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Assessment of pyrotechnological residues from Lansdown, Bourton-on-the-Water, Glos.

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Abstract

The submitted materials (22.2kg) included 22.0kg of pyrotechnological materials. Of these, 21.6kg (98.4%) were materials classifiable as fuel ash slag (FAS) of probable non-metallurgical origin. Such a high proportion of FAS is very unusual on a Roman site, although it is common residue class and its preponderance on another site in Bourton has been noted previously (albeit within a much smaller assemblage). It is extremely fragile, so large masses were uncommon and many individual context assemblages probably represent the fragments of a much smaller number of pieces before excavation than listed in the tables. Where larger fragments were available, they suggested complex, sheet-like forms of up to 100mm. The FAS was a highly variable material and there were several texturally distinct components that occurred combined in different examples. The least vitrified material appeared to grade into porous, low-density ceramic with moulds of plant material, suggesting that the precursor (of these at least) was daub. Other fragments showed a denser, sandier or gravel-bearing ceramic, often forming a thin, twisted sheet, fronted by fuel ash slag; these were interpreted as veneers of slag pulled from hearth wall. The main FAS materials were formed by vesicular glass (with a variable dark, blue, cream or golden colour), with vesicles varying from fine commonly up to a 6-10mm range. The golden coloured FAS often occurred on the base of the slag and appeared to be from situations where the FAS had not wetted, nor interacted with, the adjacent sediment. The FAS also often contained voids, or depressions in the surface, containing a yellow, brown or red ceramic material, typically with a foliated microstructure; these are interpreted as associated with fuel ash rather than hearth wall/floor. The FAS often contained pale rounded clasts (interpreted as heat- altered limestone gravel), as well as rarer examples of pebble-grade inclusions of heat-altered limestone and sandstone. FAS with similar features has previously been recorded with origins in a variety of long-burning floor-level hearths incised into calcareous substrates, including both open hearths and enclosed kilns, particularly cereal drying kilns. Such an origin is also most likely here, but other forms of 'industrial' kilns might also produce similar residues, and the evidence for possible pottery kiln wasters should also be borne in mind.

Just 74g of material was identifiable as blacksmithing slag (fragments of coal-fuelled smithing hearth cakes, SHCs). There was also 196g of clinker and 4g of coal/coke, materials providing evidence for the use of coal as a fuel, but which do not necessarily indicate a metallurgical use. A single 8g fragment of slag or dross indicated the working of copper alloys.

The collection also included a few fragments (6 certain and 3 possible, total 67g) of finely bloated ceramic with a smooth striated surface and bearing isolated quartz grains, that was different in character to the ceramic materials associated with the FAS. These are interpreted as highly bloated fragments of pottery. The texture suggests the over-heating of pottery during its firing, rather than the burning of already-fired pot sherds, accordingly these fragments are tentatively interpreted as kiln wasters.

Other materials within the submitted collection included a few pieces of rock, five fragments of mineralised iron artefacts, some fragments of probable fired daub, a fragment of burnt bone, two small fragments of pottery/CBM.

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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.

The submitted collection was not the entire assemblage of pyrotechnical residues from the site; the examined material was a subset taken from secure Roman contexts.

The summary catalogue is presented in Table 1.

This assessment was conducted in June 2019 and was commissioned by Paul Nichols of Gloucestershire County Council Archaeology Service.

Description of the assemblage

Fuel ash slags (FAS)
The FAS was a highly variable material. It is extremely fragile, so large masses were uncommon and many individual context assemblages probably represent the fragments of a much smaller number of pieces before excavation than listed in the tables. Where larger fragments were available, they suggested complex, sheet-like forms of up to 100mm, but frequently much less.

