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Assessment of archaeometallurgical residues from Moat Farm, Newent (MFN22)

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Dr T.P. Young

Abstract

The submitted materials comprised approximately 40kg of hand-picked residues plus two bulk samples.

At this assessment stage, 2l subsamples were processed from each of the bulk samples. The total macroscopic residue assemblage now totals 42kg (approximately 550 pieces) from 92 stratified archaeological contexts. The microscopic fractions of the samples only contained trace levels of hammerscale.

The assemblage mostly comprises material from bloomery iron-making, with small contributions from iron-working (smithing; 6% of the assemblage) and post-medieval blast furnace iron-smelting (5% of the assemblage).

In general, the assemblage showed a high degree of degradation and wear, with some samples showing very high levels. In combination with the relatively low density of residues in almost all contexts, this indicates that the residues were typically residual/reworked. Relatively better preserved and more abundant residues were noted for trenches 5 6, 8, and 18 in the SW of the area and trench 53 in the NW. This peripheral abundance may suggest that the early metallurgical activity was actually outside the project area. The post-medieval blast furnace slags must have been imported to the site, perhaps for track-surfacing as most examples were recovered from localities close to tracks/footpaths.

The bloomery slags were all consistent with the use of a technology commonly seen in the region (and elsewhere) in the Roman period. In this technology the slag was partially tapped from the base of the furnace, using a poker to clear a path, generating slag 'rods' and rather poor examples of tapslag cakes, alongside rather substantial 'furnace bottoms' of untapped slag. Tapped slags amount to around 28% of the smelting slag assemblage, rods and runners 12% and furnace bottom fragments about 45% (the remainder being furnace ceramic and lining slags, together with indeterminate slags). The tapslags showed evidence for being of unusually low fluidity.

The smithing slags comprised parts of large smithing hearth cakes, and were thus probably also from the production of iron (bloom smithing), rather than from its end use.

Contents

Methods

All materials were examined visually, using a low-powered binocular microscope where required. The identifications of materials in this report, as an assessment during which no instrumental analysis was undertaken, are necessarily limited and must be regarded as provisional.

This assessment was conducted in November 2023 and was commissioned by Tracy Michaels of Foundations Archaeology. The materials derive from a field evaluation at Moat Farm, Newent, Gloucestershire.

2 litre subsamples were extracted from each of the bulk samples. These were disaggregated and were wet-sieved at 10mm, 1mm and 0.1mm. The fine fractions were separated with a magnet to produce a subsample for examination for hammerscale.

Results

General nature of the assemblage

The submitted materials comprised approximately 40kg of hand-picked residues plus two bulk samples.

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Other materials included fragments of coal and coke.

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Blast furnace iron smelting residues

These materials are a mixture of pale crystalline slag and glass. Most of the glass is bright green and fairly transparent, but some is more translucent and grey. The most informative fragment is a piece from a small slag runner with arcuate ridges on the flow surface. The original flow may have been perhaps 150mm in width (if symmetrical) and perhaps 30mm thick (it is uncertain if the base of the piece is the base of the flow. The runner contains mostly crystalline slag but has areas of devitrifying glass.

The slag suggests a system rich in lime, probably from a charcoal fuelled furnace and of earlier post-medieval age. Somewhat similar textures reappear in the later 19th century under hot-blast conditions, but the small size of the flow and the lack of a sulphidic smell make an earlier origin more likely.

Bloomery iron smelting residues

Several distinct facies of bloomery slags were recovered and these are divided in table 2 and 3 into tapslag, rods, runners, tool marks and furnace bottom slags.

The **tapslags** were largely not of the very dense variety, with low-profile relatively narrow flow lobes, normally encountered on smelting sites in the region. The tapslags from Moat Farm tend to show a low number of inflated, porous lobes forming poorly structured flows and resting on a lower level with abundant fragment ed and rotated slag debris. These observations suggest that the slag was accumulating in low volumes and that it was probably rather viscous.

The **slag rods** were of between 10 and 30mm diameter, frequently lightly tapering, and formed of vesicular, but dense slag. Most examples showed contact surfaces, typically slightly dimpled, on all sides, but a few showed a freely lobate upper surface. The centres of the rods were typically more porous than the margins and some examples showed a very dense outer rim of presumably quenched origin.

In some instances, the rods were amalgamated into larger blocks – the largest such group was a cluster of probably 8 amalgamated rods, together forming a block of approximately 60mm square cross section.

Slag runners were typically wider than the rods, 30-60mm, and were crudely semicircular in cross section. In at least one instance the slag runners also formed amalgamated masses, with early-formed runners apparently displaced and rotated alongside later ones. One slag mass that might have been considered as a runner was actually an amalgamation of multiple slag rods.

Tool marks share a general morphology with slag rods but occur as\raised slag ‘ribs’ on the base of furnace bottoms. The examples listed under this heading are those which became detached from the furnace bottom block during disposal. They are believed to form from the use of a rod or poker to clear a slag channel into or below the still molten furnace bottom slag.

