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Assessment of the archaeometallurgical residues from the Milford Haven to Brecon High Pressure Gas Pipeline

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Abstract

Archaeometallurgical materials from the project include several examples where iron-working (smithing) is indicated by small assemblages of material (MHA 514, FTP Site 49, FTP Site 50.11, FTP Site 51.11). These sites reflect the ubiquity of blacksmithing as a rural activity since the Iron Age. The material from these sites is too limited to have much potential for further investigation.

In contrast, two sites, MHA 257and FTP 52.05, have produced evidence for both iron smelting and primary smithing, the two stages in the bloomery iron production process. There is some evidence to suggest that both of these sites may be Roman. Neither site preserved any metallurgical features and their slag assemblages are small. Both of these sites lie in areas where there was little or no evidence for iron production, so further investigation of these materials and the identification of their iron ore sources would be an important research goal.

MHA Site 513 yielded a piece of probable bog iron ore which may be valuable in attempting to trace the ore sources of this area and may have important implications for the material from MHA Site 257.

MHA site 500 produced moderately large assemblage of fuel ash slag. This material is not metallurgical and might indicate waste from a corn drying kiln or similar structure.

Sites MHA 508 (Iron Age & Early Medieval) and FTP 25.12 (post-medieval) apparently produced assemblages that would important to integrate into this study, but which are not currently available.

In addition to the early materials many sites produced small quantities of clinker, coke and some metallurgical residues associated with post-medieval coal-burning equipment, such as steam engines. In no case does this material seem to have any particular archaeological potential or utility.

Contents

Methods

All materials were examined visually with a low-powered binocular microscope where required. As an evaluation, 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 summary catalogue of examined material is given in Table 1 (for the Milford Haven to Aberdulais pipeline; MHA) and Table 2 for the Felindre to Brecon pipeline; FTP).

This assessment has revised all those materials listed in the initial assessments (Doonan *et al*. 2008 a and b) as being likely to be of archaeometallurgical significance, but has not involved an exhaustive checking of all the magnetic residues. Sufficient examples of the residues were re-examined to exclude 'roasted iron ore' as a component of most, if not all, of the samples. Those samples listed as containing 'roasted ore' in the initial assessment, but with no other indication of metallurgical material, are not considered further here.

This project was undertaken for National Grid at the request of Linda Bonnor, Groundwork Archaeology Ltd.

Results

Milford Haven to Aberdulais pipeline (MHA)

Evaluation site 14

This site yielded a single dense piece of iron ore (c4601). The ore is a dense goethite ore with botryoidal coatings (i.e. a Bristol Channel Orefield type ore). The piece appears to be from a 'boxstone'-type development with a perpendicular corner the mineralised cavity. The outside of the piece is smoothly rounded and may have undergone secondary rounding as a transported cobble. The piece is likely to be present here through natural agency – so the re-identification removes any evidence for metallurgical activity from this site.

Site 209

The single metallurgical find from this site is an unstratified partially melted and slagged firebrick. The colour of the residue on the brick suggests that the slagging is from the partial melting, rather than from contamination by metallurgical slag. The brick is therefore likely to be from a firebox of a high temperature coal-burning process.

Site 236

This site yielded four unstratified pieces of clinker (coal residue), presumably of relatively recent date.

Site 257

This site produced 53 pieces of iron slag (844g) from five stratified contexts (c257001, c257013, c257026, c257032, c257044) and one unstratified piece (2g).

The majority of the pieces are either certainly or probably fragments from smithing hearth cakes (SHCs) but a small proportion appear likely to be bloomery smelting slags from a slag-tapping furnace.

The largest SHC fragment (a 216g piece from c257044) shows an interesting morphology, with a strongly concavo-convex profile, a hematised upper surface and with much of the thickness of the slag in the bowl being formed of bladed olivine with individual crystals having lengths of 15mm or more. These features indicate the existence of a significant molten slag puddle and are possibly associated with SHCs generated during bloom-remelting rather than simply during forging operations.

The slag-tapping nature of the smelting operation is suggestive of either a Roman or later medieval (post ninth century) age for this activity.

Site 294

This site produced two small examples of probable coal-burning residues (clinker/coke) from contexts 115105 and 115107. Such materials are not necessarily indicators of metallurgical activity and may derive from other activities, including both domestic hearths and the use of steam-powered agricultural machinery in the 20th century.

Site 500

This site produced a single small piece of iron ore (c20024), which is likely to be present through natural agency.

