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Assessment of residues from Lydney North B, Phase 3 (CALELY20)

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Abstract

The submitted material comprised almost 16kg of residues (167) pieces, almost all deriving from the smelting of iron in a slag-tapping bloomery furnace.

The material is a coherent assemblage and from a single source, despite having been transported from its origin. An origin from the iron smelting operation of medieval (13th century) date in the area of Phase 1 of the development is likely. The residues do not show similarity with those of Roman age from the adjacent Phase 2 development.

Details of the slags add to understanding of the operation of the base of the furnace and its tapping. Given the derived nature of the collection and its similarity to the material already examined in detail during Phase 1 of the development, no further analysis of these materials is recommended.

Contents

Methods

All materials were examined visually, using a low-powered binocular microscope where required. As an assessment, the materials were not subjected to any high-magnification optical inspection, not to any form of instrumental analysis.

The identifications of materials in this report are therefore necessarily limited and must be regarded as provisional.

This assessment was conducted in February 2021 and was commissioned by Ed McSloy and Mary Alexander.

Description of the assemblage

The submitted material comprised 167 pieces (weighing 15.7kg). Almost all the fragments in the assemblage were residues from iron smelting including both slags and fragments of furnace ceramic (the certain exceptions being one small fragment of iron rod, a fragment of partially burnt coal, and a small concretion, with a combined weight of 58g).

The slags comprised 10.4kg of tapped slags, 3.4kg of slag that probably cooled inside the furnace, and 0.9kg of slags of indeterminate origin.

The slags were typically rather heavily weathered, some with very eroded surfaces, and many showed signs of physical abrasion.

Despite both the condition of the slags and their contexts suggesting the reworking of the slags away from their original point of deposition, the assemblage is remarkably homogeneous, suggesting a common origin.

The tapslags are present as relatively small fragments, with items weighing 1000g and 764g the only pieces of over 500g. The 1000g piece (from context (4465)) was from a tapped cake 90mm in thickness. The inclination of the flows in the section of the wedge-shaped fragment was markedly different between the lower and upper parts, possibly indicating that an initially-formed block had been moved and tilted before a subsequent flows overlapped it. The 764g piece (from context (4201)) was a more tabular fragment of 35-40mm thickness.

The tapslags were characterised by a very common occurrence of inclusions of grey sandy clasts, occasionally within the slag flows but particularly between the lobes, and of sandy films between flows. Some of the grey ceramic might be from the furnace structure, but much of the more sand-rich material may perhaps have been picked up from the substrate of the tapping channel.

The tapslags were very variable in flow size and lobe convexity, but very large, wide lobes were generally absent. Some examples showed particularly fine-scale slag rivulets. There were no certain examples of deflation structures nor were there any examples of slags with transversely wrinkled surfaces. Lobe surfaces (where preserved; they were often heavily corroded) were typically smooth and showed oxidation with the typical maroon tint.

The degree of vesicularity of the tapslags was very low to moderate. No extremely vesicular examples were noted. Only one example of a bulbous, inflated terminal lobe was noted.

Several bocks of slag of similar appearance but different structure occurred (a 340g piece from (4069), a 2055g piece from (4078) and a 960g piece from (4398)). These appear, between them, to indicate derivation from plano-convex slag cakes of up to 90mm thickness, but of unknown diameter (probably of at least 300mm). These cakes show a hint of poorly-developed tool marks on their bases and a lower section with strongly-developed large tubular vesicles. The upper parts show slag with some evidence for flow, including poorly-developed lobes on the upper surface associated with large roundedly tabular vesicles, which (in the case of the piece from (4398) appear to connect into a network, probably produced by slag drainage. The fragment from (4078) shows the development of tapslag-like flow lobes near its top on the thin margin of its wedge profile, where it also bears clasts of oxidised-fired furnace ceramic.

One fragment (a 106g piece from context (4323)) is perhaps intermediate in structure between these plano-convex cake fragments and the more conventional tapslag pieces, showing a very large unroofed vesicle below its upper surface, an irregular base suggesting cooling over an irregular base and with reddening of the base suggesting play of the furnace blast (albeit perhaps via the open tap-arch) onto the base of the flow.

Although 880g of material (6% of the assemblage by weight) was classified as indeterminate, this was dominantly because small size or poor preservation hindered observation of characteristics that might have permitted positive identification of the material as smelting slags. No material with a high probability of being a smithing slag was observed.

