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Evaluation of archaeometallurgical residues from the M74 Completion: WP3-LP3 Caledonian Foundry/ Scotland St Engine Works

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Abstract

The report provides an assessment of potential for the archaeometallurgical residues sampled at the Caledonian Foundry & Scotland Street Engineering Works (WP3, LP3), The assessment has been broadly conducted according to MAP2 principles and this report contains recommendations for those samples to be taken forward to further analysis, with details and justification of the recommended analysis.

86 of the samples taken from WP3-LP3 were assessed.

Samples included residues from both ferrous (from a possible cupola furnace) and non-ferrous (from crucible furnaces) casting. They also included material representative of deposits formed during finishing of the castings (lathe and mill residues, particularly from the period of the Scotland Street Engineering Works. Samples with evidence for the hot working of iron (forging) were also widely distributed across the site, although hot-working has not yet been tied to any particular location or structure.

The samples have clear potential for assisting in the determination of the use of various features and structures, the understanding of the processes employed as well as the nature of some of the metals being worked.37 samples are proposed to be taken forward for further investigation.

Contents

Methods

All samples taken from the WP3-LP3 site for archaeometallurgical purposes were examined for the assessment.

All investigated materials were examined visually, using a low-powered binocular microscope where necessary. All significant materials were summarily described and recorded to a database (Table 1).

As an evaluation, the materials were not subjected to any high-magnification optical inspection, nor to any other form of instrumental analysis. The identifications of materials in this report are therefore necessarily limited and must be regarded as provisional.

Results

The summary results are presented in table 1. The purpose of the following sections of the assessment is to provide a synthetic commentary on the raw results and to give some indication of the significance of those results.

The casting of non-ferrous metals

The casting of non-ferrous metals appears to have been associated with a pair of early circular crucible (pit) furnaces (Structure 6), apparently replaced later in

the history of the site by the bank of smaller crucible furnaces (Structure 1).

Fills of the flues of Structure 6 (6081, 6082) appear to be deposits of moulding sand filling in the abandoned structure, rather than being related to the use of furnaces – so apparently provide little evidence for hte use of the structures.

In contrast, the fills of the three chambers of Structure 1 showed residues apparently left in-situ after use of the structure. These were dominated by partly burnt fuel residues, but also contained blebs and prills of copper-alloy. Preservation was poor, apparently because of the strongly acidic environment, but it is to be hoped that at least some of these materials contain fresh metal.

Waste from the non-ferrous melting furnaces was also identified in areas outside the main moulding shop, including sample 6066 taken from an area just east of the drying room (which contained a single sherd of clinker-coated failed crucible), sample 6011 from just to the south of the boiler, sample 6034 from the centre of the E end of the fitting shop and probably sample 6008 from the southern side of the fitting shop.

Casting of ferrous materials

Iron slags were common over much of the southern half of the site, with major deposits in the eastern yard (Area 3; samples 6015, 6016, 6040, 6042, 6043, 6060). Similar slags were recovered below the southern part of the Patterson St block of the later Engine Works (6021). These iron slags were broadly of two classes: firstly rusty clinkery, dark materials and secondly tapped slags resembling blast furnace slags, particularly a brown glassy slag. These slags are compatible with what is known of 19th century cupola furnaces, although there are few, if any, good descriptions of cupola slags in the literature. Similar iron slags occurred in the makeup of the southern part of the offices (6038, 6039); although the possibility that these were brought in from outside the site as a levelling deposit needs to be borne in mind.

Identifying the source of these iron slags is more problematic. The badly damaged large furnace (Structure 5) is of the appropriate dimensions for an early solid-based cupola furnace. Slag on the base of the structure was sampled, but the sample is not currently accessible. The base is also, however, similar in size to the brass melting furnaces on the nearby Dundas Street Brass Foundry site (WP3-LP4), so determination of the nature of this furnace is very important.

