Metallurgical Residues from Wilcote, Oxon.

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Introduction

The metallurgical residues submitted for examination include 62 pieces totalling only 1.5kg, giving an average fragment weight of 25g. This small total weight, taken together with the small average fragment size emphasises the derived nature of this assemblage. Despite the small quantities involved, the material includes samples from a wide range of metallurgical activities, involving the use of iron, copper alloys and lead.

Iron working

The dominant material is from iron-working. These blacksmithing slags include small fragments of plano-convex smithing hearth slag cakes, but no even moderately complete complete cakes were recorded. Much of the assemblage comprised small lumps and blebs of fayalitic slag, which were not part of cakes, but which are typical of much blacksmithing residue. Hearth lining fragments, also probably from iron working hearths were also recovered. One piece of lining from Site A (1332) proved to be iron-enriched on examination under the SEM, despite a colour which suggested a non-ferrous metal contamination. Almost all the iron working residues either contained charcoal fragments, or had a dimpled surface characteristic of slag/charcoal contact. There was no evidence for any use of coal for fuel. Although most of the fragments appear to have been in derived contexts, the slags from Site A (1172) have adhering soil which contains micro-residues of flake hammerscale.

Copper alloy working

Copper alloy working was represented by small slag fragments from sites A (1066) and possibly B (2019). The site B midden (2004) yielded a small lump of copper alloy (2004W), which appears to have solidified in the hearth, presumably as a result of spillage. A copper alloy bleb was also recorded from this deposit (2004U), but was not submitted with the metallurgical residues. A piece of the copper alloy lump was subject to examination on the SEM, and was found to be an alloy of approximate composition Cu 78%, Sn 12%, Zn 7%, Pb 3%, broadly corresponding to a gunmetal in modern terminology, and within the range of the Roman quaternary copper-based alloys. A small (5g) slag bleb from (1066) was highly phosphatic (10-27% P on superfical semi-quantative EDS analysis). Phosphatic slags of this type have been recorded elsewhere as crucible slags. The analyses of the bleb suggest involvement of metal oxides, with the metals in the average proportion Cu 43%, Sn 41%, Pb 16%; such a composition would be compatible with residues derived from fire refining of the gunmetal composition under oxidising conditions.

A single unstratified crucible sherd was recovered from site B. This sherd is interesting in being from a thin-walled wheel-thrown crucible with an external clay coat. The internal face of the crucible has a blue-grey colour, the outside is covered with a buff coloured slag. The outer slag has a small area of red colouration, suggestive of incorporation of copper oxides. The sherd is 3-5mm in thickness, with an outer slag of 6-8mm. Semi-quantative EDS analysis shows a composition for the inner face of the wheel thrown material as including approximately 56% SiO_2 and 32% Al_2O_3, whereas the outer slagged clay layer shows a more siliceous composition with 65% SiO_2 and 22% Al_2O_3. Both surfaces show around 8% P_2O_5 and a significant content of nickel (0.1-2%). This type of crucible is less commonly encountered than hand-made, thick walled crucibles. Examples have been recorded from (amongst others) Colchester (C1, Bayley 1984), Silchester (C4, Northover & Palk 2000), Caerwent (C4, author's unpublished observations), and Caerleon (C1-C2, Zienkiewicz 1993; late C3-C4, Evans & Metcalf 1992). Where usage of these crucibles has been determined, they have been for copper alloy work; this sherd, however, shows no internal metallic residues. The published occurrences of such crucibles in Britain are mainly associated with military or possible "official" urban sites; they are much less common in rural settlements, where the hand-made crucibles are almost ubiquitous.

Lead working
Lead alloy working is represented by a piece of a small plano-convex cake of impure lead from site G (7008). The cake appears to have originally been subcircular, approximately 10cm in diameter and 1.7cm thick. The surviving piece weighs 100g and represents approximately 30% of the original cake. A small piece of this cake was removed for EDS analysis. These spot analyses are difficult to interpret, being taken from on a chip from the periphery, and being at best only semi-quantative, but they record copper ranging from 2-45%. This suggests the cake was produced during a metal reworking or recovery process, rather than being primary raw material.

