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Assessment of archaeometallurgical
residues Lakeside Avenue, Lydney
(LSL11)

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Abstract

The investigated materials comprised a total of approximately 16.5kg of hand-picked material archived as archaeometallurgical residues. The collection formed the macroscopic assemblage from the site assessed by David Starley in 2013, who raised the possibility of detailed analysis of a suite of materials, but fell short of stating such work was essential.

The present work has re-assessed the material in the light of the detailed investigations of archaeometallurgical assemblages from several other closely adjacent sites in the recent years.

Of the submitted materials 14.9kg were archaeometallurgical residues, 41% of these were certain or probable smelting residues and 19% certain or probable smithing residues.

2.7kg of residues derived from the fills of Phase 4 pit [4324], which appears to have been a smithing hearth. This hearth yielded both macroscopic smithing residues, including a 326g smithing hearth cake, as well as microresidues (hammerscale) and fuel debris (charcoal and probably minor amounts of coal). The accompanying fragments of hearth ceramic included many with a slightly convex surface, so the use of the ceramic tuyère cannot be excluded.

Other contexts produced materials that were commonly abraded and often poorly preserved from chemical weathering. Just five contexts besides the smithing hearth (272, 274, 284, 291, 298) produced assemblages with more than two items – all in Area 2 and all attributed to Phase 6.

In general, this assemblage contains mostly residual material (with the exception of the smithing hearth) and is generally somewhat poorly preserved. There would be little archaeological benefit from any further investigation.

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Methods

All materials were examined visually, using a low-powered binocular microscope where required.

The collection formed the macroscopic component of the assemblage from the site assessed by David Starley in 2013, who raised the possibility of detailed analysis of the suite of material types present, but fell short of stating such work was essential.

The present work has re-assessed the material in the light of the detailed investigations of archaeometallurgical assemblages from several other closely adjacent sites in the recent years.

This assessment was conducted in April 2024 and was commissioned by Ed McSloy of Cotswold Archaeology.

Results

General nature of the assemblage

The investigated materials comprised a total of approximately 16.5kg of hand-picked material archived as archaeometallurgical residues. Of the submitted materials 14.9kg were archaeometallurgical residues, 41% of these were certain or probable smelting residues and 19% certain or probable smithing residues.

2.7kg of residues derived from the fills of Phase 4 pit [4324], which is likely to have been a smithing hearth. Other contexts produced materials that were commonly abraded and often poorly preserved as a result of chemical weathering. Just five contexts besides the smithing hearth (272, 274, 284, 291, 298) produced assemblages with more than two items – all in Area 2 and all attributed to Phase 6. In general, this assemblage contains mostly residual material (with the exception of the smithing hearth), is distributed at a very low density across the site and, again with the exception of the smithing hearth [4324], there is no indication that the metallurgical activities were undertaken within the extent of the present site.

Iron smelting residues

The iron smelting slags mostly comprised small fragments of tapped slag, but a few fragments were a more diagnostic.

Context (274) produced a small fragment from a slag 'rod', which is a characteristic component of assemblages of smelting slags of Roman age in the region; rods are interpreted to form in holes created by use of a rod through the frontal arch to stimulate slag flow.

Two blocks of amalgamated dense flow slags (both from context (284), part of post-medieval culvert (285)) appear to be within-from furnace accumulations. One piece has what was probably a vertical face exhibiting non-wetted lobes that chilled against a relatively cool margin in the base of the furnace. The second is a dense slag, apparently of more massive microstructure. These cannot be attributed to a particular furnace type with certainty, but the most likely source would be a furnace bottom block of 'Cardiff Castle'-type. This style of residue assemblage is known from several Roman sites in the region, including Cardiff Castle (Young & Kearns 2011; Young 2021a), but also more locally from the Lydney North B, Phase 2 project (Young 2019b, 2021c). These furnaces that produced these residues are only known, with some qualification, from Woolaston (Fulford & Allen 1992), but are believed to have been large structures probably of 'bottle' or 'dome' shape. Structural failure within a large furnace is the most likely source for the large blocks of highly vitrified ceramic material also from context (284) (this material was interpreted by Starley (2013) as vitrified stone, but an interpretation as very highly vitrified furnace ceramic is preferred here).

In contrast to the evidence for residues from a 'Cardiff Castle'-type furnace from Area 2, a Phase 4 pit in the more southerly Area 6 produced a small concavo-convex block of slag, probably from the bottom of a small furnace (pit [6218]). Furnace bottoms of this type may originate in smaller Roman furnaces and in furnaces of medieval age, but a Roman age is indicated by the stratigraphic context of this item.