The main casting floor in the moulding shop is dominated by deposits of used black sand (samples 6004, 6018, 6050, 6081, 6082). The curious brick feature, Structure 13, held a deposit of clean sand, apparently an unused moulding sand (6073); investigation of this may help with determination of the nature of preparation of moulding sand at this works.

Finishing of castings

There is little evidence pertaining to the finishing of castings in the early period, but the various machine bases in the Patterson St building provide evidence for finishing processes during the later phases of the Engine works.

Residues have sampled from Structure 2 (N end of building; coarse swarf suggests a large lathe with large base for track for tailstock; samples 6086, 6087, 6088), Structure 19 (centre of the building; small swarf suggests a small lathe or milling machine; samples 6036, 6037, 6044), Structure 21 (centre of building; granular deposit, sample 6049, of uncertain origin and also a box just to the N, sample 6047 with coarse lathe swarf) and Structure 15 (S part of building; collection of artefacts in granular deposit, sample 6010).

A single deposit in a box in the fitting shop (Area 2), sample 6003, also yielded lathe swarf and was apparently late in the history of the building.

Hot working of ferrous materials

Microresidues from the hot working of iron, probably forging in a smithy, to judge from the small scale of the residues, were found widely across the site. None of the occurrences was in-situ, and the location of the iron working is not yet known. It is known from the 1857 Ordnance Survey map that a smithy was part of the Engine Works immediately west of the excavated area – so some or all of the residues may derive from there. Microresidues were recorded from samples 6006, 6013, 6014, 6017, 6022, 6026, 6028, 6032, 6051, 6052, 6053, 60757, 6068, 6070, 6076, 6084.

Macroscopic slags from smithing were recovered mainly from the backfill of the casting pits in the moulding shop (samples 6006, 6051).

Interpretation

The residue assemblage recovered from this site includes material from many, but certainly not all, of the activities on the site.

On the non-ferrous side of the operation, residues are limited to material left in the late crucible furnaces on their abandonment, together with a few waste deposits, one of which contained a single sherd of failed crucible. This paucity of evidence reflects the small amount of waste (besides fuel residues) produced during non-ferrous foundry work. It contrasts markedly with the much better structural evidence for non-ferrous melting furnaces.

Only very small amounts of non-ferrous alloys appeared to be present in the residues from the finishing operations.

Ferrous work is well represented by residues from melting furnaces, finishing machine work and hot working. These suites of evidence do not necessarily derive from contemporaneous activities however.

Evaluation of potential

The Caledonian Foundry/Scotland Street Engine Works site has had a complex history, involving many different types of products over its lifespan, according to the documentary evidence.

The archaeometallurgical residues have considerable potential to assist in the determination of that history

and in the interpretation of individual structures within the site.

The residues from foundry work (both ferrous and non-ferrous) are much less well known and understood than most other classes of archaeometallurgical residues. It is anticipated, therefore, that results of analyses on materials from this project would also be of much wider significance to archaeometallurgy, in addition to providing local interpretative detail.

A proposal for the samples to be taken forward for further analysis is given in Table 2. The samples have been selected both to answer specific questions about the use of specific structures and to address technical questions about materials and processes.

In particular the site has much to offer in understanding the development of crucible furnaces – a subject almost undocumented in the contemporary metallurgical and engineering literature.

The technical questions that can be addressed through investigation of the residues are varied dependent upon the materials themselves:

1. *non-ferrous metal prills*: direct analysis to determine the particular alloys being melted
Samples 6002, 6012

2, non-ferrous melting crucible
Sample 6066

3. ferrous metal inclusions in or associated with melting slags: direct analysis to determine the particular alloys being melted
Sample 6042 (other samples may also yield iron)

4. *ferrous metal swarf*: direct analysis to determine the particular alloys being worked. Morphological investigation to identify type of machine tool employed.
Samples 6003, 6036, 6037, 6044, 6048, 6087