‘**Furnace bottom**’ (FB) has been used here to describe a slag mass the formed on the floor of the furnace (the term requires revision and it is not equivalent to the ‘furnace bottom’ of a non-tapping furnace). No complete examples were recovered, but several substantial pieces shows the margin of the FB, the relationship between FBs and slag rods, and other aspects of the morphology. The furnace bottom slags were generally rather poorly preserved and exhibited an apparently granular texture, although this may be effect of\alteration.

In one instance an FB fragment showed some crudely semi-circular channel on its upper surface and these are interpreted as poorly preserved wood moulds, as seen in FB slags from other sites.

Indeterminate slags

This category includes those residues for which an origin in either smelting or smithing cannot be determined unambiguously.

Furnace/hearth ceramic includes fired clay, often showing a vitrified or slagged surface, that derives from the wall of the smelting furnace or smithing hearth. These origins are not usually intrinsically distinguishable. The Moat Farm site produced very small quantities of this class of residue. Given the dominance of smelting over smithing slags, it I most likely that the majority of this material derives from smelting furnaces.

Lining slag is slag rich in input from the melting of the furnace/hearth wall, rather than having a large input from metallurgical reactions. Because of this, apart from being produced during wall failure, it tends to be more common in smithing contexts than smelting.

Dense indeterminate slag is most commonly material from one of the other main classes of slag, but which does not show distinguishing features because of fracture, lack of original external surfaces, abrasion or overgrowth by concretionary material.

Iron smithing residues

Smithing microresidues (flake and spheroidal hammerscale) were recovered from the two bulk samples (from contexts (603) and (506)), but only at trace levels. This probable just represents the general background over the western part of the site and does not have any particular importance for those particular contexts.

Smithing macroresidues were also generally rather sparse (forming a total of at most just 6% of the overall assemblage). The smiting hearth cakes can show a close textural similarity with parts of the furnace bottoms, so the discrimination of fragmental material can be uncertain.

The most significant piece of smithing reside was most of a large SHC from context (2822). The fragment (1990g) indicates that the complete SHC would have weighed over 2kg, a weight that would indicate formation during bloom smithing.

Less certain is the identification of a 306g fragment from context (607) and a 372g fragment from context (819).

Other materials

The **Iron/concretion** category comprises corroded material or concretionary material that is associated with a metal precursor. This may be an artefact, or commonly just small fragments of iron from the production or working processes.

Coal/coke are separated out because they commonly do not have a metallurgical origin. Coke is a material formed by the incomplete combustion of\coal, and although it may be produced deliberately for metallurgical purposes, it is most commonly found as a result of coincidental incomplete combustion of fuel. Coal was employed on occasion in the Roman period for smithing but cannot be used for bloomery iron smelting. Coal and coke may derive from domestic sources, but the most common source on rural sites is as waste from steam-powered agricultural equipment of the late 19th or early 20th centuries.

Interpretation

The residues represent a rather small assemblage given the extent of the evaluation. This suggests the metallurgical activity lay elsewhere.

For the post-medieval blast furnace slags, the residues must have been imported – and their distribution on the site hints that they may have been employed for track or path consolidation in the wetter areas.

There are several relatively nearby furnaces that might have been capable of supplying such hard-core material (Riden 1993):
Elmbridge (SO71926430) 1638 – 1751
Linton (SO676267) before 1618 - 1685
Longhope (SO692184/SO685099) before 1609 – 1685

Longer distance transport of slag from a later furnace cannot be excluded, but the slags appear more likely to be early.

The bloomery slags are of a morphology entirely consistent with a Roman age. The details are discussed below.

The distribution of the bloomery slags is illustrated in Figure 1. They show a close association with the linear features on the ridge in the SW of the site. The good assemblage from Trench 6 suggests that the source of these residues may be outside the area to the SW. The significant concentration of material in Trench 53 may suggest a second source close to the NW of the survey area, again potentially outside it.

Discussion

Although it is a commonly held view that Roman iron smelting employed exclusively slag-tapping furnaces, this is only partially correct. It is becoming apparent that there is a common group of furnace types in which only a portion, often less than 50% appears to have been tapped. These furnaces show the development of substantial ‘furnace bottoms’, tapping through narrow channels (often requiring the use of a poker or rod to open slag channels through the furnace bottom) and fairly small tapslag accumulations at the distal ends of the runners.

At the large end of the spectrum of furnaces of this general type are the large ‘dome’ furnaces at Bexhill. These produced ‘furnace bottoms’ of over 100kg on occasion. The bases of the ‘furnace bottoms’ commonly display tool marks – the slag filled holes created by rodding. These tool marks are continued beyond the furnace bottom slag as isolated or amalgamated slag rods. The furnace bottoms also included examples of moulds of large pieces of wood, reminiscent of those in pre-Roman wood-packed non-tapping ‘slagpit’ furnaces.