A single piece of iron ore was recovered from a fill of Ditch 9 (context (5126)). This piece comprised a dense sheet of apparently massive goethite which, where weathered, revealed an internal structure indicative of a stalactitic structure (*sensu* Young & Thomas 1998, 1999). This dense sheet was overlain by a black botryoidal goethite crust on one face. The texture indicates a local Forest of Dean ore.

Iron smithing residues

2.7kg of residues derived from the fills of Phase 4 pit [4324], which appears to have been a smithing hearth. This hearth yielded both macroscopic smithing residues, including a 326g smithing hearth cake (SHC), as well as microresidues (hammerscale) and fuel debris (charcoal and probably minor amounts of coal). The accompanying fragments of hearth ceramic included many with a slightly convex surface, so the use of the ceramic tuyère cannot be excluded. The modest weight of the single SHC and the presence of coal in the hearth, are both suggestive of the use of this the hearth for blacksmithing (the end use of iron), rather than for any stage of iron production. The hearth was therefore likely to have been a part of the general

occupation of the site, rather than indicating any 'industrial' function.

The valley fill of Area 8 (context (8088)) produced two larger items of slag, both from smithing: one was a 722g SHC, the other a 1090g fragment also from the bottom of a smithing hearth but lacking the features of a conventional SHC, possibly because it derived from a coal-fuelled hearth, rather than a charcoal-fuelled example. Both pieces are likely to derive from blacksmithing.

Interpretation

Pit [4324], a smithing hearth, provided the only evidence for metallurgical activity within the site. This hearth was associated with blacksmithing, probably part of the routine activity within the settlement and not an indicator of an 'industrial' activity.

All other materials appeared to be residual. A concentration of post-medieval features containing iron smelting slag in Area 2 may perhaps suggest derivation of the residues from a location to the north of the site.

Evidence for the dating of the residual materials was poor but, where present, it pointed to a Roman age, even for materials in post-medieval contexts. There was some evidence, albeit tentative, that more than one furnace type may have been involved in the production of the smelting residues.

Further work

In general, this assemblage contains mostly residual material (with the exception of materials from the smithing hearth [4324]) and is somewhat poorly preserved. The assemblage is distributed at a very low density across the site and, again with the exception of the smithing hearth [4324], there is no indication that the metallurgical activities were undertaken within the extent of the present site.

There would be little archaeological benefit from any further investigation, so no further analysis is proposed.

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Appendix: Suggested publication text

The site yielded 14.9kg of archaeometallurgical residues from iron working (19% by weight) and iron smelting (41%) with the remainder of indeterminate origin (mostly small fragments and pieces of hearth/furnace ceramic. This is a very sparse assemblage, suggesting that no major metallurgical activities were undertaken within the site.

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A single piece of iron ore was recovered from a fill of Ditch 9 (context (5126)). This piece comprised a dense sheet of apparently massive goethite which, where weathered, revealed an internal structure indicative a stalactitic structure (*sensu* Young & Thomas 1998, 1999). This dense sheet was overlain by a black botryoidal goethite crust on one face. The texture indicates a local Forest of Dean ore.

The valley fill of Area 8 (context (8088)) produced two larger items of slag, both from smithing: one was a 722g SHC, the other a 1090g fragment also from the bottom of a smithing hearth but lacking the features of a conventional SHC, possibly because it derived from a coal-fuelled hearth, rather than a charcoal-fuelled example. Both pieces are likely to derive from blacksmithing.

Site activities thus only comprise blacksmithing, but residual material derived from activity outside the site included further smithing evidence, but also for the smelting of a local iron ore possibly in two different styles of furnace, both probably of Roman age.

Table 1: summary catalogue of supplied materials by context. Assm = assemblage, FHS = flake hammerscale.