There were several texturally distinct components that occurred combined in different examples. The least vitrified material appeared to grade into porous, low-density ceramic with moulds of plant material, suggesting that the precursor (of these at least) was daub. Other fragments showed a denser, sandier or gravel-bearing ceramic, often forming a thin, twisted sheet, fronted by fuel ash slag; these were interpreted as veneers of slag pulled from hearth wall. The main FAS materials were formed by vesicular glass (with a variable dark, blue, cream or golden colour), with vesicles varying from fine commonly up to a 6-10mm range. The golden coloured FAS often occurred on the base of the slag and appeared to be from situations where the FAS had not wetted, nor interacted with, the adjacent sediment. The FAS also often contained voids, or depressions in the surface, containing a yellow, brown or red ceramic material, typically with a foliated microstructure; these are interpreted as associated with fuel ash rather than hearth wall/floor. The FAS often contained pale rounded clasts (interpreted as heat-altered limestone gravel), as well as rarer examples of pebble-grade inclusions of heat-altered limestone and sandstone.

Ironworking (blacksmithing) and coal residues
Just 74g of material was identifiable as blacksmithing slag (fragments of coal-fuelled smithing hearth cakes, SHCs). These fragments were extremely dense slags from small SHCs with flat tops (locally covered with a black glass) and slightly prilly bases (with coal residues trapped between the prills).

There was also 196g of clinker and 4g of coal/coke, materials providing evidence for the use of coal as a fuel, but which do not necessarily indicate a metallurgical use. Their occurrence here in contexts closely associated with those yielding the more certain blacksmithing residues provides circumstantial evidence that they too might be from ironworking.

Copper alloy working residues
A single 8g fragment of slag or dross indicated the working of copper alloys. The piece shows an altered dark slag-like material, locally with green copper corrosion products, in the form of a crudely prolate spheroid. This piece might be a drossy slag or might be a concretionary mass around a corroded casting spill.

Possible pottery wasters
The collection also included a few fragments (6 certain and 3 possible, total 67g) of fine bloated dark grey ceramic, bearing isolated quartz grains, that was different in character to the ceramic materials associated with the FAS. These are interpreted as highly bloated fragments of pottery. The texture suggests over-heating of pottery during its firing, rather than the burning of already-fired pot sherds, accordingly these fragments are tentatively interpreted as kiln wasters.

Concretions on iron
There were five fragments of mineralised iron artefacts. Two of these were small fragments of thin iron sheet from related contexts ((2145) and (2152)), one was a ring of mineralised iron (unless the corrosion from around a now-missing iron core), possibly a socket fragment from (2398) and two were indeterminate small iron fragments or objects (from (2509) and (2729)).

Other materials
Other materials within the submitted collection included a few pieces of rock, some fragments of probable fired daub, a fragment of burnt bone and single small fragments of pottery and CBM.

Distribution of the assemblage

The FAS derives from 212 contexts, with a wide stratigraphic (Table 2) and geographical (Table 3) spread. The largest collections were recovered from fills of waste or quarry pits in areas 17, 38, 40, 46 and 54, all towards the northeast of the site. These areas may represent the locations of suitable sites for the dumping of waste, rather than actual location of the activity. These fills are currently attributed to C3, C3/4, C3/4, C2-4 and C2 dates respectively which, subject to final dating, suggests that the FAS was residue from a persistent long-lived activity.

Interpretation

The dominant FAS in this assemblage occurs in far greater quantities and is more generally distributed than is typical for Roman-British sites. A similar dominance of FAS, albeit within a much smaller assemblage, was noted for a collection of residues from Bourton Business Park (Young 2011b).

FAS forms as a viscous partial melt of a substrate under the fluxing influence of calcareous wood ash. This effect is enhanced if the substrate is itself calcareous, and most known examples result from long-burning fires in hearths cut into calcareous substrates. Such hearths might be open, or enclosed (i.e. a kiln). The complex textures of the FAS are driven by localised vitrification of fuel ash, material derived from the hearth floor and material derived from the hearth walls. The material derived from the cut may include clays, silts, sands, gravels and pebbles, and some similar natural ceramic materials may also be introduced accidentally with the fuel. Within metallurgical settings, FAS can only be generated where none of the metal being worked is lost to the hearth. This rarely occurs in iron-working but may be the case in some non-ferrous metalworking processes.

The most common archaeological occurrences of fuel ash slag relate, however, to non-metallurgical processes, particularly to the use of cereal drying kilns. FAS has been documented from cereal kilns at South Hook (Young 2010a, 2010b), Ysgol Bro Dynefor, (Young 2015), and Bornais (Young 2005, 2016b). Coarse fuel ash slags were also generated in large external hearths at Bornais (Young 2012a).