The most significant pyrotechnological remains from the site were fuel ash slags (FAS), particularly from context 500178, but to a lesser extent from c500177 and probably c50085. These fuel ash slags are friable, grey in colour and typically with a 'blebby' morphology. Most of the blebs are on a millimetre scale, but some FAS are in small aggregates or larger blebs up to about 15mm across.

Such FAS might be formed in many different circumstances, even in domestic hearths, but there seems to be a particularly common association between such fine-scale FAS and ash from corn driers. There is no particular information on age that can be drawn from these residues.

Site 508

This site produced potentially interesting slag material from both Iron Age and Early Medieval contexts. The finds are amongst the material sent to Kevin Leahy and therefore currently not available for inspection.

Site 509

This site yielded a partially melted rock fragment from c255006, that might be a residue (clinker) from relatively modern use of coal.

Materials from c255105 and c255106 are too fine-grained for certain visual identification, but include materials that are dark and glassy in appearance that might either be burnt residues or may in part be coal dust.

A small piece of glassy material was identified by previous work as being significant (from c255206) as being in a stratified prehistoric context, but was in the material sent to K. Leahy and was not available for re-examination.

Site 511

Attention was drawn to this site because of s statement in the initial assessment that 13.7g of vitrified clay was recovered from burnt mound deposit c511009. This particular material has not been positively identified in the present re-evaluation, but is probably to be identified with that labelled 511099 (see below) and therefore an error. Two samples from c511009 were present (<511002> and <511004>), but neither contained any vitrified material.

Site 513

Previously, modern slags had been recorded from c268038, a fill of ditch c268037. This proved however to be a misidentification and the fragment (now broken in 3) was a piece of high grade iron ore, probably a bog iron ore and of probably local origin. This piece may have been deposited through entirely natural agency.

Site 514

This site probably produced a very small quantity (14g) of probable ironworking (smithing) slag. This material was recorded in the initial assessment, but appears to have had incorrect context numbers assigned.

The larger collection is from context c511099 and weighs 13,69g; this is apparently the assemblage recorded as being from context c 511009 (site 511). This record requires further checking as to the origin of (511099).

The smaller collection is from context c511394, sample <511046>, from the fill of undated pit/ditch c511395. This seems to have been entered into the previous assessment of the material as being from context c511046.

Unstratified material

The unstratified material included one concretion around a corroded probable iron nail and about 15 pieces of clinker.

Felindre to Brecon pipeline (FTP)

Site 23.4

A tiny quantity of iron slag (0.6g) was recovered from this site (c234075)by Cambrian Archaeological Projects. This was in the material sent to Kevin Leahy and is currently not available for inspection.

Site 25.12

A quantity of smithing slag was recovered from this site by Cambrian Archaeological Projects, of which at least some was sent to Kevin Leahy. This material was not available for inspection.

There was an apparent abundance of coal on this site. Coal was used as a smithing fuel in the Roman period and the progressively from about the 13th century onwards, becoming almost ubiquitous by the 19th. The interpretation of this as a late- or post-medieval site therefore seems plausible, despite the rather scanty structural remains.

Site 38.17

This site produced various strongly burnt clay fragments from prehistoric contexts, but these are unlikely to be metallurgical residues.

A single unstratified piece of clinker was also present. This is likely to be of relatively modern origin.

Site 49

There is a single unstratified, incomplete SHC apparently from this site. The bag is incompletely labelled and there must be a slight chance that this piece actually derives from site 50.11, from which there is a possible SHC margin fragment labelled as from context 49. Two partially labelled SHC pieces involving the number 49 may just be a coincidence, but may not.

Site 50.08

This site yielded two pieces identified initially as ‘glass waste’ and then re-identified as ‘blast furnace slag’ in the earlier assessment. Although an identification of one of the pieces as blast furnace slag is not unlikely, the larger piece is a very uniform dark glass and an alternative possibility for both pieces is that they are remelted dark bottle glass. The context for the pieces is a post-medieval ditch. They are not considered to be indicators of metallurgical activity in the vicinity.

Site 50.11

This site produced a variety of metallurgical residues including rather indeterminate hearth lining slags (501101), together with denser slags probably from smithing (finds #10, #21 and #28). The assemblage also included a piece of granular lead -working waste. This assemblage is only small, but suggests that variety of metallurgical activities were being undertaken.

Site 51.11

The site appears to represent an ex-situ dump of stone with charcoal and good evidence from micro-residues for iron-working (smithing).

Site 52.05

This site produced a small assemblage of approximately 25 pieces of slag and two pieces of iron from a stone spread.