5. ferrous g*ranules from machine bases*: Analysis to determine if these are grinding residues – and if so direct analysis to determine the particular alloys being worked. Morphological investigation to identify type of machine tool employed.
Samples 6010, 6027, 6032, 6035, 6045, 6049, 6086

6. *moulding sand*: determination of type of sand employed, possibly the additives use and the nature of the contamination from use.
Samples 6004, 6018, 6050, 6081, 6082 (used); 6073 (fresh)

7. *cupola slag*: investigation of the cupola melting process, raw materials and fluxes. Are 6042 and 6043 from the early make-up layers from another source? Is 6078 really a cupola base slag?
Samples 6015, 6016, 6040, 6042, 6043, 6078

8. *ferrous hot working fines*: investigation of the hot working processes
Samples 6013, 6028, 6070, 6076, 6084

9. *ferrous smithing slags*: investigation of the nature of the smithing being undertaken
Samples 6006, 6051

10. *fuel ash:* to assist with the interpretation of the other samples
Sample 6069

Summary Catalogue

sample	*context*	*notes*	*location*	*area*
6001		Not seen	general fill in STR 1 the crucible furnaces	1
6002	60422	coke-dominated assemblage, with lots of copper alloy prills and blebs. All looks rather altered - presumably a very acid environment	crucible chamber 60409 primary fill STR1	1
6002	60422	ashy deposit with large pieces of coke. Some isolated pieces of corroded cu alloy - but mostly staining on coke. Some well flowed dense clinkery slag	ditto	1
6003	60064	metallic debris, including swarf corroded on to wood. Other debris present as well	possibly assoc with brick feature, S end of site	2
6004	60169	black even fine sand - used moulding sand	used moulding sand = 6092, 6093	1
6005	60344	slightly sandy black fuel waste - lots of coal dust and small lumps of coke no evidence for clinker	pit 60419 fill, in moulding area NE of site	1
6006	60344	fairly clean blocks of material. Some concretionary lumps with scale, some coke but mainly large clinker masses. Some have masses of flake hammerscale in crevices - so very likely to be coal fired smithing slag cakes	ditto	1
6007		Not seen	curvilinear brick feature just S of probable chimney	2
6008	60223	large collection, 2 tubs, of clinker rich fuel residue including clinker, coke, shale and coal, not swarf! Has a few specks of Cu alloy so maybe from crucible furnace?	swarf few m SE of swarf 6003	2
6009	60426	orange sandy material with more clay-rich lumps in - these may be completely decomposed firebrick pieces as have similar texture	crucible chamber 60408 primary fill STR1	1
6010	60198	many large iron artefacts (nuts, washers etc…), brown sandy ferruginous matrix, coke, clinkers, stone	assoc STR 15 machine base	P
6010	60198	large iron objects, ?leather object, general rubble	ditto	P
6011	60224	fuel ash deposit with degraded burnt shale, coal, clinker, a few flakes of cu-corrosion	dump adjacent to external wall, nr boiler	2
6012	60493	lumps of coke, and burnt shale debris set in a brown clayey matrix. Some charcoal fragments have screws and nails associated - in most cases with the iron missing, though one screw is intact.	crucible chamber 60409 primary fill STR1	1
6013	60026	coal burning residues with shale, coal and clinker - including well formed droplets. Magnet produces both flake and spheroidal hammerscale	spread SW	2/P
6013	60026	coal rich detritus with some coke, a few brick fragments and plenty of hammerscale	ditto	2/P
6014	60521	black sand - probably a used moulding sand, but coarser than other examples. A few small concretionary lumps of iron cemented sand	dump area 2S, NW part of Engine Shop	2
6015	60262	variable large slag blocks. Largest is a nice tapped bowl of brownish glass. Others are more clinkery - these could be cupola slags	early dump, E of drying room	1
6016	60263	mixture of coke and rather rusted clinkery slags.	early dump, E of drying room	1
6017	60074	dark grey sandy deposit with coal residues, clinker, spheroids and some flake scale, coke and burnt shale	waste deposit area 2w, just N of 6013	2/P
6018	60454	homogeneous used black moulding sand	general spread, NE part of P = 6033	P
6019	60535	dark brown soil with coal, clinker, shale	as 6018, central P	P
6020	60536	mid brown deposit with mixed clasts of stone, pebbles slate brick etc	mixed rubble, central P	P