Other occurrences of FAS have not been directly associated with their originating hearths/kilns and thus their origin is more speculative. Large domestic hearths may have been responsible for the 'Iron Age Grey' slags that occur particularly in Middle Iron Age contexts in central and eastern England (Cowgill 2000, 2008; Cowgill *et a*l. 2001; Swiss & McDonnell 2001) and which share many structural and morphological features with the coarse fuel ash slags from external hearths at Bornais (Young 2012a). The generation of fuel ash slags in these settings is also similar in many ways to the formation of 'cramp' (Photos-Jones *et al*. 2007). Other origins include a possible source in lime-burning (Young 2012b) and in the conflagration of buildings constructed with daub (Young 2012b), although both these processes are likely to generate FAS with different morphological characteristics to that recorded from Lansdown.

On a regional basis, FAS is commonly encountered in small quantities within residue assemblages of Roman both from sites on the limestones of the Cotswolds (Mickleton, Young 2017b) and on the limestone gravels of the Severn Vale (e.g. Whaddon, Young 2018a; Uckington, Young 2013; Hucclecote, Young & Bowstead Stallybrass 2003). Of these, only Mickleton yielded a significantly large assemblage (1.5kg).

The only other large assemblage of FAS in the current region was that from within Iron Age the hillfort rampart at Malmesbury (Young 2009c, 2011a). This material was similar in general morphology to the present assemblage, despite its Iron Age date.

In this instance, the presence of possible pottery wasters raises the possibility that the FAS was generated in a pottery kiln, rather than a cereal drying kiln. Although this is a theoretical possibility, the scarcity of wasters compared with the FAS suggests that either they are not related, or at very least that most of the FAS derives from another process (such as cereal drying). The small quantity of the possible wasters would suggest that if correctly identified this was not a major industry.

The ironworking (and probably also the copper alloy working) resides indicate a low level of metallurgical activity in the general area. The coal fuel employed for the blacksmithing is a typical feature of Roman blacksmithing in the region and the residues can be compared with those from sites such as Cleevelands (Young 2017a, 2018b), Kingswood (Young 2017c), Trowbridge (Young 2009a, 2009b) and Lockleaze Villa (Young 2018c). The use of coal and the apparently small size of the SHCs from which the fragments derive, both indicate that the SHCs derive from end use blacksmithing rather than any stage of the iron production process.

Some other sites in the region have produced solely charcoal -fuelled blacksmithing slag (e.g. Ebrington, Young 2016a; Mickleton, Young 2017b; Thornbury, Young 2018d). Some of the charcoal-using sites are relatively early in the Roman period, but it is not yet known whether age is the only control, or whether some rural estates with their own woodland resources continued with charcoal. The driver for the change from charcoal to coal during the Roman period is not understood.

Some care must be exercised in assuming that the single piece of evidence for copper-alloy working must be of Roman age. Somewhat similar low levels of residues were recorded at Bourton Business Park, where there was suspicion that the copper alloy residues were, at least in part, residual Bronze Age materials (Young 2011b).

Further work

Although further investigation of fuel ash slags is highly desirable, that work needs to be focused on examples where the precursor materials may be sampled and where the originating structure can be identified. Without these, it would be very difficult to extract further useful information through laboratory analysis of the Lansdown assemblage.

The very limited of metalworking residue from the site would not justify further analysis.

Accordingly, no further analysis is recommended. The assemblage is however sufficiently unusual that its retention within the deposited archive is strongly recommended.

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Table 1: summary catalogue of submitted materials.

context	s wt	l wt	l no	notes
101	28	28	4	pale FAS
107	14	14	1	FAS
117	18	18	1	FAS
122	86	86	6	variegated FAS
125	54	54	8	FAS, coarsely vesicular, some very dark
135	24	24	1	FAS
204	38	38	4	FAS
205	<1	<1	1	FAS
303	32	32	3	FAS
308	2	2	1	FAS
314	26	12	2	FAS
		14	1	FAS, vesicular and bloated tabular clast, just possibly a waster
402	44	44	3	FAS
403	20	20	1	dark dense bloated ceramic, less altered section shows fine organic tempering, so probably a dense daub
502	28	28	2	FAS
601	8	8	2	FAS
603	<1	<1	1	FAS
606	<1	<1	1	FAS
806	30	30	1	FAS, very coarsely vesicular
902	58	58	6	FAS
1110	20	20	1	denser, ceramic-rich, rough, FAS
1111	66	18	1	bloated ceramic - least altered texture suggests probably originally a potsherd
		48	15	FAS
1113	54	54	10	FAS fragments