The assemblage is rather reminiscent of that from site 257 (MHA) described above. The smelting slags form a subordinate component of the assemblage, but are certainly identifiable as tapped bloomery smelting slag.

They included possible examples of small slag runners.

The smithing slags are presented by good, if fragmented, examples of SHCs, which share a common texture to their lower surface: a smoothly dimpled abrupt contact.

At least one (and probably more) of the SHC pieces shows well developed narrow ridges on the lower surface of the cake. These marks are probably associated with the use of tools (a poker?) to assist with slag removal.

All the SHCs are formed of a very dense slag. Several show the development of tubular vesicles on the lower part of the bowl. One example (find #15) shows bladed olivine of 20mm length in the lower part of the cake. All examples showing evidence for fuel, show evidence for charcoal.

One of the main characteristics of this assemblage is the large size of the SHCs, with find #2 (the only example sufficiently complete as to permit extrapolation of original size) suggesting an original weight of around 1.5kg.

These characteristics (large SHC weight, dense slag structure) strongly suggest that the smithing undertaken on the site was largely primary smithing undertaken for processing of raw blooms. Given the accompanying evidence for iron smelting, this indicates that the material derives from a site undertaking both stages of the process of bloomery iron production. In many ways it resembles MHA site 257.

The presence of very dense SHCs with smooth tops and large bladed olivine crystals may possibly indicate (e.g. Young 2011a, sample LFW13) that a bloom remelting technique was employed – either as a part of the refining process or for small-scale steel production.

The presence of tapped smelting slags suggests that the site is either Roman or medieval in age (i.e. circa. AD 50-400 or 900-1600). The tool marks present on the base of many of the SHCs are an unusual feature, but can be paralleled at many Roman sites around the Bristol Channel area (Price 2000; Allen 2009, 2010 – albeit with the smithing slags misidentified as smelting slags by Allen). Thus a tentative Roman date might be suggested for this assemblage.

Interpretation

The pipeline has produced evidence for several significant ironworking, and particularly iron-production, sites from an area where early iron production is rather poorly known.

The most important sites are:

MHA Site 257: probably Roman iron smelting and bloomsmithing

MHA Site 508: apparent evidence for Iron Age and Early Medieval iron working but materials not available

MHA Site 513: not a metalworking site, but the recovery of probable high grade bog iron ore from this locality may have implications for the poorly-understood iron resources of Pembrokeshire

FTP Site 25.12: probable post-medieval smithy (material not seen).

FTP Site 50.11: evidence for iron- and lead- working at Roman roadside site.

FTP Site 51.11: microresidue evidence for ironworking. Age unknown.

FTP Site 52.05: probably Roman iron smelting and bloomsmithing

The evidence for iron production at MHA Site 257 and FTP52.05, both possibly of Roman age, is very important. Previous evidence for Roman iron production in South Wales has been almost limited to areas close to the Glamorgan ores (Caergwanaf, Cardiff; Young 2010, in press) or within the sphere of influence of the Forest of Dean ore sources (e.g. Monmouth, Caerleon, Caerwent, Usk; Young 2010, in press).

The new evidence from FTP Site 52.05 can be added to that from the Roman site at Maesderwen (7km SE of FTP Site 52.05), to suggest that there may have been exploitable local resources in the Brecon area, perhaps bog iron ores on the floodplain of the Usk, beyond a likely distance of transportation of Forest of Dean ores.

Similarly, the evidence from MHA site 257, particularly when taken together with the find of ore from MHA site 513, helps build a broader picture of the utilisation of iron sources, again apparently mainly bog iron ores, in the area north of Milford Haven. This may also assist with the interpretation of sites such as South Hook (Young 2011b).

Evaluation of potential

Although the sites yielding just a small quantity of ironworking residues have little potential for further detailed investigation, the two principal sites, MHA Site 257 and FTP Site 52.05, are both worthy of additional analysis. Such further work would be aimed primarily at trying to characterise the ore resources being exploited at these sites. In neither case is there current detailed knowledge of iron smelting in their area.

Analysis of the iron ore from MHA Site 513 would be a useful addition to the regional database, and might assist with the interpretation of MHA Site 257.

Beyond the potential for understanding the distribution and exploitation of hitherto unknown iron ore sources, firm dating of the ironworking sites would assist increasing understanding of the development of iron exploitation in the region.

A scattering of post-medieval industrial resides and more general waste from coal-burning (clinker and coke) found across many sites is not of great archaeological significance and has no potential for useful further investigation.

Two apparently significant sites (MHA 508 and FTP 25.12) did not have their assemblages available for reassessment – so examination of these is desirable.