sample	context	notes	location	area
6021	60537	cemented fragmented slag layer, glassy vesicular slags could be cupola slags? Some coke debris. Seems to rest of a level of small quartz pebbles	mixed waste deposit, P S of 6018/9	P
6022	60082	ashy deposit with clinker, shale coal dense magnetic slag debris, flake hammerscale	area 2 SW waste deposit, near 6013/17	2/P
6023	60304	fuel residue, coal, shale, clinker (some moderate pieces) including brown spheroids	area 2 N - central part of engineering works	2
6024		Not seen	backfill of brick inspection pit 60246, central to engineering works	2
6025	60396	single very large lump of coke	moulding sand in W of area1 - corridor?	1
6026	60216	brown soil with various clasts, brick, stone etc. matrix is rich in flake hammerscale	area2, W end of engineering works	2
6027	60664	brown friable very fine sand, slightly accretionary in places. Some of the sand is magnetic. Very homogeneous	general within brick walls 3 S, E end of Engine works nr 6031, 6032, 6028.	3
6028	60621	coal, coke and shale in dark sandy matrix, occasional piece of flake hammerscale Some moderately large concretionary lumps	E end of engineering works nr 6032,6031	2
6029	60666	fuel ash material with lots of burnt shale, mixed with large amount of sand. Some small ferruginous concretions	near W end of engineering works, spread	2
6031	60676	heterogeneous sample mainly concretionary lumps - some black sandy, some ferruginous and full of wood chips. One wood chip rich lump has piece of Cu-alloy in as well	E end of engineering works nr 6028,6031	2
6032	60665	muddy brown deposit with variable clasts - including burnt shale, coal dust, clinker and dense clinkery slag. Some of the sand grade material is angular highly magnetic ?slag. Some flake hammerscale	E end of engineering works nr 6028,6033	2
6033	60602	fuel residue, coke, burnt shale, clinker	spread = 6018, spread N end P	P
6034	60608	clinker and coke, with abundant spheroids, some of clinker is in dense well-flowed pieces, burnt shale, pieces of coal, rare flecks of Cu-alloy corrosion	Rectangular feature, E end of Engine works	
6035	60573	rusty granular deposit. Many of the granules are dark, angular and magnetic. Not clear what this is - presumably corroded iron fragments?	spread/makeup related to 6033, 6018, 6019	P
6036	60576	rusty brown sediment with large quantities of smallish swarf, also lots of wood fragments	machine base S of STR19, centre P	
6037	60592	big bag of lathe swarf	machine base STR19, centre P	P
6037	60592	brown sandy deposit containing abundant smallish lathe swarf. Also fragments of stone and piece of dense clinkery slag with Cu oxides	ditto	P
6038	60594	coal - mainly fresh, just a little burnt material, lots of sand grade rounded coal pieces. Lots of white and black spheroids, some coke	In yard just W of Office	3
6039	60595	fuel waste - clinker including spheroids, coal, burnt shale	SE part of yard	3
6040	60594	slag debris and coke cemented by iron into massive blocks, cupola debris?	In yard just W of Office	3
6041		Not seen		3
6042	60598	iron cemented slag, some so dense maybe iron is present	In side S part of Offices, W side	3
6043	60559	clinkery slag, iron rich , in part corroded on to iron plate, also has an included part fire brick, probably cupola waste	In side S part of Offices, E side	3
6044	60731	bag of lathe swarf, medium to small	machine base STR19, centre P = 6037	P
6045	60798	brown sandy soil, small shard of clear glass, brick fragment, stones, small burnt shale chips	infill of cuts on MB 60450, STR11	P