context	sample wt	item wt	item no.	notes
272	296	226	9	rather irregular tapslag fragments
		8	3	ferruginous cemented coarse sand/gravel
		62	1	partially-melted wall material; lying on substrate with red siltstone pebbles.
274	1760	1136	62	maroon surfaced tapslag
		232	10	highly vesicular grey iron slag; lacking diagnostic external morphology
		120	3	dense iron slag; larger piece show large rounded voids - suggesting the inner parts of a large tapslag cake or furnace slag cake
		22	3	oxidised fired ceramic
		106	5	reduced fired ceramic
		28	1	slag rod, 22x18mm and c35mm long; shows lateral remnant of connection to other elements
		122	12	indeterminate small iron slag fragments
284	1995	22	2	highly rusty slag fragments
		84	1	fragment of reduced highly indurated and bloated wall fragment
		314	1	angular fragment of grey vesicular material with vitrified stone clast and one surface with very fine charcoal impressions; probably a large piece of failed wall; locally has large voids which may show droplets of pale glassy slag.
		398	1	glassy slag with veins of white crystalline material (plagioclase?); mostly mid-grey and very rich in sand-grade material; some charcoal clasts; overall this piece is dense considering its apparent composition; probably a large piece of partially melted wall.
		728	1	very dark iron slag, shows non-wetted (probably, these are deeply etched) lobes on one surface and also shows margins of flow lobes internally.
		142	1	section through a sheet of vitrified and largely, but partially, melted ceramic; both surfaces (and locally internal voids) are coated in a green glass.
		276	1	rounded block of very dense slag; surfaces show hints of internal lobing; one face shows a partial mould of split wood showing polygonal cracking.
284	940	64	2	fragments of vesicular mid-grey slag - probably bloated wall; shows glassy inclusions and crusts.
		940	6	large block and a few fragments derived from it; similar to 398g block above; charcoal-bearing grey slag mixed with granular (sand grade) pale material; suggests interaction of iron slag and lime, likely to be from wholesale failure of furnace wall.
291	106	48	4	tapslag
		40	1	dense slag with rather chaotic irregular voids - probably a tapslag
		4	1	sandy lining slag with green glass surface
		3	1	small irregular dense iron slag blebby fragment
298	572	394	assm	many pieces of gravel cemented by Fe-Mn pan
		82	1	angular dense iron slag fragment; indeterminate, but most likely to be a central fragment from an SHC

		18	1	dimpled greenish base of dense flow; probably the base of tapslag flow
		80	1	maroon surfaced tapslag
4049	300	242	1	dense slag penetrating into oxidised-fired wall; slagged wall from near blowhole
		56	1	rather messy-appearing iron slag; probably charcoal mould bearing material that has been broken from the above block
4058	50	50	1	unusual open textured concretion, gravelly, large penetrative voids, some Mn mottles
4165	26	26	1	vesicular tap slag, rather irregular, smooth shiny base
4321	476	58	11	small pieces of indeterminate vesicular iron slag - mostly rather low density
		16	1	oxidised fired lining with greenish glazed slag coating
		46	1	internally orange superficially grey lining, shows convex surface; could just be fragment of a tuyère
		144	1	very irregular slag mass fragment; shows one maroon surface lobe internally, but unclear if a furnace slag or a smithing slag
		30	1	fragment of detached green glassy lining slag
		12	1	reddish orange fragment of very hard fired ceramic (or just possibly stone)
		3	1	quartz pebble
		50	1	very dense concretionary lump, equant, could be slag or iron core
		88	3	porous slag in charcoal rich concretion - probably originally a slag rich in charcoal moulds
4322	2175	326	1	dense crudely plano-convex mass; 75x80x50mm; granular appearance; probably a SHC
		266	1	slag inside charcoal-rich concretion
		464	1	tabular block of slag; gently curved smooth base; open-textured top; coated in charcoal-rich accretion
		414	14	rather gravelly oxidised fired clay much well slagged; mostly apparently grey smooth surface
		234	3	rather undiagnostic porous slags; in charcoal-rich concretion
		112	2	small fragments of SHC; one a lining-dominated greenish lip.
		188	23	small fragments of indeterminate slag and concretion dust with traces of FHS
4323	1220	174	14	oxidised fired silty, often gritty, ceramic; typically well vitrified and slagged
		118	8	poorly preserved low density lining slags
		184	13	ashy, charcoal-rich concretionary material; some pieces may be cored on slag, but not seen
		456	13	decomposed natural conglomerate and sandstone; most pieces with adhering concretionary material
		6	1	mineralised iron fragment
	balance		assm	debris - includes some FHS