A local variety of these furnaces is the ‘Cardiff-type’, known from its residues rather than surviving structures. In these the ‘furnace bottom’ may be several tens of kilograms and is connected with the

tapped slag by runners (as in the Bexhill furnaces). This type of furnace is distinguished by the presence within the 'furnace bottoms' of abundant clasts iron ore (often partly reacted) and the moulds of roundwood charcoal or wood. The 'Cardiff type' has been recognised at Cardiff Castle (Young & Kearns 2011; Young 2021a) as well as at several other sites in S Wales and the forest of Dean (Alvington, Young 2009; Caergwanaf, author's unpublished data; Cannop, Young 2011, 2013; Lydney, Young 2021; Weston-under-Penyard, Young 2015; and probably Woolaston).

Sites with an assemblage with a high proportion of slag rods and runners, but apparently lacking some of the specialised features of the 'Cardiff type' have also been recognised from S Wales and Forest of Dean hinterland: Kingswood (Young 2017), Frocester Court (Price 2000; Thomas 2000), Peterstow (Young 2012), Thornbury (Young 2015a) and Worcester (McDonnell & Swiss 2004).

Remains of the iron furnaces that might have produced these residues are few, poorly known and mostly poorly preserved (e.g. Bridgewater 1965, Fulford & Allen 1992, Jackson 2012).

This general type of furnace also occurs outside the immediate region of the Forest of Dean and South Wales, with a very similar slag assemblage recently recorded from North Tawton, Devon (Young 2022).

Although the Moat Farm assemblage sits neatly within this general tradition, there are some peculiarities. In particular, the tapslags are extremely irregular, often with chaotic lower layers, large inflated lobes and suggestions of a small size for the tapped slag cakes. Also, rather than having stacked runners, as at Cardiff for instance, runner-like morphologies comprise stacks of amalgamated rods. These features tentatively suggest that the furnaces were relatively small and that they produced slag of a rather low fluidity. The reason for the low fluidity cannot be determined without detailed analysis, but it probably relates to an unusual composition, either of the furnace ceramic or the ore.

Interestingly, the nearest post-medieval Blast Furnace, at Elmbridge, did not smelt Forest of Dean ore, but ore from a small ore body at Aston Ingham (Bick 1992), just 4km west of the present site. Whether this different source would have generated less fluid slag when employed in a bloomery than the standard Dean ore is unknown.

The nature of the distribution of the assemblage with dispersed smelting slag and a paucity of evidence for smithing is typical of many sites. Smelting may have been undertaken close to locations of production of charcoal, whereas smithing was typically undertaken close to permanent settlement.

Further work

This assemblage is an indication of metallurgical activity in the vicinity of the site in the Roman period, but the relatively low volumes suggest that it may not have been within the bounds of the site.

Given that the slags are reworked and from a source probably external to the site, additional analysis of the residues would probably not be justified. Accordingly, no additional detailed work on the residues is recommended at this stage.

Notwithstanding this, the material is a suite of slightly unusual properties compared with other assemblages from the Dean area, and thus the assemblage should be retained as part of the site archive.

FIgure caption

Figure 1. Plot showing total archaeometallurgical reside (excluding blast furnace slag) for each trench.

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Table 1: summary catalogue, weights in g.

Context		S wt	I wt	I no	notes
307		4	4	5	coke
506		2230	422	7	fragments of slag rods/runner
			284	9	tapslag fragments, mostly abraded
			928	19	charcoal-bearing vesicular iron slag in irregular rounded lumps, worn, where seen the surfaces are dimpled - probably furnace slags
			36	2	internally prilly small pieces of slag - could be tapslags but not certainly so
			566	4	dense slags in rounded lumps - probably furnace slags rather than SHCs
506	<11>	80	80	assm	small fragments of extremely comminuted slag
507		250	8	1	tapslag
			4	1	elongate lobe, possibly tapslag, but perhaps more likely a rod - 10mm square section
			122	1	block of very porous slag but has hints of lobed top - probably a tapslag
			114	2	fragments of granular slag with curved bases - could be FB tool marks, but whole cross section of potential tool marks not seen
603	<1>	2970	770	6	more or less conventional tap slag pieces with multiple lobes
			526	6	tapped slags with irregular bulbous lobes, or just single lobes
			58	4	indeterminate slag fragments
			132	3	slag rods, one shows freely-lobed top
			52	1	small fragment with at least two amalgamated rods
			576	1	large block with 6? amalgamated rods
			854	1	large stone with accretion contain lots of small tapped slag fragments
604		2250	1640	1	furnace bottom margin, 100mm deep extends out 100mm at max, top shows wood/fuel poor impressions and is reddened, base prilly with a few pieces of c4mm round stems
			294	3	coarse tapslag, rather irregular, pale clasts on prilly base
			300	1	triangular biconvex lump of granular slag - texture similar to that in the upper part of the FB piece above
607		468	306	1	dished slag, top hard smooth concave surface, base finely prilly with abundant charcoal, probably an unusual SHC, 100mm long to break, 110mm wide, 40mm deep, bowl part about 15mm thick, resting on variable prilly material
			38	4	small dense slag scraps
			4	1	vitrified lining
			106	1	fragment of margin of sheet, slightly waxy-looking surface, top slightly dimpled/lobate, base granular ?prilly. Top of FB? Crust from base/side of furnace?