sample	context	notes	location	area
6046	60827	brown deposit with large lumps of wood. Large burnt shale pieces, stones, coke etc in sandy matrix	infill of pipe feature adjacent to STR11, similar to 6068	P
6047	60825	demolition rubble - not examined	fill of concrete hollow - late	P
6048	60828	brown rusty deposit with large pieces of lathe swarf, lumps of matted hair, bottle glass, rusted iron lump shows cu corrosion flecks in accretion	within timber boxed area - late	P
6049	60829	friable yellow brown sand with large ferruginous concretions. Some of these at least are on clinker - others the core is unclear	machine base STR 21, mixed deposit	P
6050	60843	used moulding sand, has ferrous concretions	machine base STR 20	P
6051	60847	dark grey sandy deposit with some concretions and large lumps of clinker. At least one lump of clinker shows contact with a clay wall/base. Dense spheroids were trapped between slag and clay. Clinker spheroids were present in the sand, but apparently only a single piece of flake scale. However these look like smithing clinkers.	pit 60716, within moulding floor	1
6052	60848	sandy material, variably accreted, black, fuel residues, sand and granules and a little flake hammerscale	overlying pit 60717, within moulding floor	1
6053	60849	dark soil with wood chips, a quartz flake, lump of grey quartz tempered cay, fuel waste (including spheroids) and a little flake hammerscale	fill of pit 60718, within moulding floor	1
6056	60162	heterogeneous sample with brownish colour, sandy with large clasts of sandstone, brick and apparently brown clay. Rare clinker fragments	fill of pit 60424, within moulding floor	1
6057	60721	coal rich deposit, both large lumps and dust. Some small clinker, flake hammerscale, a few larger clinker pieces	fill of pit 61012, within moulding floor	1
6058	60719	coal residues, black with lots of coke and coke fines. Some blebby clinkers. Lots of white and dark non-magnetic spheroids	fill of pit 61011, within moulding floor	1
6059	60728	fuel residue. Mainly formed by lumps of coke. Has some small clinker pieces.	fill of pit 61013, within moulding floor	1
6060		Not seen	cemented slag in yard	3
6061	60856	black sandy deposit, some small clinker fragments, possibly derived moulding sand, but coarser than some samples	black deposit outwith floor 60792, N of drying room	1
6062	60865	yellow brown rubbly deposit. Lots of stone brick etc - just occasional pieces of coke	general demolition rubble over furnace STR7, E of area 1	1
6063	60745	deposit dominated by comminuted burnt shale, with some larger pieces, some coal debris and unburnt shale	fill of ?furnace 60746, STR18 E of drying room	1
6064	60879	dark brown deposit with abundant chips of brick and slate	fill of furnace STR 7, E of area 1	1
6065	60851	degraded ash with shale chips, bears large clasts of coal, shale and moderately dense lumps of clinker to 100mm	fill from ?furnace STR 8 - drying room	1
6066	60741	dark deposit with large accretionary lumps - some at least on clinker. Has some large coke pieces, at least one sherd of crucible covered in clinker - fragmented in hearth	deposit E of drying room	1
6067	60883	well rotted material dominated by burnt shale. Some coke fragments. Several highly corroded pieces of iron may be nails, brick fragments	basal fill of furnace STR 7 E of area 1	1
6068	60884	fuel ash and clinker deposit with a small quantity of flake hammerscale	surrounding pipe, similar to 6046	P
6069	60786	ash deposit of rotted comminuted shale fragments plus coke. No clinker	ash in entrance to furnace STR10, drying room	1
6070	60873	sandy fuel waste, coal dust, small clinker pieces, spheroids, some flake hammerscale	fill of pit within brick feature STR17 drying room area	1