context	s wt	l wt	l no	notes
1114	76	76	10	FAS in irregularly and finely lobate pale green vesicular glass
1115	390	348	31	variegated frothy FAS
		42	2	finely bloated ceramic/stone
1116	<1	<1	1	bloated grey ceramic, some internal slagging
1120	30	30	7	FAS
1123	6	6	1	pale, almost golden, prilly FAS
1136	10	10	1	FAS
1143	36	<1	1	probable coke
		36	3	clinker, some blebby some largely coatings around shale
1144	44	44	6	grey FAS
1148	18	18	6	small scraps of FAS
1155		70	5	clinker with large shale fragment
		<2	1	FAS
1199	18	8	2	dark red fired porous ceramic with FAS coat
		10	1	pale lobate glassy FAS
1206	78	78	1	greenish FAS in large lump, part of a thick sheet with ceramic inclusions
1218	2	2	1	fine FAS/bloated ceramic
1221	112	112	13	variable FAS, mostly grey and slightly granular, several pieces show gradation into ceramic, including one with a strong oxidised firing colour
1271	22	16	2	maroon-surfaced clinker one with fragments of shale as inclusions
		6	1	pale FAS
1300	4	4	4	FAS debris
1309	154	98	6	FAS, shows ceramic contact including twisted pieces, red inclusions and pale lime inclusions
		56	1	probably vitrified and partially-melted sandstone
1337	18	18	1	thin stone passing into finely vesicular FAS, with pale cream lime/sand enclaves
1361	212	212	33	small fragments of FAS
1377	4	4	3	scraps of FAS

context	s wt	l wt	l no	notes
1385	16	16	1	FAS
1388	2	2	3	FAS
1390	38	38	4	clinker, one with large shale pieces,
1397		26	6	FAS
		14	2	clinker
		<1	1	coal
		<1	1	coke
1418		<1	1	coke/
		1	1	coal shale
1421	252	198	32	FAS
		52	1	probably SHC fragment, irregular, possibly lobate base, very dense body and upper veneer of glassy lining material, very dense piece
1434	52	50	5	pale frothy FAS
		2	1	dark vitrified ceramic grain
1436	4	4	2	FAS
1437	162	162	20	varied FAS fragments, range from bloated clay to thick sheet fragments
1448	50	38	6	FAS
		12	2	highly bloated potsherds
1459	82	82	8	grey frothy FAS
1463	32	32	11	small fragments of FAS
1467	134	134	42	small fragments of FAS
1479	98	98	4	coarse frothy pale FAS
1489	18	18	5	pale FAS
1502	602	602	16	variegated FAS, including some large blocks of thick (80mm?) sheets
1510	60	60	13	FAS, probably fewer original pieces
1524	48	48	12	FAS, most pale but 2 slightly reddened
1526	28	28	3	pale FAS
1550	28	28	3	FAS, one piece with charcoal in vesicle

context	s wt	l wt	l no	notes
1561	142	132	19	rather variable FAS
		10	1	clinker
1566	16	16	2	pale FAS
1572	4	4	1	FAS nub
1577	2	2	2	FAS
1592	66	66	2	green glassy dense FAS with large vesicles
1594	4	4	2	FAS
1600	160	160	14	varied FAS fragments
1613	2	2	1	FAS
1623	140	140	8	frothy FAS, but some pieces moderately dense
1626	<1	<1	1	FAS
1630	<1	<1	2	FAS
1632	2	2	3	FAS fragments
1635	212	212	8	dark, ceramic-rich FAS, clinkery, vesicularity finer than most other samples
1645	206	206	22	FAS
1650	18	18	4	FAS
1651	198	198	4	FAS in varied pieces from 80mm thick sheet to bloated ceramic
1652	46	46	3	variegated FAS all passing back into porous friable ceramic materials
1660		4	2	FAS
		<1	1	very fine bloated ceramic, possibly pottery
1663	52	52	9	variegated FAS with greenish to steely glass
1673	224	224	15	FAS, mostly pale and low density, but one piece is darker and denser
1675	642	642	10	FAS, largest piece is part of sheet 40-70mm thick with some layering, with grey glassy and buff layers of around 20mm; small pieces broadly similar - all coarse vesicular variegated FAS
1679	4	4	1	FAS