703	570	338	1	finely granular/prilly slag, base shows two parallel tool marks 30x25mm and 10x10mm, perpendicular face is finely prilly - is this a prilly vertical face or were the tool marks vertical?
		160	3	dense tapslags fragment, one with pale grey ceramic clasts
		72	1	dense vesicular slag fragment, angular, indeterminate
819	1355	352	9	tap slag fragments of various sizes, all slightly worn appearance
		250	1	triangular fragment of dense granular slag, one end shows what appears to be contact with flat, fissured wood
		372	1	block from margin of slightly biconvex cake, base smooth, top irregular and obscured - probably not tapslag so may be SHC fragment
		238	3	fragments of internally prilly slag - probably from FB?
821	826	44	1	exploded iron lump
		70	1	extremely dense tapslag fragment
		74	1	low density, vesicular tapslag with irregular lower lobes
		120	1	abraded dense vesicular slag, possibly a broad slag channel fragment
		122	1	dense slag crust/bowl fragment, abraded, indeterminate
		336	1	dense slag sheet, lower part 20mm very dense slag with smooth slightly dimpled base, upper part rough, probably basal furnace slag, but SHC or even flow cannot be excluded
		56	3	vesicular slag fragments
		2	2	lobe fragments - possibly from tapslag
823	1020	258	1	broken plano-convex cake, porous rusty slag, probably furnace floor rather than SHC
		96	1	broken angular piece of porous iron slag, probably a furnace slag
		172	3	fragments of slag rods 20mm to 35mm in diameter
		10	1	indeterminate porous slag fragment
		254	2	fragments of FB bases with marked tool marks up to 35mm diameter
		226	5	tapslag fragments
1006	16	16	1	worn dense flow slag, not necessarily a tapslag
1501	276	90	3	small pieces of tapslag
		168	1	35x40mm 80mm long runner fragment, dimpled surfaces,
		16	1	small flow lobe possibly squeezed by tongs
1502	280	190	11	small scraps of tapslag
		14	1	small fragment of dense worn slag
		70	1	fragment of worn slag sheet, granular texture

1508		226	70	3	small pieces of worn tapslags
			14	1	small fragment of runner/rod 30mm wide
			138	1	irregular lump of slightly granular slag - probably a furnace slag
1603		350	98	6	worn tapslag fragments
			252	2	dense massive slightly vesicular slag pieces - possibly originally from same lump but no longer joining, much very fine charcoal - probably a furnace slag
1703		104	42	2	fragments of prilly slag, one with maroon top so possibly tapped
			58	1	worn nub of dense vesicular indeterminate slag
1704		44	24	4	small fragments of tapslag
			18	1	dense slag fragment, indeterminate
1708		158	88	2	dense tap slag fragments
			70	1	low density flow-lobed pale slag - possibly a wall slag rather than a tapped variety
1712		1155	952	1	block from dense slag sheet, very irregular, accretion on top - basal crust from furnace?
			204	1	slightly irregular crudely plano-convex worn lump of dense slag, indeterminate
1801		160	160	1	extremely dense slag, hints of internal lobing, top maroon slightly dished, tapslag
1802		978	336	1	dense very rusty block of massive furnace slag
			80	2	slag rods, 20-25mm in width
			86	1	rather open-textured granular furnace slag
			128	1	dense dimpled slag with open voids on top - unclear if from furnace slag or perhaps more likely tap slag flow
			340	2	very dense tapslag blocks, large irregular lobes
1803		460	214	7	tapslag fragments
			1	1	accretion
			158	1	30mm diameter rod passing into bowl
			82	1	25mm diameter rod, dimpled sides base, slightly flow-lobed top, attached flow lobe to one upper side
1805	10 of 1	2035	750	1	irregular block of dense slag, unclear if FB of part of a tapped cake, minor lobes locally visible but mostly featureless surface
			154	1	probable tap slag fragment, c30mm thick, upper lobate surface poorly preserved, internally not lobate so some possibility this is not tapped
			358	1	fragment of slag sheet c45mm thick, locally granular, traces of two probable small rods/channels on base
			210	1	rounded nub of dense slag, hint of slightly lobate top

