slag with numerous pieces of fine oxidised clay mixed in with flow lobes
		614	1	slightly messy lobate slag in angular block, some small pieces of fine red clay visible
		470	1	fragment of wall slag from around blowhole; appears to have slag penetrating parallel to face within the wall; wall dark red to purple
		400	1	probable foot of wall piece with large lobe abutting curved surfaces - parts of wood mould
		220	1	thin rounded slag sheet - possibly similar to 'pull' above but not as neat
85010	155000	650	1	SHC-like mass sitting on top of an pre-existing crust fragment; 110x110x60mm; probably a slag from the furnace rather than being a simple SHC
		250	1	triangular lobe with basal crust that has tubular vesicles; probably a foot of wall flow?
85010	155000	155000	1	complete furnace bottom (sf003)
86005	50	50	1	fragmented lump of flow lobed slag, upper face shows maroon surface cf. tapslag

86008	1965	456	1	amalgamated prilly slag - not coarse basal lobes, much finer
		352	1	dense dark elongate slag block; just possibly an SHC, but lacks clear diagnostic features; could be internal denser block from furnace
		104	1	fragment of indurated furnace wall
		58	1	finely prilly slags attached to a thin skin of furnace/hearth wall (which appears very slightly convex)
		86	1	small angular fragment of dense but vesicular iron slag
		920	10	iron slag fragments that have been secondarily reddened; a variety of flowed and massive textures, all probably FB
86010	1495	1350	4	amalgamated flow slags with wood moulds
		124	7	smaller slag fragments, mostly of rather blebby slags
98014	828	828	1	rounded accretionary mass, very irregular shape, very dense - compatible with FB fragment
118016	278	126	8	probable single fragment, broken, of vitrified and slagged oxidised fired wall with large dark slab-like lobe
		134	2	badly weathered soft accreted slag fragments
119019	1380	1380	1	triangular block with wall contact on one side; flat top to slag cake showing flow slag rivulets across top; below, the amalgamated flow slag shows large wood moulds; roundwood c30mm as well as larger spilt pieces
120008	565	108	1	irregular cherty rock fragment, smooth face with protuberance - burrow?
		8	1	reduced hearth/furnace ceramic
		1	1	rounded iron slag grain
		112	1	amalgamated flow slags with moulds
		336	2	sand coated iron slag fragment, one sheet like and slightly prilly, the other may be more massive, both indeterminate
123011	540	60	6	flow slag debris
		250	1	T-shaped bulbous lobe of slag; base has an angle - so probably from foot of wall in smelting, but an origin in smithing cannot entirely be excluded
		226	1	weathered fragment of dense internally lobed slag
123013	836	806	1	weathered block from burr region; 10mm of so of indurated sandy lining attached
		30	1	low density weathered flow slag
tr127 u/s	925	684	8	dense, dark, fresh-appearing slags with large flow lobes in places
		90	10	more finely prilly slag, one piece shows surface reddening suggestive of tapslag
		116	10	fragments of dark slag with small voids, often rather messy fine structures, more like smithing than smelting
		35	2	one fragment of grey indurated wall and another with lobes but of wall-like material
133013	438	434	1	very dense grey slag, complex form possibly suggesting 'rod' of 50mm diameter, but may be function of intersecting wood moulds
134019	228	228	1	small fragment of amalgamated flow slag with the margins of several large wood moulds

135006	1200	768 8 392	6 2 3	grey foliated indurated clay - possible furnace structure? porous pale brown material, appears mineralised, but could possibly be bone worn accreted probable flow slag fragments
136005	166	32 24 108	1 2 1	rounded concretion with unknown core prilly slags, fine amalgamated flow slag lobes, coarse, dense
136007	214	206	6	sandy accreted slag fragments, no real detail visible
137004	6	6	1	dark fresh flow slag with wood moulds
137006	30	30	1	strongly coloured weathered vitrified oxidised fired wall
238004	766	758	2	highly weathered and accreted FB fragments
243009	562	562	1	large block of furnace wall; multiply repaired; dark slag surface to 30mm; white weathered internal surface, resting on grey indurated lining with red fracture surfaces
243009	1340	1340	1	large angular block of massive dense grey slag - presumably upper part of FB
243009	848	848	1	irregularly shaped slag block with lobes forming a ?basal surface; irregular shape may be due to to poorly preserved wood moulds
243012	620	620	1	dense slags from bowl-shaped margin; contact area shows well-formed lobes, which are not visible inside, where the slag is massive with several poorly preserved large wood contacts
243018	584	584	1	SHC; plano-convex; 90x100x45mm; base irregularly smooth; top obscured but appears slightly lobate
250023	44	44	1	small angular fragment of dense iron slag with complex curved surfaces
250027	936	564 372	1 2	very dense slag lump; probably internally flow lobed, but with quite small lobes large free amalgamated lobed flows; presumably from distal/lateral areas; very coarse lobes
250028	356	356	1	rounded lump of massive slag, weathered, soft and worn
254007	4335	1480 264 2520	4 1 2	rounded/subangular blocks of very dense slag with accreted sand folded or angled slag sheet; typically 17mm thick; way up uncertain large blocks of amalgamated flow slag around wood moulds

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254017	216	216	1	very dense thin slag puddle fragment; base shows two component lobes, possibly shallow toolmarks, base shiny and shallowly dimpled (non wetted?)
254021	1710	922	1	amalgamated flow slag with wood moulds - the largest >120x55x40mm; basal lobes descend to an approximately planar surface
		770	1	rather open amalgamation of flow slags round voids
258008	294	294	1	rounded lump of massive iron slag, very badly decomposed, soft and accreted
273006	108	108	1	dark fresh looking slag; dimpled base; irregularly lobate top with possible fuel moulds; possibly slightly folded; could possibly be coal-fuelled smithing slag

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Table 2: weight in g of slag classes by context. Conc. = concretion,

context	FB	wall	wall slag	cf tapslag	indet	conc	SHC
74004	8389	432					
76005		286					
81005	3859						
85009	12139	1240	948				
85010	155000						
86005				50			
86008	1462	104	58		352		
86010	1474						
98014	828						
118016		126			134		
119019	1380						
120008	448	8			1		
123011	287				250		
123013	836						
tr127 u/s	772	35		2	116		
133013	434						
134019	228						
135006	392						
136005	132					32	
136007					206		
137004	6						
137006		30					
238004	758						
243009	2188	562					
243012	620						
243018							584
250023	44						
250027	936						
250028	366						
254007	2520				1744		
254017	216						
254021	1692						
258008					294		
273006					108		
<i>total</i>	<i>197406</i>	<i>2823</i>	<i>1006</i>	<i>52</i>	<i>3205</i>	<i>32</i>	<i>584</i>

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*geoarchaeological, archaeometallurgical & geophysical investigations*

Unit 6,  
Western Industrial Estate,  
Caerphilly,  
CF83 1BQ

*Office:* 029 20881431  
*Mobile:* 07802 413704

*E-Mail:* [Tim.Young@GeoArch.co.uk](mailto:Tim.Young@GeoArch.co.uk)  
*Web:* [www.GeoArch.co.uk](http://www.GeoArch.co.uk)