context	s wt	l wt	l no	notes
1683	2	2	1	FAS
1687	108	108	8	FAS
1689	22	22	2	FS fragments
1698	192	192	19	variegated FAS with clumps of very porous ceramic, some yellowish some brick red
1704	2775	2775	95	FAS, mainly fragments from >100mm masses - but still lacking surfaces, some pieces show short-range impressions of wood surfaces, one piece shows inclusion of burnt bone
1709	30	30	3	FAS
1710	32	32	10	FAS
1731	2	2	1	green-glazed FAS
1736	8	8	4	FAS
1742	116	116	22	FAS ranging from twisted bloated ceramic to coarse frothy pale green glass
1780	634	598	47	FAS
		36	1	contorted dense bloated ceramic - probably not pottery - probably peel from margin?
1785	1250	1035	60	variable FAS, some in large blocks
		140	2	indurated and fired dense ceramic or stone
		75	1	naturally-cemented limestone gravel
1799	4	4	3	FAS
1841	38	38	10	FAS
1842	32	32	9	FAS
1848	46	46	7	FAS
		<1	1	bloated ceramic, possibly stone but might be waster
1893	128	94	9	FAS
		34	2	highly-bloated fragments of pottery, rim of moderately large jar?
1897	18	18	5	FAS - apparently glass in veins extending into porous ceramic/soil
1899	20	20	4	FAS
1900	<1	<1	2	FAS debris
1918	22	22	2	FAS

context	s wt	l wt	l no	notes
1919	68	68	4	probably single lump of FAS fragmented
1952	212	6	1	fired clay passing into FAS, clay oxidised fired and contains fine organics
		206	26	FAS
1955	60	60	1	FAS block c60mm thick
1956	192	192	10	FAS fragments with complex textures - arcuate lobed pale glass and bloated ceramic all intermingled
1957	36	34	6	FAS
		2	1	limestone
1958	26	26	1	FAS
1960	4	4	1	bloated ceramic/fine FAS with possible limestone gravel clasts
1974	40	40	5	FAS, single broken lump?
1989	10	10	2	FAS
2012	<1	<1	1	finely bloated grey ceramic or more likely coke
2018	8	8	4	FAS
2046	12	12	1	FAS
2050	22	22	8	FAS
2062	8	8	1	FAS
2067	142	142	8	FAS
2072	12	12	4	FAS
2084	16	16	1	fragment of rind of box-stone oxidised ironstone nodule
2099	10	8	1	clinker with slightly lobate base and black glassy top, angular fragment from larger piece, 25mm thick
		2	1	possibly burnt stone
2117	18	18	4	FAS
2129	48	48	3	FAS
2140	<1	<1	1	FAS
2145	12	6	4	FAS
		6	1	small fragment detached from margin of mineralised iron sheet