		52	1	small irregular nub of vesicular low-density slag - probably lining influenced
		128	1	very irregular slag piece - probably a basal slag crust with a penetrating slag rod
		220	1	dense slag piece, vesicular upper part, base smooth convex, top reddened very irregularly ridged - possibly fragment of wide runner, >80mm wide 35mm thick
		124	1	30mm diameter, 105mm long slag rod, base rises and becomes transversely elliptical to one end
		34	1	15x15mm slag rod, top lobate, 65mm long
1808	228	224	4	fragments of highly accreted rather messy tapslags
1809	1485	692	1	worn margin of cake with ceramic inclusions - suggests burr-like location, probably part of FB but could just be SHC
		336	1	fragment of dense burr with lilac-coloured ceramic
		462	1	irregular block of granular lag, has rod-like piece 10mm in diameter along part of one face
1810	94	94	1	chaotic internally-brecciated tapslag with one large broken inflated lobe, slag granular elsewhere - so maybe includes some furnace slag too
1811	242	242	3	all tapslags, but only one shows preserved lobes, one totally fragmented upper surface, third piece shows curious concentric shell-like lobes
2006	20	20	1	fragment of vesicular iron slag with some convoluted oxidised surfaces
2103	44	40	1	fragment of failed hearth/furnace wall, some oxidised ceramic with denser slag probably holding failed wall/lining slag attached to main wall?
2203	52	52	5	worn indeterminate slag scraps, 2 are probably but not certainly tapslags
2303	556	208	3	tap slag, slightly waxy in appearance
		228	1	dense vesicular slag piece with regularly curved surface, probably a burr
		82	2	weathered porous furnace slag fragments
		32	1	slightly irregular, tapering slag rod fragment
2403	490	340	1	angular block of dense furnace slag, base shows a change in curve or tool mark
		148	9	tap slag fragments
2203	52	52	5	worn indeterminate slag scraps, 2 are probably but not certainly tapslags
2818	46	2	2	tiny fragments of low-density slag
		44	1	dense vesicular iron slag - shape suggests this a FB toolmark, but no original surfaces are preserved
2406	24	24	4	worn tap slag fragments

2407		124	124	6	tapslag, sightly fresher material
2408		480	418	16	heavily worn dense tapslag - one large piece shows part of a thick cake
			52	1	worn rounded lump of vesicular iron slag
			12	1	small slag fragment with radial crystal structure -could be rod fragment or tapslag, but too small to determine
2409		7	1	1	coal
			6	1	worn tapslag fragment
2411		294	114	5	worn pieces of dense vesicular slag, all could be tapslag, but none definitely so
			1	2	tiny chips of lining slag
			178	17	worn fragments of tapslag
2412		122	118	10	worn tapslag fragments
			1	1	small fragment of reduced fired coarse clay
2501	surface finds	10	10	2	small pieces with microprilly bases, possibly tapslags
2503		224	92	5	tapslag fragments
			124	2	vesicular dense iron slags, potentially tapslags but lack diagnostic features
2506		8	8	1	tapslag
			<1	1	blue glass - fuel ash slag?
2507		78	78	5	heavily worn tapslag fragments
2507		10	10	1	green glassy blast furnace slag
2601	surface finds		30	1	tapslag
			66	2	very worn iron slag pieces, probably tapslags based on internal lobing
2603		14	14	1	small fragment of tap slag, relatively fresh appearance
2603		20	2	1	oxidised fired clay with veins or inclusions of vitrified material
			18	1	probable but not certain worn tapslag

2703	12	12	1	tapslag fragment
2704	2	2	2	fired clay, one piece is vesicular and is probably over-fired pottery
2704	190	146	1	slag runner - contains two roughly semicircular-section runners - one pushed to one side and rotated, suggesting multiple use of same overall tapping channel
		1	1	grey fired clay
		8	1	fired clay with grass impressions on surface
		14	1	stone
		2	1	vitrified and vesicular ceramic, probably a peeled lining slag
		16	1	small dense slag fragment, possibly a tapslag piece
		6	1	scrap of vesicular iron slag
2705	468	156	3	well preserved, coherent tapslag fragments
		302	5	well preserved tapslags in incoherent masses with prills and a high degree of brecciation
2705	1210	984	1	large sub-equant knobbly block of dense slag, at least two separate areas of iron rusting and explosion, spalling - likely a large block from furnace bottom
		102	7	small fragments of tapslag - slightly fresher appearance than most of the assemblage
		4	1	dark fired clay
		118	1	broken length of very porous runner/tool mark from FB base, very porous low density slag
2706	238	234	1	dense vesicular slag with curved base containing two parallel slag rods, 20 and 15mm diameter, but whole could be runner 65mm wide, up to 70mm long
2710	308	308	11	tapslag, fresher than most of the material, locally microprilly bases, only a few pieces show maroon top
2711	26	26	1	tapslag
2712	146	28	3	worn tapslag fragments
		28	1	20mm diameter rod section
		88	1	grey hard fired furnace wall, discoloured face shows lots of parallel grass? Imprints
2713	22	22	1	tapslag, worn
2714	50	50	1	worn tapslag
2804	18	18	1	small fragment of indeterminate iron slag