Distribution
The residues showed little discernable pattern in their distribution. Phase 1 deposits in Site A produced evidence for both blacksmithing and copper-alloy working. Phase 2 yielded blacksmithing slags in sites A and F, but the midden in site B gave evidence for both blacksmithing and copper alloy work. A phase 2 ditch in site G yielded the cake of lead. The small amount of material suggests that the metallurgical activity was occurring at some distance from the excavated area.

References

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context	SF	label	weight	pieces	id		Period	Group	
Site A									
1022	10	slag	20	1	iron slag	quarry pit 1021	1	5	dimpled iron slag with some included clay.
1066	77	slag	5	1	Cu slag	quarry pit 1065	1	5	lining/fuel ash slag with Cu corrosion products.
1172		slag	80	2	iron slag	quarry pit 1065	1	5	1 piece of dense slabby cake with some charcoal, smaller piece shows abundant fine charcoal, adhering soil has flake hammerscale
1064		slag	20	1	iron in slag	pit 1063	2	12	corroded iron piece with charcoal (?slag) in corrosion.
1413		slag	180	3	iron slag	posthole 1411	2	16	3 pieces, two conjoining, with twisted appearance, 1 surface with small dimples, other with sand-grade grains.
1332		slag	25	1	iron slag	posthole 1331	2	18	vitreous slag with devitrification structures, greenish with black surface (cf. piece from 2066)
1332		fired clay/vitrified	75	2	lining	posthole 1331	2	18	2 pieces of lining, 1 violet coloured.
1074		slag	260	9	iron slag	pit 1073	2	23	1moderate smithing cake fragment, 3 balls of lining slag, 1 sheet of dense slag with charcoal on base, 2 probable iron slag fragments, 1 rusted iron rich slag with charcaol, 1 charcoal-rich iron slag.
1122		slag	90	2	iron slag	track 1013	3	26	small piece of slag dimpled on all sides, main piece corroded & worn dense slag from smithing cake with charcoal.
		total wt (av.)	***755***	***(34)***					
Site B									
2019		slag	5	2	slag ?Cu	ditch 2018	2	31	lining-rich slags - may be from non-ferrous metalworking.
2053		slag	55	1	iron slag	ditch 2052	2	31	small rusted smithing cake fragment, smooth top, sediment on base.
2065		slag	55	3	iron slag	ditch 2064	2	31	small piece has dark red-surfaced slag on sandy core (stone?), medium piece is pumice-like white slag with dark/red surface, large piece also unusual – like smithing cake but weathering brown.
2066		slag	115	3	iron slag	ditch 2064	2	31	main piece from a moderate smithing cake with large iron fragment, 1 piece of strange dark glassy slag with devitrification structures (cf. piece from 1332), small piece vitrified lining slag.
2011		slag	70	9	iron slag	ditch 2010	2	32	pale weathering vesicular slags, ranging from vitrified fluxed lining to denser iron slag, charcoal impressions.
2026		slag	70	4	iron slag	ditch 2025	2	33	large piece corroded smithing cake with charcoal, medium piece very vesicular includes probable vitrifying pebble, 2 small pieces as medium.
2017		slag	15	1	iron slag	pit 2016	2	34	small eroded piece of dimpled slag.
2022		vitrifed fc	20	1		ditch 2020	2	34	lining.
2009		slag	10	1	iron slag	pit 2008	2	34	rusted vesicular slag.
2004		slag	30	2	iron slag	layer	2	36	two pieces of iron- and charcoal-rich slag, very rusty.
2004 G		slag	75	3	iron slag	layer	2	36	3 pieces probably from 1. Weathered smithing cake fragment with very large fayalites.
2004 S		slag	10	1	iron slag	layer	2	36	small slightly prilly iron slag.
2004 W		slag	30	1	Cu	layer	2	36	piece of copper alloy lost in hearth.
2032		slag/fe	65	2	iron slag	?			large piece is an vesicular, charcoal-bearing iron slag with grogged? clay lump and sand grains. Small piece is brown-weathering slag with a chert fragment.
u/s		crucible	5	1	crucible	u/s			sherd of wheel turned crucible, with thick external slag.
		total wt (av.)	***630***	***(18)***					
Site F									
6006		slag	15	2	iron slag	ditch 6005	2	28	small piece of iron slag with charcoal and showing vitrfied lining on convex surface at one end.
6011		slag	70	2	iron slag	ditch 6009	2	29	probably two parts of same piece, abraded smithing slag.
		total wt (av.)	***85***	***(21)***					
Site G									
7008		slag?	100	1	lead	ditch 7006	2	38	gently plano-convex slab of cast lead-based alloy. Burnt(?) sediment on base.
		total wt (av.)	***100***	***(100)***					