context	s wt	l wt	l no	notes
2152	30	30	1	ashy material in concretion around iron, possibly a small sheet fragment
2168	132	46	13	FAS, grey frothy
		4	1	crude ceramic with one slightly oxidised surface
		82	7	sheet-like poor grey ceramic in slightly curved bloated sheets, incipient dense FAS
2169	1165	360	1	130x120x65mm, slab of FAS with rough, still dirty base, and smooth surface in crude bloated raised lobes, one side shows rounded depression with clay surface surrounded by raised deformed slag - suggests that the lump was pressed in and surround raised above level of the rest of the top.
		790	32	FAS fragments, all highly vesicular, with glassy top in most examples
2170	1390	1390	30	FAS fragments, all frothy in a variety of forms, the lightly denser examples carry small white rounded grains - fired gravel grains or clumps of ashy residue
2171	230	162	17	pale frothy FAS
		18	1	grey frothy FAS with inclusion of reddish altered probable ceramic
		52	3	incipient FAS in moderately dense altered ceramic
2172	148	148	2	edge of FAS sheet to 55mm
2173	256	256	12	FAS, grey frothy, thickest piece in slightly contorted form, large internal voids, contacts with ceramic of poor nature
2174	780	780	26	FAS fragments, grey frothy, upper surface is pale grey glaze, base rough local poor ceramic, contains some very large voids in places
2199	32	32	9	FAS
2217	6	6	1	dark FAS grading into bloated ceramic
2221	16	16	6	FAS, mostly as thin layer attached to grey bloated ceramic
2224	10	10	4	small fragments of FAS
2228	16	16	2	dark slightly dense glassy FAS
2229	18	18	3	FAS
2235	40	40	3	FAS, pale and grey, some with gradation into pale calcareous material
2239	8	8	3	fine FAS fragments
2240	32	28	5	FAS
		6	1	burnt bone
2245	8	8	1	bloated ceramic
2258	10	10	3	FAS

context	s wt	l wt	l no	notes
2263	6	6	3	FAS
2265	24	24	1	natural sandy ironstone pebble
2270	8	8	1	dense dark FAS, possibly altered stone rather than ceramic?
2272	94	94	15	FAS
2273	18	18	1	FAS formed of vesicular good dense grey glass
2280	2	2	1	finely bloated ceramic
2284	8	8	1	partially melted curved ceramic fragment with white limey inclusions
2285	22	22	1	pale FAS forming thin viscous deformed folds over pale grey bloated ceramic rear
2299	18	18	2	dense FAS, larger piece little more than a contorted glaze on a grey bloated ceramic
2327	48	48	7	pale cream FAS in medium-fine FAS
2335	444	272	31	bloated and frothy FAS, with low proportion of solid material
		38	2	fragments of twisted clay sheet - possibly pulls from hearth wall?
		26	2	dense lumps, possibly altered stones?
		64	8	well-altered pieces but with a high proportion of intact ceramic
		44	5	ceramic pieces with a low degree of alteration, low density, two show planar fronts, one a slightly convex front, several show mixed oxidised/reduced firing
		1	1	small rounded mass, showing bloating and fissuring of convex external surface, probably a highly bloated stone or sherd
2347	32	32	1	FAS in 20mm thick thin pale buff vesicular sheet
2359	8	8	1	FAS
2369	208	100	1	30mm thick sheet of FAS, frothy grey, shiny slightly lobate surface, rear shows runnels of glassy slag with buff calcareous material between
		48	12	FAS
		60	1	20mm thick slab of bloated ceramic - probably vitrified sandstone
2382	36	34	12	frothy dark FAS
		2	1	labelled planar fragment of bloated sandy dark fragment, overfired ceramic, potentially pottery
2383	36	36	4	coarsely vesicular grey glassy FAS
2388	6	6	3	FAS
2393	2	2	2	FAS

context	s wt	l wt	l no	notes
2397	14	14	2	moderately dense FAS
2398	108	90	23	FAS
		14	1	concretion upon what appears to be iron ring or socket fragment, just possibly mineralised iron around now missing circular cross-sectioned object
2399	12	12	3	FAS
2400	30	30	5	FAS
2418	20	20	5	FAS from moderately dense 15mm thick sheet
2425	24	24	5	dark, almost red in places FAS
2428	60	60	10	FAS
2443	4	4	1	small fragments of fine dark grey FAS
2446	6	6	1	FAS
2453	4	<1	1	FAS
		4	1	maroon-surfaced clinker forming right angled piece, possibly a fuel mould or tool impression?
2458	212	212	27	grey FAS, vesicular, bears fine altered pale gravel
2459	4	4	1	FAS
2463	44	44	13	FAS
2473	8	8	3	FAS, one rounded bleb
2488	24	24	1	FAS
2495	36	36	7	FAS, mostly in thin sheets with fragmentary ceramic stuck to one face
2509	184	20	1	iron object in ashy concretion
		10	1	small rounded piece of bloated stone/pottery/CBM, not necessarily waster
		156	16	FAS
2515	258	162	6	FAS with large porous ceramic coated ?wood moulds
		16	1	oxidised fired laminated clay, suggestive of fired daub fragment
		82	5	FAS coating on ceramic debris, probably altered substrate rather than clasts
2518	26	26	4	FAS