2814	122	122	6	fine grained fayalitic? dense tap slag
2818	46	2	2	tiny fragments of low-density slag
		44	1	dense vesicular iron slag - shape suggests this a FB toolmark, but no original surfaces are preserved
2820	60	54	1	very worn slag fragment with flat top with crystal terminations - unclear if FB or SHC
		2	1	very worn isolated flow slag lobe
2822	2040	1990	1	large part of probable large SHC, 150x130x90(50), central top of bowl shows olivine terminations, rising rusty material to either side appears disturbed by extraction
		42	1	grey fired, coarse clay artefact, original face curves with c20mm radius, but original form unclear
2824	214	214	1	charcoal-rich slag with narrow pieces up to 60mm long
2828	36	36	1	slag rod, dimpled lower half, top free lobe surface, section 18x15mm
2833	8	6	1	worn tapslag
2906	128	128	1	flow-ridged flow of blast furnace slag, some green glass but mostly crystalline
3002	736	634	1	very dense work slag slab, base shows several possible poker-type tool marks creating irregular surface, top shows some tabular rounded voids and possible lobes - so probably an internal slag puddle
		102	1	very worn block, possibly an abnormally large tapslag lobe
3114	10	10	2	dense slag scraps, very worn
3119	1	1	2	sandy ferruginous concretions, natural
3120	28	24	1	corroded iron artefact, starting to 'explode'
3122	70	6	1	tapslag
		62	1	dense slag crust with elongate fayalite, indeterminate
3123	56	48	2	tapslag fragments
		6	1	coarse fired sandy clay, reduced

3124	62	60	4	worn slag fragments, indeterminate
3125	72	72	2	worn indeterminate iron slag fragments, probably granular FB pieces
3127	70	16	1	very worn tapslag
		48	1	rough rounded nub of vesicular dense furnace type slag
3403	8	8	1	very worn tapslag fragment
3404	58	34	2	granular slag fragments, one showing much rusting
		8	1	lobed low-density slag - lining slag?
		14	1	tapslag
3411	30	30	1	concretion on iron
3533	1	1	1	grey devitrifying blast slag
3605	146	6	1	lining slag
		134	1	equant bock of hard reduced-fired furnace ceramic
4606	56	54	4	tapslag
4703	728	530	1	rounded block of dense but vesicular furnace slag
		186	1	dense block with some large rounded voids - perhaps from top of FB?
4703	450	450	7	blast furnace slags, mostly crystalline and vesicular, but some zones and small fragments of green glass
4709	22	22	2	worn tapslag fragments
5308	206	204	1	block of tapslag, well-formed dense top, base very irregular with tiny prills and areas of rough surface
5309	2830	592	17	tapslag fragments, mostly rather chaotic forms, concentric shells etc
		684	1	large runner fragment comprising at least 8 individual rods internally - marked by chilled margins, section 80x65mm, 85mm long
		332	2	smaller amalgamated rod pieces, rods to 40mm, one piece has 3, the other one, but with fragments of another on top?
		162	4	smaller fragments of FB type slags
		138	1	dense equant slag block, hint of lobes on top so may be from a tap slag cake

		124	1	complex (folded? prodded?) slag sheet
		794	1	large block forming one side of a slag bowl, not enough to confirm whether FB or SHC, (130) x (80) x 84(45)mm
5310	2795	376	1	irregular block of triangular slag, granular, crude wispy flow lobe on top
		1105	1	irregular very dense slag block, 1 side shows a fluted morphology, could be fill lines on overhanging rear wall with front vertical face of block very rusty - an alternative might be to see these as tool marks, but they are curved
		628	1	irregular block of granular lag, probably furnace bottom sheet with ash and charcoal on base - could just be the margin of a large SHC but this appears less likely
		592	1	extremely dense slag block with curving base into side. Slightly granular, presumably FB not large SHC
		88	2	fragments of massive, vesicular iron slag
5315	22	22	1	tapslag fragment
				also some crumbs of fine fired clay/pottery
5317	86	86	1	probable tapslag, contains pale grey ceramic clast
5320	2715	776	1	large angular block of vesicular furnace slag
		582	4	small irregular fragments of probable furnace slags
		492	3	tap slag, two pieces from a thick, rather porous cake
		296	1	irregular block, like furnace slag, but has fine grey ceramic inclusions and a hint of smooth surfaces - presumably from furnace mouth
		504	1	large worn runner comprising two internal rods 55mm wide, 150mm long, rods 30 and 25mm
		162	1	fresh lock with compound of 4 small rods15-20mm, mass 40x30 section
5322	810	806	1	large fragment of slag block in rather granular slag, vesicular, smooth base, presumably FB
		1	1	tiny indeterminate slag fragment from ?sediment contact
5323	656	340	1	fragment from plano convex cake of rather granular slag, contains iron (starting to explode)
		172	7	fragments of tapslag
		138	1	deformed (folded brecciated) probable basal sheet, locally thickened part of sheet could be crude rod
5324	76	76	4	tapslag, apparently chaotic internal structure, porous
7903	64	64	1	tapslag
8203	638	280	1	block with 5 or 6 amalgamated rods, appears to be an isolated piece not a FB base fragment
		268	1	tap slag with slightly chaotic low density large bulbous lobes
		82	1	probable tap slag forming one side of a large angular tap tube - 50mm wide, probably 30 tall, just to one side of void