sample	*context*	*notes*	*location*	*area*
6071	60909	brown stiff sandy mud with granules of a variety of origins, but mainly stone, although coke and brick grains also occur	deposit just S of STR 5 - possible cupola	P
6072	60906	sandy fuel waste, coal dust, small clinker pieces, spheroids	overlies 6071 and adj to machine bases	P
6073	60942	clean fine moulding sand	fill of ?furnace STR 13	1
6074	60334	laminated gritty mud. Bears clasts of charcoal, glass with a little fine coal and clinker blebs	deposit of early phase, lies outside drying room	1
6075	60746	layered dark soft clayey sediment, small particles of sandstone brick, spheroids of clinker, a little coal dust, some sand	within flue area STR 18, near 6063	1
6076	60869	muddy coarse sand, dark grey, bearing some flake and spheroidal hammerscale, and stone clasts	bottom of STR 17, (below 6070?)	1
6077	60399	silty material strongly iron cemented, has clasts of fuel and fuel waste, has flecks of Cu alloy	corroded metal from oval metal feature, E end of engineering works	1
6078	60797	Not seen	slag from base of cupola STR 5	P
6079	60950	dark brown well sorted sandy deposit, occasional lump of clinker - not a metallurgical deposit	base of hearth of STR6 furnace	1
6080	60774	fresh coal, mainly fines, but some pieces up to several centimetres	SE part of moulding shop.	
6081	60959	dark brown deposit with flecks of fuel and stone, some clinker blebs. Large lumps are ferruginous concretions with a sandy matrix bearing coke clinker and wood	flue STR6 furnaces	1
6082	60962	brown sandy deposit with ferruginous concretions	flue STR6 furnaces	1
6083	60966	dark brown loose fine sand. A few fragments of coal and brick. Otherwise just well sorted well rounded sand	silt from flue	1
6084	60958	rich deposit of probable smithing waste, dominated by coal fines, a little clinker and some flake hammerscale	general spread area 3 S	3
6085	60219	very fine black sand deposit bearing small pieces of degraded sandstone	used moulding sand build up area 1	1
6086	60992	ferruginous brown gritty material, some corroded iron fragments, specks of cu-alloy corrosion, lumps of sandstone	machine chamber STR2 (N end of P)	P
6087	60993	sandy granular deposit, ferruginous, with rare clinker spheroids, blebs of Cu-alloy corrosion common. Small clumps of short hair also abundant	machine chamber STR2 (N end of P)	P
6087	60993	very coarse large lathe swarf	ditto	P
6087	60993	very large swarf in granular ferruginous matrix, locally rusted into concretionary blocks	ditto	P
6088	60994	loose brown sandy deposit, occasional pieces of coke and clinker but sparse and small. Wood fragments.	machine chamber STR2 (N end of P)	P
6092	60169	fine black - dark grey sandy material. Inclusions only range up to a coarse sand grade	used moulding sand = 6004, 6093	1
6093	60169	Not seen	used moulding sand = 6004, 6092	1