The assemblage also included approximately 3.4kg (21% of the assemblage by weight) of fragments of structural ceramic from the smelting furnace. Most of this material is reduced fired, pale grey in colour and with a high content of quartz sand. The ceramic is mostly in small fragments, but two substantial pieces (608g, from context (4069) and a slightly smaller one of 108g, from context (4307)) provide additional evidence. Both of these appear to show multiple relining events over a thickness of 60mm, each with a thin glaze on the surface of the deeply vitrified ceramic.

The larger piece is gently convex on its inner surface, possibly suggestive of formation round the upper section of the tapping arch, or perhaps more likely suggestive of a slightly swollen basal chamber compared with the upper shaft of the furnace.

Interpretation

Despite the secondary contexts from which the residues were recovered, the assemblage is remarkably coherent and strongly suggests derivation from a single source.

The residues show little in common with the Roman material from the adjacent (Phase 2) area. The Roman slags are characterised (Young 2019b) by dense tapslags which commonly bear small ore fragments. The ore fragments were even more common in the massive slags, provisionally interpreted as having cooled within the furnace. These massive slags also commonly bear moulds of small pieces of roundwood charcoal or wood.

The residues do however show considerable similarity with those from the medieval iron smelting in the Phase 1 area further NW (Young 2017, 2019a). In particular, the inclusion of grey ceramic and sandy material within the tapped slags can be matched there. The material from the Phase 3 site probably matches that from the Phase 1 area in the range of vesicularity, but the weathering makes this slightly uncertain. The general forms and surface features of the tapped slags match those observed in the Phase 1 assemblage (e.g. Young 2019a Figure 1).

Although the Phase 1 area produced some examples of slags believed to have cooled within the furnace ('furnace' slags), the examples from Phase 3 provide substantially more information. They suggest a furnace in which the slags were able to 'pool' in the base of the furnace. The observed examples (particularly the pieces from contexts (4078) and (4398)) show poorly developed toolmarks on their bases, which, although they could be moulds after marks generated during furnace preparation, are likely to be from attempts of encourage the slag to flow from the tap arch, probably through use of a poker or bar. The development of the tubular vesicles shows that, at least the last slag to pool, was able to do so for a significant period of time before it solidified. The tapslag-like lobes on the thin edge of the example from (4078) probably represent slag flow away from the furnace and the thinning indicates that there was a lip or rise between the interior floor of the furnace and the exterior tapping area. The presence of fired clay clasts within the slag in the thin area is suggestive of debris from the opening-up of the tapping arch in the later stages of the smelt. These features correspond to the observation of the floor of Furnace [1639] within the Phase 1 area, which shows a dished form within the area of the shaft, connected to a lower trough -like tapping area outside over a low lip.

This morphology of furnace and corresponding slag type has been found also at Tisbury, Wiltshire (author's unpublished data) and at Torr Quarry, Somerset (Young 2014), both in examples of 11th-13th century date. Such slags might, on their own, easily be mistaken for large smithing slag cakes and early attempts to interpret the Tisbury example suggested that furnace had been employed for remelting blooms. The Lydney evidence suggests that this was not the case (as had previously been suggested for the Torr Quarry material). This furnace slag morphology provides another link between the residues with the Phase 3 site and the activity in the area of Phase 1.

Although derivation of the present assemblage from the waste dumps present in the area of Phase 1 of the development cannot be proven, a link with that smelting operation (or one with identical technology nearby) should be considered extremely likely.

Further work

The similarity of the material described here to that investigated in detail during Phase 1 of the development of the site means that further detailed analysis of these reworked materials is unlikely to be able to generate significant further useful information. Accordingly, no additional analysis is recommended.

The slag assemblage does, however, contain elements particularly the furnace slags, that were less well-represented in the archived collections from Phase 1. It is therefore recommended that the collection is preserved in the deposited site archive to permit future investigation.

References

Young, T.P. 2014. Report on Archaeometallurgical residues from Torr Quarry, Leighton, Wanstrow, Somerset. *GeoArch Report 2014-12*. 63pp.

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Young, T.P. 2019a. Analysis of iron smelting residues from Lydney B North (LYF17). *GeoArch Report 2019/04*, 61pp.

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Table 1: summary catalogue of materials. Weights in g.