9404	1	1	2	coke
11203	<1	<1	1	chip of tapslag
f6 u/s	74	74	1	translucent green blast furnace slag, slightly devitrifying
u/s f6 surface	30	18	1	hollow slag nub of dense slag, possibly tapslag
field 7 plough soil 10m S of T42	1305	1165	8	blast furnace slag, mostly bright green glass
		44	1	blast furnace slag, grey glass
		90	1	blast furnace slag, mostly highly vesicular slightly lilac crystalline, but small area of green glass
1502 crossed out, NE of land drain	556	456	13	tapslag fragments, some good dense lags some less dense
		88	1	rounded nub of iron slag, possibly a worn rod fragment
surface W of T6 over anomaly	76	70	2	20mm diameter rod fragments
		10	1	fired clay grading from reduced to oxidised

Table 2: weight in g of slag classes by context. SHC = smithing hearth cake, conc. = concretion, indet. = indeterminate

Context	Blast furnace slag	Bloomery slag					Indeterminate			SHC	Other	
		Tapslag	Slag rod	Slag runner	Tool marks	Furnace bottom	Lining slag	Hearth/ furnace ceramic	Indet. dense		iron/conc	coke
307												5
506		284	422			1494			36			
506												
507		130	4		114							
603		1296	740						58			
604		294				1940						
607						106		4	38	306		
703		160			338				72			
819		352				488				372		
821		144		120					516		44	
823			172			608			10			
1006									16			
1501		90		168					16			
1502		190							84			
1508		70		14		138						
1603		98				252						
1703		42							58			
1704		24							18			
1708		88						70				
1712						952		204				
1801		160										
1802		468	80			422						
1803		214	240								1	
1805		364	158	220		358	52		750			
1808		224										

1809						1154			336		
1810		94									
1811		242									
2006									20		
2103								40			
2203									52		
2303		208	32			82			228		
2403		148				340					
2406		24									
2407		124									
2408		418									
2409		6									1
2411		178					1		114		
2412		118						1			
2501		10									
2503		92							124		
2506		8					<1				
2507	10	78									
2603		14						2	18		
2703		12									
2704				146			2	9	22		
2705		560			118	984		4			
2706					234						
2710		308									
2711		26									
2712		28	28					88			
2713		22									
2714		50									
2804									18		
2814		122									
2818									46		
2820		2							54		

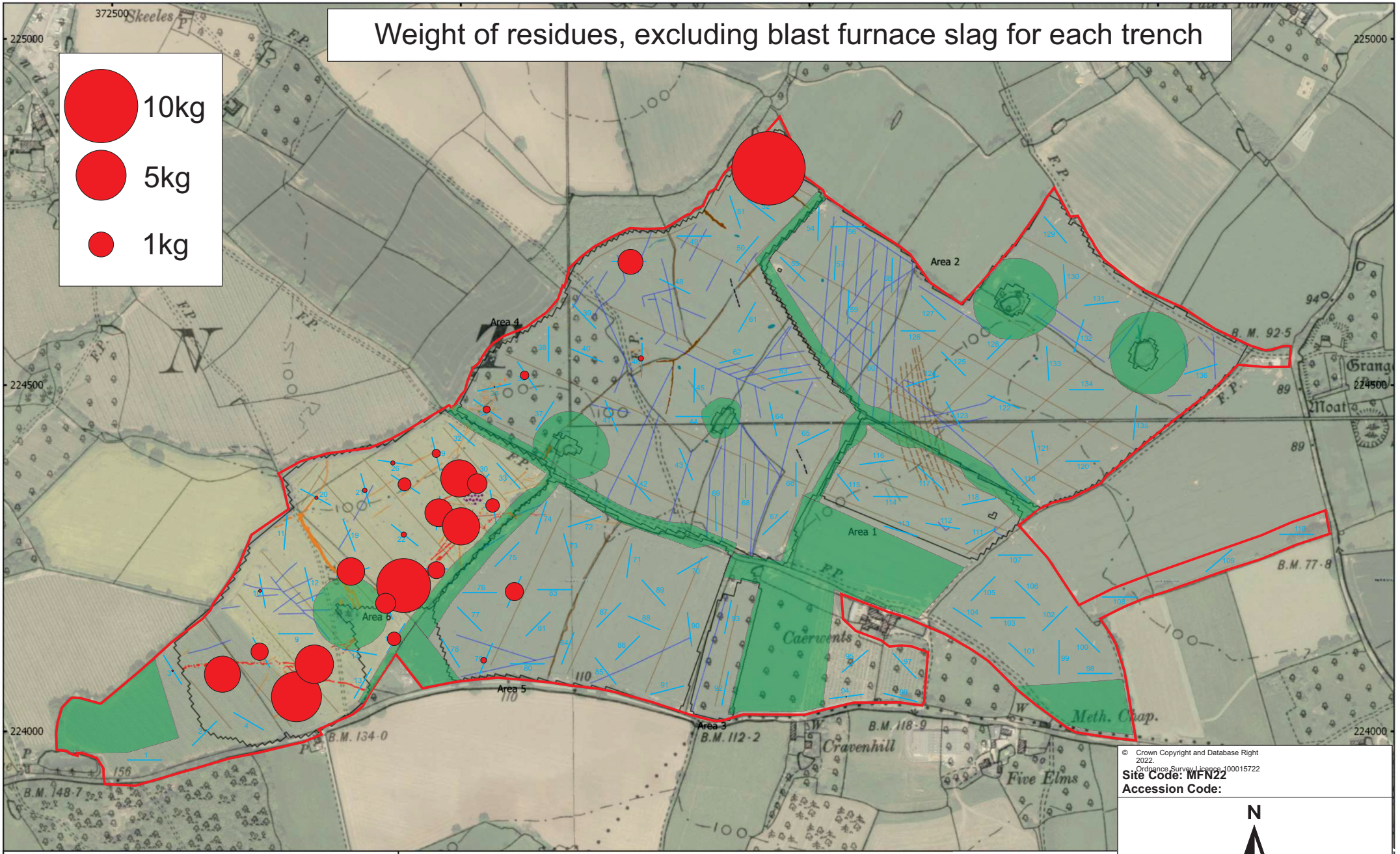
2822						42		1990	
2824				214					
2828			36						
2833		6							
2906	128								
3002				634			102		
3114							10		
3119									1
3120									24
3122		6					62		
3123		48				6			
3124							60		
3125				72					
3127		16		48					
3403		8							
3404		14			8		34		
3411									30
3533	1								
3605					6	134			
4606		54							
4703	450			716					
4709		22							
5308		204							
5309		730	1016	162			918		
5310				2413			376		
5315		22							
5317		86							
5320		492	666	1654					
5322				807					
5323		172		138			340		
5324		76							
7903		64							