context	s wt	l wt	l no	notes
2524	178	150	13	variegated FAS and cream/buff limey layers
		28	1	FAS on denser clast of grey bloated ceramic with coarse quartz - possible highly altered waster
2537	42	42	8	FAS, including variegated material with deep red porous ceramic inclusion
2544	96	96	7	dense dark ceramic rich greenish FAS
2548	8	8	1	probable fragment of copper-alloy slag/dross
2551	30	16	6	FAS
		13	1	sandstone
		2	1	ironstone
2557	12	12	4	FAS
2568	4	4	1	FAS
2575	16	16	2	FAS, fragile poorly consolidated, possibly single piece
2579	118	118	7	variegated FAS
2582	72	72	10	FAS
2584	40	40	5	rather prilly FAS
2601	2	2	1	green glassy bleb
2602	4	4	1	FAS
2603	24	22	2	2 small fragments of very dense slag of clinkery appearance, one has flat top, other has lobate base with coked coal fragments in interstices
		2	1	FAS
2607	2	2	1	burnt coal
2618	16	16	4	FAS
2627	22	22	1	FAS
2631	2	2	1	FAS with pale clast
2633	10	10	1	FAS
2649	46	46	9	FAS, ranges from deep glaze and glass through to sintered sediment
2652	2	2	2	FAS

context	s wt	l wt	l no	notes
2661 / 2646	158	158	20	FAS
2664	<1	<1	2	FAS
2666	14	14	5	FAS
2667	6	6	2	FAS
2670	50	50	12	FAS, probably from thin sheet with very large vesicles
2681	122	122	11	FAS, including pieces pulled from wall with probable organic temper
2685	26	26	3	FAS
2693	76	66	7	FAS
		10	1	slab of dark grey finely vesicular ceramic material dense in core - unclear if stone or waster
2700	2	2	2	FAS
2709	914	914	43	FAS in frothy lumps, sheets etc up to a maximum thickness of around 45mm
2710	26	26	4	FAS
2711	20	20	5	FAS, probably 1 original lump
2713	20	20	1	green glazed slightly contorted FAS strip
2716	214	72	7	FAS dominated by altered limestone clasts in various stages of decomposition
		142	6	variegated FAS
2718	818	818	13	large blocks of FAS indicative of sheets 35-80mm in thickness, one with large stone clast inside
2719	88	88	12	dark slightly spiky FAS
2729	33	<1	1	burnt dab
		6	1	corroded iron
		26	5	FAS
2746	18	18	1	FAS
2752	46	46	6	FAS
2755	12	12	1	dark FAS with reddened porous laminated clast
2758	70	70	2	FAS
2759	48	48	1	contorted variegated FAS

Table 2: summary catalogue of weight of material classes (in g) by context. FAS = fuel ash slag, CBM = ceramic building material, SHC = smithing hearth cake.

Context	FAS	Bloated sherd	CBM	SHC	Clinker	Coke /coal	Iron	Cu-alloy dross	Rock	Bone	Daub
101	28										
107	14										
117	18										
122	86										
125	54										
135	24										
204	38										
205	<1										
303	32										
308	2										
314	26										
402	44										
403											20
502	28										
601	8										
603	<1										
606	<1										
806	30										
902	58										
1110	20										
1111	48	18									
1113	54										
1114	76										
1115	390										
1116	<1										
1120	30										
1123	6										
1136	10										
1143					36	<1					
1144	44										
1148	18										
1155	<2				70						
1199	18										
1206	78										
1218	2										
1221	112										
1271	6				16						
1300	4										
1309	154										
1337	18										
1361	212										
1377	4										
1385	16										
1388	2										
1390					38						
1397	26				14	1					
1418						1					
1421	198			52							
1434	52										
1436	4										
1437	162										
1448	38	12									
1459	82										
1463	32										
1467	134										