Table1. Summary catalogue of samples from WP3-LP3. Nfa = no further action

Samples proposed for further investigation

sample	*context*	*description*	*material of interest*	*location*	*objective*
6002	60422	fuel waste with copper alloy prills and blebs	copper alloy metal	fill of crucible furnace 60409	check for and analyse prills
6003	60064	swarf corroded on to wood.	swarf	poss assoc with brick feature, S end of site	analyse swarf
6004	60169	black even fine sand - used moulding sand	used moulding sand	used moulding sand = 6092, 6093	analyse used sand
6006	60344	large clinker masses, some with flake hammerscale	smithing slag	casting pit 60419 fill, in moulding area NE of site	possibly analyse smithing slag
6010	60198	large iron artefacts in sandy ferruginous matrix	uncertain machine residues	assoc STR 15 machine base	sort, but probably nfa
6012	60493	fuel waste	copper alloy metal	crucible chamber 60409 primary fill STR1	check for and analyse prills
6013	60026	fuel waste with hammerscale	hot working fines	spread Sw	possibly analyse scale
6015	60262	large slag blocks both brownish glass and clinkery	cupola slag?	early dump, E of drying room	analyse slags
6016	60263	mixture of coke and rather rusted clinkery slags.	cupola slag?	early dump, E of drying room	analyse slags
6018	60454	homogeneous used black moulding sand	used moulding sand	general spread, NE part of P = 6033	analyse used sand
6021	60537	cemented fragmented slag layer	cupola slag?	mixed waste deposit, P S of 6018/9	analyse slags
6027	60664	friable very fine brown sand, some magnetic	fresh moulding sand?	general within brick walls 3 S	analyse sand
6028	60621	fuel waste with hammerscale	hot working fines	E end of engineering works nr 6032,6031	analyse
6032	60665	brown deposit with angular highly magnetic grains.	uncertain machine residues	E end of engineering works nr 6028,6033	analyse
6035	60573	rusty deposit with angular and magnetic grains	uncertain machine residues	spread/makeup related to 6033, 6018, 6019	possible analyse granules
6036	60576	rusty brown sediment with small swarf	swarf	machine base S of STR19, centre P	analyse swarf?
6037	60592	lathe swarf	swarf	machine base STR19, centre P	analyse swarf?
6040	60594	cemented slag and coke debris	cupola slag?	In yard just W of Office	cupola slag? needs examination and analysis
6042	60598	cemented slag, possibly with iron	cupola slag?	In side S part of Offices, W side	analyse slag? Look for iron..
6043	60559	clinkery slag, iron rich , in part corroded on to iron plate	cupola slag?	In side S part of Offices, E side	analyse slag - cupola waste?
6044	60731	bag of lathe swarf, medium to small	swarf	machine base STR19, centre P = 6037	analyse swarf?
6045	60827	brown sandy deposit	uncertain machine residues	infill of cuts on MB 60450, STR11	sort and analyse if anything relevant
6048	60828	brown rusty deposit with large pieces of lathe swarf	swarf	within timber boxed area - late	analyse swarf?
6049	60829	friable yellow brown sand with concretions	uncertain machine residues	machine base STR 21, mixed deposit	sort and analyse if anything relevant
6050	60843	used moulding sand, with Fe concretions	used moulding sand	machine base STR 20	check nature of concretions
6051	60847	smithing slags/clinkers	smithing slag	pit 60716, within moulding floor	analyse smithing clinkers
6066	60741	dark deposit with accretions. Clinker-coated crucible sherd	crucible	deposit E of drying room	describe crucible
6069	60786	ash deposit with rotted comminuted shale fragments	fuel ash	ash in entrance to furnace STR10, drying room	describe and analyse
6070	60873	sandy fuel waste, spheroids, some flake hammerscale	hot working fines	fill of pit within brick feature STR17 drying room area	describe and analyse
6073	60942	clean fine moulding sand	fresh moulding sand?	fill of ?furnace STR 13	analyse fresh sand

sample	*context*	*description*	*material of interest*	*location*	*objective*
6076	60869	muddy coarse sand, bearing hammerscale	hot working fines	bottom of STR 17, (below 6070?)	describe and analyse
6078	60797	slag attached to brick base	cupola slag?	slag from base of cupola STR 5	analyse cupola(?) slags
6081	60959	dark sand deposit with ferruginous concretions	used moulding sand	flue STR6 furnaces	check nature of concretions
6082	60962	dark sand deposit with ferruginous concretions	used moulding sand	flue STR6 furnaces	check nature of concretions
6084	60958	smithing waste with some flake hammerscale	hot working fines	general spread area 3 S	analyse fines?
6086	60992	ferruginous brown gritty material	uncertain machine residues	machine chamber STR2 (N end of P)	check nature of gritty material
6087	60993	very coarse large lathe swarf	swarf	machine chamber STR2 (N end of P)	analyse swarf?

Table 2. Samples from WP3-LP3 for which further investigation during the analysis phase is suggested.

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