8203		350	280					
9404								1
11203		<1						
F7 surface	1299							
F6 u/s	74							
F6 surface		18				10		
1502 crossed out, NE of land drain		456					88	
surface W of T6			70					

Table 3: weight in g of slag classes by trench.

Context	Blast furnace slag	Bloomery slag					Indeterminate			SHC	Other		total
		Tapslag	Slag rod	Slag runner	Tool marks	Furnace bottom	Lining slag	Hearth/ furnace ceramic	Indet. dense		iron/conc	coke	
3												5	5
5		414	426		114	1494			36				2484
6		1590	740			2046			96	306			4778
7		160			338				72				570
8		496	172	120		1096			526	372	44		2826
10									16				16
15		350		182		138			100				770
16		98				252							350
17		154				952		274	76				1456
18		1766	478	220		1934	52		1086		1		5537
20									20				20
21								40					40
22									52				52
23		208	32			82			228				550
24		1016				340	1	1	114			1	1473
25	10	188							124				322
26		14						2	18				34
27		1006	28	146	352	984	2	101	22				2641
28		130	36			214		42	118	1990			2530
29	128												128
30						634			102				736
31		70				120		6	132		25		353
34		22					8		34		30		94
35	1												1
36							6	134					140
46		54											54

47	450	22				716							1188
53		1782		1682		5174			1634				10272
79		64											64
82		350	280										630
94												1	1
112		<1											
field 7 plough soil 10m S of T42	1299												
f6 u/s	74												
1502 crossed out, NE of land drain		456							88				
surface W of T6			70										
u/s f6 surface		18						10					
totals	*1962*	*10428*	*2262*	*2350*	*804*	*16176*	*69*	*610*	*4694*	*2668*	*100*	*7*	***42130***



MSSO846 - Elgin Energy Solar
Figure 5 - Magnetic Interpretation Over Historic Maps and Satellite Imagery
1:5,000 @ A3
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Contains historic maps: Ordanance Survey, 6" 2nd edition c. 1882-1913 © National Library of Scotland
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- Archaeology Probable (Strong)
- Archaeology Probable (Weak)
- Archaeology Possible (Strong)
- Archaeology Possible (Weak)
- Agricultural (Strong)
- Agricultural (Weak)
- Industrial/Modern
- Industrial/Modern (Spread)
- Natural (Zone)
- Magnetic Disturbance
- Ferrous/Debris (Spread)
- Undetermined (Strong)
- Undetermined (Weak)
- Agricultural (Trend)
- Service
- Ridge and Furrow (Trend)
- Drainage Feature
- Ferrous (Spike)

magnitude surveys

Site Code: MFN22
Accession Code:

N

- Evaluation Trench
- Area with No Solar Development

0m 200m

FIGURE 1: Proposed Trench Locations

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