Table 1: summary of the metallurgical residues, by context.

	lining (1332)			lead cake 7008							crucible u/s site B									copper 2004W									Cu slag 1066			
	A1	A2	A3	C1	C2	C3	C4	C5	C6	C7	D1	D1	D2	D3	D4	D5	D6	D7	D8	E1	E2	E3	E4	E5	E6	E7	E8	E9	H1	H2	H3	H4
Na	5.7	5.5	4.3														13.1	12.6	10.5													
Mg	2.4	2.2	2.0								3.9	1.8	6.4	3.8	4.1	4.0	5.7	5.4	4.5										2.6	2.7	1.6	2.4
Al	21.4	48.2	21.1	1.4	0.8	5.7	1.3	0.2	1.9	0.6	58.3	21.0	39.9	28.6	35.6	37.2	21.0	20.6	20.4	0.8	0.9	0.9	0.8	0.5	0.7	1.0	3.1	1.5	9.9	21.7	18.6	22.5
Si	43.8	29.4	45.9	3.2	2.8	<	1.0	0.3	2.6	2.0	31.5	62.9	44.7	47.4	48.9	49.7	51.9	50.7	56.1	0.3	1.1	1.3	15.0	4.5	2.5	0.4	1.1	2.2	14.0	35.1	32.8	30.6
P	5.4	5.4	3.0							0.4	4.3	1.2	8.4	11.3	10.5	8.3	5.9	7.4	5.5										26.6	14.5	9.9	16.4
Cl	0.1	4.1	<											4.3	<	<	<	0.5	<													
K	5.3	1.5	5.9	10.8	9.2	<	1.5	<	8.1	6.0	<	4.5	<	<	0.3	0.4	1.4	1.9	2.0	<	0.1	0.1	0.1	70.0	6.2	0.2	0.3	0.2	0.9	2.2	2.6	1.9
Ca	3.6	1.1	3.2								<	3.4	<	<	0.2	0.3	0.6	0.7	0.8										33.4	10.1	8.9	8.3
Ti	1.1	0.3	1.2								<	0.5	<	<	<	<	<	<	<													
Cr	0.1	<	<																													
Mn	0.1	<	<	0.5	<	<	<	<	<	0.2	<	<	<	<	<	<	<	<	<										<	<	<	<
Fe	10.9	1.1	13.5	2.1	<	<	<	<	<	0.4	<	4.8	<	<	<	<	<	<	<	0.2	0.3	0.2	<	0.2	0.8	0.3	0.6	0.4	2.6	6.1	13.1	7.0
Ni	<	1.2	<	<	<	<	<	<	<	<	2.0	<	0.5	4.5	0.3	0.1	0.2	0.3	0.3	0.2	<	0.1	0.1	0.2	0.2	0.1	0.2	<	<	0.2	<	<
Cu	<	<	<	3.9	19.8	44.8	4.2	1.5	22.5	13.7	<	<	<	<	<	<	<	<	<	79.5	76.1	91.2	75.3	9.9	47.0	66.3	59.0	69.9	8.4	2.5	5.3	3.3
Zn	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	4.2	4.4	1.5	1.0	5.1	13.7	9.8	20.0	8.6	<	<	<	<
Sn	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	11.7	13.5	3.0	3.2	<	14.9	18.8	14.6	12.3	<	3.6	5.0	5.4
Sb	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	0.3	<	<	<	<	<	<	<	<	<	<
Pb	<	<	<	78.1	67.4	49.5	91.9	98.0	64.8	76.6	<	<	<	<	<	<	<	<	<	3.3	3.6	1.6	4.3	9.6	14.1	3.1	1.2	4.7	1.6	1.1	2.2	2.4

Table 2: summary of semi-quantative elemental EDS analyses, normalised to 100wt%. < = below detection. blank = not determined,