4343	32	32	1	concretion, sandy, contains much charcoal, and some probable coal; significant amount of FHS
4406	14	14	1	exploded small Mn concretion in pinkish cemented sand
4452	22	22	1	highly fragmented concretion; fragments include exploded Mn-rich concretion, plus fragments of sandstone; unclear if Mn nodule formed inside a sandstone fragment, or if the sandstone fragment was part of a concretion.
4862	472	472	1	crescentic slag piece with curvature of 140mm external radius; base crudely dimpled, top irregular, internally vesicular; possible basal furnace slag, possibly deformed (rolled)
4966	336	336	1	concavo-convex slag fragment; basal sheet partly rusty, partly smooth grey slag with small fuel impressions and a sandstone clast; upper part irregular; some crude lobes and some probable fuel moulds, but accreted and details not visible
5064	104	104	1	very worn piece of extremely dense tap slag with almost no vesicles
5107	118	118	1	small fragment of very dense tapslag (almost no vesicles) in very fine flow lobes; maroon surfaced
5126	100	100	1	complex dense ore; sheet of apparently massive goethite, with black botryoidal crusts down one side; where it is weathered, the dense layer appears to be at least partially of stalactitic facies
6067	256	148	1	angular fragment; resembles piece of tapslag, but pale; internally dense with large oblate voids; base shows coalesced descending prills, locally with impressions and clasts of charcoal; top has minor smooth areas, but mostly rough, suggesting top is missing; coarse grained; so probably a basal furnace slag fragment
		70	3	fine-grained vesicular slags of slightly irregular appearance
		40	2	coarse-grained irregular slag fragments (all the pieces from this context could be from single original block)
6208	32	32	1	open-textured prilly slag; pale grey; heavily accreted with charcoal-rich material; some charcoal in slag too
6213	62	62	1	very heavily weathered and etched fragment of tapslag
6217	1610	1595	1	concavo-convex cake, slightly broken; 200x150x70mm; base well formed, rough surface, with various offsets and curved surfaces, hinting at possible tool marks, but without certain examples; interior porous, probably very finely vesicular with very small fuel moulds and vesicles; top locally smooth and maroon, but laterally higher and rougher; probably a small furnace bottom slag from a tapping furnace
6223	108	108	1	fractured margin of tap slag cake; lobes are rather bulbous, with large rounded internal cavities

6231	1955	928	1	worn large block of tapslag; lower 20mm shows more obvious definition into flow lobes; upper 40mm is massive, almost free of vesicles, with only slight traces of internal lobing and well-formed upper surface; lobes wide and flat, suggesting high fluidity
		950	3	large block of porous slag broken into 3; shows some sandstone pebble inclusions and impressions of fuel on ?upper surface; probably largely failed wall?
		68	1	concretion, possibly on iron, no MD response
8088	1825	722	1	well-formed dense charcoal-bearing SHC, probably slightly folded during extraction, now 100x120x65mm, but probably originally wider and flatter.
		1090	1	160mm w x 90mm l x 60mm h fragment of channel-like large slag cake; finely vesicular and low density with glassy patches (inclusions?), lining-like inclusions and with a base that shows abundant coked coal fragments
8100	2	2	1	small chip of highly vesicular coarse charcoal-bearing slag - including part of margin of round wood fragment

Table 2: summary of investigation of material classes by context. Yellow tone = samples from hearth [4324], grey tone = samples without macroresidues. Indet. = indeterminate slag, conc. = concretion. For other categories see text.

context	iron ore	tapslag	dense FB	low density FB	rod	indet.	wall	dense wall	lining slag	SHC	poss SHC	FHS	conc.	natural	iron			
272	fill of p/h 721	226					62							8	296	288		
274	fill of p/h or pit 273	1136			28	496	128								1788	1788		
284	culvert 285		804			64		1878							2746	2746		
291	fill of pit 2004	88				3			4						95	95		
298	298 p/h packing	98									82			394	574	180		
4049	fill of p/h 4048						298								298	298		
4058	cut for ditch 7													50	50	0		
4165	fill of pit 4166	26													26	26		
4321	fill of hearth 4324					290	74		30				50	3	447	394		
4322	fill of hearth 4324					1102				902		Y			2004	2004		
4323	fill of hearth 4324						174		118			Y	184	456	6	938	292	
4343	fill of hearth 4324											Y	32		32	0		
4406														14	14	0		
4452	fill of p/h 4450													22	22	0		
4862	ditch fill ditch 12			472											472	472		
4966	fill of p/h 4964					336									336	336		
5064	fill of dtich24	104													104	104		
5107		18													18	18		
5126	fill of ditch 9	100													100	100		
6067	fill of ditch 18			148		110									258	258		
6208	pit fill pit 6206					32									32	32		
6213	fill of ditch 25	62													62	62		
6217	pit fill of 6218			1595											1595	1595		
6223	pit fill of 6224	108													108	108		
6231	fill of pit 6232	928					950						68		1946	1878		
8088	fill of valley 8087									1812					1812	1812		
8100	fill of quarry8099					2									2	2		
<i>total</i>		100	2794	1004	2215	28	2435	1686	1878	152	2714	82		334	947	6	16375	14888

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