One site (MHA site 500*)* produced a significant quantity of fine-grained fuel ash slag, probably from a non-metallurgical process such as a corn drier. Further analysis of this material is not likely to be beneficial unless there are specific archaeological questions.

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Table 1: Summary Catalogue (MHA). Assm = assemblage of sieved residues, 1 (m) = one original piece broken in m fragments, n+ = n fragments plus some fine debris.

site	context	sample	label	weight (g)	no	notes
eval 14	4601		slag	126	1	good dense botryoidal-surfaced oxide ore in rounded lump - either boxstone or boxstone modified and rounded to be a cobble,
209	(RDX 117)		slag	1690	1	partially melted and slagged firebrick
236	u/s		slag	330	4	2 pieces of hard, slightly bloated ceramic with maroon brown glazed exterior; 2 pieces of more conventional dark glassy clinker with pale clasts
257	257001		slag	186	29+	fragmented iron slags, ranging from pieces with moderately-sized charcoal moulds through to dense slags probably from core of an SHC
257	257001		slag	34	6	small fragments of slag formed of small lobes with charcoal moulds, largest piece may suggest that these are fragments of a slag rod/runner/spike
257	257013	(? poorly legible)	slag	84	1 (4)	fragment from margin of SHC with tubular vesicles in lower crust, very weathered,
257	257026		slag	84	8+	grey vesicular slag fragments, all probably from SHCs
257	257032		slag	2	1	tiny chip of charcoal-rich slag
257	257044		slag	454	8	216g: piece from bowl of SHC, concavo-convex, steep side with slightly hematised surface on interior, over 15mm thick bladed fayalite, outer few mm finer, grading into rough outer surface; 90g: 2 conjoining pieces of dense weathered slag, variably vesicular, angular fragment similar to those from 257001; 132g: 2 pieces of slag with lobate purple tinged tops - both probably, but not certainly, tapped smelting slags; 4g: 3 tiny slag scraps.
257	257 u/s		slag	2	1	tiny tap slag fragment
294	115.10.5		furnace lining	1.88	1	dark FAS/coke. Very low density, dark glassy.
294	115.10.7		furnace lining	5.28	1	heavily bloated pale orange clasts in dark vesicular slag, a FAS, probably clinker
500	20024		slag	21.15	1	small iron ore piece, has strong cleavage reflections from within iron ore - presumably from calcite.
500	50085	50004	slag	4.31	assm	small dark, possibly FAS particles, but most of sample is natural
500	500177	50010	slag	<	assm	dark carbonaceous material with blebs and droplets of FAS
500	500178	<50009>	magnetic residue	332	assm	dominated by small pieces of blebby pale grey fuel ash slag. Resemble corn drier rakings from other sites
500	500178	50009	slag	22	assm	larger pieces of FAS identical to material above. Pale grey, blebby...
509	255006		slag	154	1	slightly lilac bloated ceramic material, low density, has glazed crack surfaces and maroon corrugated lobes on top - probably a bloated mudrock fragment - probably clinker
509	255105	255003	slag?	0.27	assm	coal dust?
509	255106	255004	slag	0.13	6	2 of 6 are dark glassy slaggy materials, too small to identify - might even be burnt bone
511	511009	511002	magnetic mat	110	assm	poorly sorted rounded sand gravel - all appears natural
511	511009	511004	magnetic mat	3.35	assm	rounded rock grains dominated by red siltstone (<4mm?)
513	268038		slag	106	1 (3)	block of iron ore with brownish zones a few mm across surrounded by narrow zones of black, botryoidal material

site	context	sample	label	weight (g)	no	notes
514	511099		slag	13.69	6+	small angular slag fragments grading from yellow-green altered glassy lining slags, through black lining slags to dense vesicular iron slags with lining clasts. Might all be from a single disintegrated SHC
514	511394	511046	slag	0.52	1	broken green-weathering bleb of grey crystalline vesicular probably iron slag, c.7mm diameter originally
u/s				20	2	concretion around elongate iron piece - nail?
u/s			slag	22	2	clinker
u/s			furnace lining	88	13+	clinker

Table 2: Summary Catalogue (FTP). Assm = assemblage of sieved residues, 1 (m) = one original piece broken in m fragments, n+ = n fragments plus some fine debris.