Context	FAS	Bloated sherd	CBM	SHC	Clinker	Coke /coal	Iron	Cu-alloy dross	Rock	Bone	Daub
1479	98										
1489	18										
1502	602										
1510	60										
1524	48										
1526	28										
1550	28										
1561	132				10						
1566	16										
1572	4										
1577	2										
1592	66										
1594	4										
1600	160										
1613	2										
1623	140										
1626	<1										
1630	<1										
1632	2										
1635	212										
1645	206										
1650	18										
1651	198										
1652	46										
1660	4	<1									
1663	52										
1673	224										
1675	642										
1679	4										
1683	2										
1687	108										
1689	22										
1698	192										
1704	2775										
1709	30										
1710	32										
1731	2										
1736	8										
1742	116										
1780	634										
1785	1175								75		
1799	4										
1841	38										
1842	32										
1848	46	<1									
1893	94	34									
1897	18										
1899	20										
1900	<1										
1918	22										
1919	68										
1952	212										
1955	60										
1956	192										
1957	34								2		
1958	26										
1960	4										

Context	FAS	Bloated sherd	CBM	SHC	Clinker	Coke /coal	Iron	Cu-alloy dross	Rock	Bone	Daub
1974	40										
1989	10										
2012						<1					
2018	8										
2046	12										
2050	22										
2062	8										
2067	142										
2072	12										
2084									16		
2099					8				2		
2117	18										
2129	48										
2140	<1										
2145	6						6				
2152							30				
2168	132										
2169	1150										
2170	1390										
2171	232										
2172	148										
2173	256										
2174	780										
2199	32										
2217	6										
2221	16										
2224	10										
2228	16										
2229	18										
2235	40										
2239	8										
2240	28									6	
2245	8										
2258	10										
2263	6										
2265									24		
2270	8										
2272	94										
2273	18										
2280	2										
2284	8										
2285	22										
2299	18										
2327	48										
2335	444	1									
2347	32										
2359	8										
2369	208										
2382	34	2									
2383	36										
2388	6										
2393	2										
2397	14										
2398	90						14				
2399	12										
2400	30										
2418	20										

Context	FAS	Bloated sherd	CBM	SHC	Clinker	Coke /coal	Iron	Cu-alloy dross	Rock	Bone	Daub
2425	24										
2428	60										
2443	4										
2446	6										
2453	<1				4						
2458	212										
2459	4										
2463	44										
2473	8										
2488	24										
2495	36										
2509	156		10				20				
2515	244										16
2518	26										
2524	178										
2537	42										
2544	96										
2548								8			
2551	16								15		
2557	12										
2568	4										
2575	16										
2579	118										
2582	72										
2584	40										
2601	2										
2602	4										
2603	2			22							
2607						2					
2618	16										
2627	22										
2631	2										
2633	10										
2649	46										
2652	2										
2661	158										
2664	<1										
2666	14										
2667	6										
2670	50										
2681	122										
2685	26										
2693	76										
2700	2										
2709	914										
2710	26										
2711	20										
2713	20										
2716	214										
2718	818										
2719	88										
2729	26						6				<1
2746	18										
2752	46										
2755	12										
2758	70										
2759	48										

Table 3: distribution (weight in grams) of pyrotechnological and related materials by area.

context	FAS	Bloated sherd	CBM	SHC	clinker	coke/coal	iron	Cu-alloy dross
eval 1	224							
eval 2	38							
eval 3	60							
eval 4	44							
eval 5	28							
eval 6	8							
eval 8	30							
eval 9	58							
area 1	<2				70			
area 3	38				68	2		
area 5	46	<1						
area 8	86							
area 9	10							
area 13	94	34						
area 15	18			22		2		
area 16	558				8		36	
area 17	1090							
area 18	562							8
area 19	220						6	
area 21	24							
area 25	486				4			
area 26	646		10				20	
area 27	114							
area 29	920	3					14	
area 31	38	12						
area 32	230							
area 33	18							
area 35	192							
area 36	158							
area 38	7666			52				
area 39	312							
area 40	4088							
area 42	18							
area 43	2							
area 45	4	<1						
area 46	1034				10			
area 47	62							
area 49	52							
area 50	520	18						
area 51	84				36	<1		
area 52	30							
area 53	86							
area 54	1408							

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