C	w	no	notes
4022	198	1	dense tapslag flow, thin rivulets, clast of grey ceramic
4025	356	3	dense tapslag fragments, each with grey ceramic clasts
4027	60	5	small worn tapslag fragments
	38	4	worn fragments of indeterminate slag
4041	80	1	dense tap slag with wide lobes, base has inclusions of sandstone and probable entrained sand
4043	76	1	tapslag, has been run out over gritty sand
	24	1	probable tapslag, vesicular, very weathered, traces of internal lobes
4062	106	2	worn tapslag fragments, dense
4069	608	1	large block of indurated furnace wall, 55-60mm thick, even grey colour, very sandy, 3 previous vitrified surfaces within
	318	4	dense tapslag
	44	1	vesicular tapslag, highly weathered, sandy material fused to one surface
	180	1	dense slag, weathered, hints of lobes and multiple sandy lining inclusions
	340	1	dense slag block, hints of lobing in places, large voids from large fuel or wood
4078	2055	1	185x125x75mm block from margin of a plano-convex mass? Internally coarse grained, massive, with large tubular vesicles, top shows large unroofed vesicles, slight hint of tap slag like lobes towards thin side. Possibly part of a furnace bottom slag (unless representing a homogenised tapped slag); base in several crude rounded lobes 80mm or so across. Thin edge show shows multiple oxidised-fired ceramic clasts in the section
4079	6	1	worn tapslag fragment
	22	1	fragment of dimpled slag sheet, with lining fragments om upper surface
	8	1	worn indeterminate vesicular slag fragment
4081	324	4	tapslag fragment, largest carries grey ceramic clasts
4098	18	3	fragments of tapslag, one with grey ceramic clast
4101	236	4	very dense tap slags

	96	1	complicated block of indurated vitrified and failed furnace wall
4103	242	5	worn tapslag fragments, largest bears grey ceramic clast
4107	134	2	dense tapslag fragments with grey ceramic clasts
4112	708	6	tapslags, variable, all weathered, most vesicular highly weathered, denser varieties less so
	118	1	slag with rounded base, and smooth oxide surface, below coarse crystalline top. Unclear if this is the base of a tapped flow or a possible complex SHC
4118	1330	3	substantial pieces of weathered tap slag, two show lobes sheets that are particularly thin in cakes up to 60mm thick. One passes down into more vesicular material with burnt sandstone clasts, one is disrupted with lobes subsiding into underlying fuel, again with gravel and grey ceramic clasts, this piece has some charcoal-bearing porous structureless slag resting on its upper surface
4118	410	5	tapslag fragments, 2 with grey ceramic clasts
	44	1	grey indurated wall, highly bloated on one side
4127	130	1	dense tapslag with grey ceramic clast
4145	162	1	deeply etched dense tapslag block
4172	4	1	isolated corroded flow lobe, presumably tapslag
4180	110	4	worn tapslag fragments
4184	70	1	tapslag fragment
4186	2	1	tapslag
	<1	1	burnt coal
	30	2	indeterminate highly weathered slag, one with small charcoal fragments
4188	18	2	tapslag fragments
	10	1	weathered indeterminate slag fragment
4190	22	1	very worn dense slag, probably tapslag
	4	1	chip of vitrified lining

4194	42	2	dense tapslag fragments
	28	1	indurated grey vitrified lining with reddened surface
4195	46	3	flow-lobed slag, probably tapslag, 2 of 3 have grey sandy cermaic
	8	1	grey vitrified lining
4201	764	1	block of tap slag 35-40 mm thick, weathered and abraded
4201	44	1	tapslag fragment, grey ceramic/stone clast
4203	152	4	worn tapslag fragments
	70	1	unusual porous slag, coarsely crystalline slag with tubular vesicles, central disc like section expanding outwards in both directions (somewhat resembles 70g piece from 4455), only part of original mass so original form unclear
	56	1	fuel dimpled slag - could be from base of tapslag flow, but no certain lobing above
4209	386	4	worn dense tapslag fragments, inclusions of grey lining/substrate common
	136	4	worn fragments of rather amorphous slag, all with traces of internal lobing
	32	1	thin sheet formed of lobate slag, probably tap slag related
4221	84	1	margin of block of tapslag with low convexity flows
	60	1	tapslag with narrow flows
	38	1	vitrified, slagged, reduced-fired lining
4323	106	1	curious block, tapslag-like locally on top above very large unroofed voids in a slightly vesicular slag, with a base with a red colour suggesting it has been blown and with a topography suggesting draping over underlying obstacles
	48	3	small fragments of tapslag
	<1	1	indurated grey wall fragment
	14	1	small bleb of concretionary material with some charcoal binding brown siltstone fragments together
	42	1	irregular fragment of porous vesicular slag with grey sandy ceramic clasts
4228	40	1	dense tapslag, small lining? inclusion
4248	80	3	worn tapslag fragments
	116	1	worn massive slag fragments
4253	8	1	tapslag fragment