site	context	sample	find	label	weight (g)	no	notes
49					392	1	worn and weathered concavo-convex SHC. 100mm x 75mm x 50mm, well formed bowl, vesicular slag on top, base worn but possibly microdimpled, edges knocked off and top layers probably missing
50.08 (rdx 50.9)	u/s			glass waste	30.6	2	4.2 g piece variably devitrified, possibly blast furnace slag; 26.4 g larger bit, rounded end of piece, even dark glass with fuel impressions on one (lower) side
50.11	50.11.001	50.11.002		slag	26	assm	low density lining/FAS in blebby forms
50.11			10	slot H CuA slag	12.16	1	elongate dense Fe-slag bleb with many moulds of charcoal on base, gently rounded top
50.11	49		21	slag	92	1	irregular slag sheet, finely rough on one side, other with charcoal impressions on one side and broken face over rest - possible SHC margin?
50.11	50.11.045		22	slag	25.8	1	lead working waste, oxidised, contaminated with charcoal, granular, formed of angular lumps in core - just possibly litharge
50.11	50.11.114		28	slag	3.09	1 (2)	slag bleb, dense, from within fuel bed [50.11 magnetic residues are stone not slag]
51.11	51.11.001	51.11.001		magnetic	76	assm	stone and smithing fines - fired clay, slag fragments, slag blebs, slag droplets, slag flats, small amount of hammerscale (FHS and SHS) but possibly very finest grade material not sampled
51.11	51.11.001	51.11.1			22.69	assm	as above but dominantly stone - but has more fine FHS
52.05	52.05.02		1		99	1	piece from middle of an SHC 35mm thick. Base smooth-rough, basal 3mm have strong tubular vesicles, rest dense irregular sparse vesicles
52.05	52.05.02		2		932	1	dense plano-convex SHC fragment, with raised lump on planar top, (130mm) x (70mm) x 80mm (65mm bowl) probably c. 60%? Well-developed tool marks on base
52.05	52.05.02		3		262	1	large piece of dense SHC with tubular vesicles in lower 15mm section , above more normal vesicular, (100mm) x (45mm) x 40mm
52.05	52.05.02		3		26	1	small irregular piece of vesicular slag
52.05	52.05.02		4		540	1	part of dense SHC - similar to the others from the site, with a finely dimpled base with a possible toolmark, dense structure, irregular rough top. (95mm) x (65mm) x 50mm
52.05	52.05.02		5		70	1	irregular shaped piece of vesicular slag with some smooth to lobate protrusions around margin - probably SHC, but indeterminate
52.05	52.05.02		6		74	1	small sheet of tap slag, small runnels c 15mm, broken from edge of thicker flow
52.05	52.05.02		7		28	1	vesicular slag with slightly dimpled base - probably an SHC fragment
52.05	52.05.02		8		14	1	irregular rounded lump of concretion
52.05	52.05.02		9		112	1	irregular 40mmx20mm section of concavo-convex sectioned trough passing back into more massive vesicular slag - runner/detached tool mark? 90mm long
52.05	52.05.02		10		6	1	small smooth sheet-like 5mm thick irregular slag piece indeterminate
52.05	52.05.02		11		8	1	irregular indeterminate vesicular slag fragment
52.05	52.05.02		12		46	1	small angular fragment of slag with dimpled base, 30mm thick
52.05	52.05.02		13		134	1	irregular dense lobe with slightly corrugated top, with some large rounded voids in dense slag - probably a tapped smelting slag

site	context	sample	find	label	weight (g)	no	notes
52.05	52.05.02		14		60	1	smoothly lobate piece with shiny dimpled base - probably the margin of a tapslag flow
52.05	52.05.02		15		170	1	SHC fragment 40mm thick, lower 20mm is bladed olivine, upper 20mm includes large rounded shiny vesicles up to 40mm across, below smooth top, base with small dimples
52.05	52.05.02		16		26	1	40mm long small slag runner/tube c. 25mm diameter
52.05	52.05.02		18		48	1	runner or detached tool-mark, dimpled slag trough 65mm x 30mm x 15mm
52.05	52.05.02		19		248	1	probably central part of small SHC, plano-convex piece but all edges missing except one, slightly dimpled base, top shows a very large smooth internal vesicle, then rough above
52.05	52.05.02		21		24	1	50 mm long runner, 15mm wide and 10mm deep, dimpled surface
52.05	52.05.02		22		18	1	irregular low-density flowed bleb with charcoal imprint on base
52.05	52.05.02		23		4	1	small lobe of probable weathered tap slag
52.05	52.05.02		25		146	1	corroded T-shaped iron object
52.05	52.05.02		26		28	1	corroded iron lump
52.05	52.05.02		30		28	2	small pieces of probable tapped slag

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