4259	192	1	worn tapslag block
	8	1	tapslag fragment with grey ceramic clast
4261	92	1	very dense tapslag
4275	146	1	very dense tapslag fragment, slightly fresher than most in collection, mixture of low and high convexity lobes of quite large size, base not preserved
4300	56	2	tapslag fragments
4307	192	1	block of indurated grey furnace wall. Penetrated by irregular fissures with green glaze, probably 2 or 3 relining episodes
4316	50	2	heavily worn fragments of somewhat vesicular slag - both indeterminate
4319	98	3	tapslag fragments
4347	4	1	very weathered slag, probably tapslag
4396	52	1	strongly oxidised fired ceramic with deeply slagged surface
4398	960	1	possible slag from furnace throat. Base shows irregular linear lobes, possibly toolmarks, the slightly irregular basal slag is overlain by a zone with tubular vesicles. This finished in a layer with large horizontal voids, possibly forming a network of tunnels from slag drainage; piece wedge shaped in section -so possibly slag flow from furnace over slight lip? top not preserved - just unroofed large vesicles. Piece maybe compared in part with the large fragment from (4078).
4419	74	2	dense tapslag fragments
	12	1	rounded nub of charcoal-bearing slag
	40	1	irregular piece of charcoal-bearing slag with a dimpled surface
4421	34	1	unusual piece of slag forming rounded, spout-like shape. Possibly a deformed smithing slag (has charcoal inclusion), base dimpled, top with tapslag like oxide veneer, original end shows rounded termination of the slag sheet
4426	118	1	termination of tapslag flow with slightly vesicular structure mainly - but one lobe has inflated into large bulbous hollow section
	56	1	weathered tapslag fragment
	18	1	weathered indeterminate slag fragment
	10	1	7x9mm rectangular section piece of iron, 43mm in length

4455	1000	1	block from 90mm thick tapslag cake, has some vesicularity; shows marked change in orientation from parallel to base to ?horizontal - unclear if block reoriented or just progressive accumulation
	480	1	block from dense tapslag flow 50mm thick with some gravel clasts
	100	2	weathered fragments from thin tapslag flows
	70	1	rounded lump of charcoal-bearing slag - either from base of furnace or part of SHC, but too small to determine
4471	362	1	broken in 2; fragment of 40mm thick tapslag flow, roasted ore clast on base and substantial grey ceramic internally. Well-formed convex flow lobes
4503	98	4	highly weathered and worn tapslag fragments
4512	30	1	slightly vesicular tapslag fragment
4515	46	1	weathered tapslag with grey ceramic clast
4568	158	8	tapslag fragments
	36	1	vesicular slag, possible runner fragment, but very worn

Table 2. distribution of residue facies by context. All weights in g.

Context	tapslag	indet. slag	wall ceramic	furnace slag	coal	concretion	iron	total
4022	198							*198*
4025	356							*356*
4027	60	38						*98*
4041	80							*80*
4043	100							*100*
4062	106							*106*
4069	542		608	340				*1490*
4078				2055				*2055*
4079	6	30						*36*
4081	324							*324*
4098	18							*18*
4101	236		96					*332*
4103	242							*242*
4107	134							*134*
4112	708	118						*826*
4118	1740		44					*1784*
4127	130							*130*
4145	162							*162*
4172	4							*4*
4180	110							*110*
4184	70							*70*
4186	2	30			<1			*32*
4188	18	10						*28*
4190	22		4					*26*
4194	42		28					*70*
4195	46		8					*54*
4201	808							*808*
4203	152	126						*278*
4209	554							*554*
4221	144		38					*182*
4323		162	<1			48		*210*
4228	40							*40*
4248	80	116						*196*
4253	8							*8*
4259	200							*200*
4261	92							*92*
4275	146							*146*
4300	56							*56*
4307			192					*192*
4316		50						*50*
4319	98							*98*
4347	4							*4*
4396			52					*52*
4398				960				*960*
4419	74	52						*126*
4421		34						*34*
4426	174	18					10	*202*
4455	1580	70						*1650*
4471	362							*362*
4503	98							*98*
4512	30							*30*
4515	46							*46*
4568	158	36						*194*
total	*10360*	*890*	*1070*	*3355*	*<1*	*48*	*10*	*15733*

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