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Assessment of archaeometallurgical residues from land north of Culmstock Road, Hemyock, Devon

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Abstract

The submitted assemblage comprised approximately 151g of material (approximately 350 pieces) derived from the smelting of iron in non-tapping furnaces. In addition to the present assemblage, 14kg of residues were recovered during an earlier Archaeological Evaluation. The evaluation produced two contrasting ^{14}C dates from the slag dump (15013), suggesting the smelting was probably of between the late 7th and 9th centuries.

The excavation revealed the basal pits of two non-slag tapping furnaces ([14006] and [15004]) in areas 14 and 15 respectively. These were of rather similar dimensions (shaped like an inverted cone, 0.7m by 0.6m in plan and 0.5m in depth).

Furnace [14006] contained a large slag block (a 'furnace bottom') and some smaller fragments (total weight 25.4kg), probably representing most of the slag from its last smelt. Furnace [15004] contained very little slag, suggesting it had been cleared after its last smelt. Both furnace pits contained significant quantities of ceramic materials from the furnace superstructure, indicating that the furnaces had a planar blowing wall, with a hollow eroding close to the blowhole during the smelt and being repaired repeatedly. The blowhole (or a blowhole, it is unclear whether there would have been more than one, but the width of the burr suggests this may possibly have been the case) was 18mm in diameter. This evidence closely parallels that from a previously investigated site to the south of Culmstock Road, from Burlescombe and probably from the early phase at Ramsbury.

Close to furnace [15004] lay pit [15009]. During fieldwork this was described as a furnace but, if so, its elongate shape must indicate a very different type of structure to furnaces [14006] and [15009]. It seems more likely it was a pit of uncertain purpose, that was used to dispose of 58kg of slag and furnace material (including 42.7kg comprising one complete fresh FB and at least three very worn substantial fragments of FBs). The FB of fresh appearance (weight 23kg) was of remarkably similar structure to the example from [14006] and must have been produced in an almost identical manner, perhaps in furnace [15004].

Further north, pit [15017] was similar to pit [15009], and also interpreted as a furnace; its upper fill yielded 25kg of residues.

Areas downslope of furnaces [14006] and [15004] contained small slag dumps (contexts (14013) and (15013)), yielding 5kg and 40kg of residues respectively, broadly of similar character to that closer in and near the furnaces, but more highly comminuted and weathered.

Features in Area 13 produced only a small quantity of slag of the most dense and robust types seen in the other areas. They also produced very small quantities of a box-stone ore, compatible with those of the 'clay with flints' previously postulated to have ben the ore employed in the Hemyock area.

The site thus provides important new evidence for the smelting of iron at Hemyock.

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Methods

All materials were examined visually, using a low-powered binocular microscope where required. As an assessment, the materials were not subjected to any high-magnification optical inspection, not to any form of instrumental analysis.

The identifications of materials in this report are therefore necessarily limited and must be regarded as provisional.

This assessment was conducted in June 2019 and was commissioned by Jacky Sommerville of Cotswold Archaeology.

This project follows a phase of field evaluation for which an archaeometallurgical assessment was also undertaken (Young 2017). The results of that earlier work are included into this account and discussion. The site is referred to as Culmstock Road N in this report, to differentiate it from the early medieval iron smelting site to the south of Culmstock Road (henceforth Culmstock Road S; Young 2014; Rainbird & Young 2015).

Description of the assemblage

Iron smelting slags

The assemblage included two largely intact furnace bottoms (FBs), one found *in situ* in Furnace [14006] designated as context (14009) and one dumped into pit [15009] as a part of fill (15010).

Furnace [14006] contained a large slag block (a 'furnace bottom') and some smaller fragments (total weight 25.4kg) in adjacent contexts, probably representing most of the slag from its last smelt. The FB was 420mm wide, 250mm long and 250mm deep.

The FB showed the development of a prominent 'burr' (the zone of interaction of the slag and wall) extending most of the width of the cake. The right-side of the cake (when viewed in the direction of blowing; the southern side in plan) showed a particularly tight angle between the blowing wall and the adjacent side. The FB formed into a pit pre-packed with split wood. This wood appears to have been packed steeply (being preserved as moulds in the flow slags of the lower part of the FB), following the shape of the sides of the pit. Although most of the upper part of the FB was formed of slag with finer porosity associated with the moulds of charcoal fuel, the wood moulds extended through to the upper surface of the slag cake within the tight southern corner. The wood moulds were surrounded by particularly dense slag, often coarsely lobate, which close to the pit wall formed a continuous dense sheet.

The upper-central parts of the FB comprised, so far as could be determined from the outside, by porous slags formed of amalgamated fine prill surrounding the fuel moulds.

Away from the dense burr, the contact between the FB and the pit wall was mainly a non-wetted surface, showing a strongly lobate structure. The surface layer of this material was conspicuously dark, shiny and often with a rich lustre. Similar material formed the margins of some of the wood moulds.

The FB from context (15010) weighed 23kg. It measured 280mm front-back, 400mm wide, 240mm from flat top to base, with its burr approximately 240mm wide and 150mm deep. The top of the FB was approximately triangular. The right side of the cake bends turns through a right angle and has a foliated structure to the top – suggesting the presence of collapse wood moulds wood. Large wood moulds also show near the base. The left side of the cake in contrast shows a prominent flat-topped slag flow extending obliquely at 130mm below the top. The base of the FB appears to mould the base of furnace pit (or a layer of deposit within it) rather than being suspended above further wood.

Almost of all the fragmental slag recorded from the site can be matched with the components observed within these two FBs (in so far as the internal structure of the two can be judged from the external examination). Two slag facies found in the fragmental material are less certainly identifiable with the blocks:

Dense slag in the form of a puddle with a free surface (locally showing tapslag-like flow lobes) was an element of several collections within the assemblage (540g from (15019), 1775g from (15006), 2890g from (14011)). A small flow, although probably not of such dense slag, extends from the left-side of the 23kg FB from context (15010).

Secondly, some tabular to plano-convex masses of porous slag cannot be matched with observed components. This facies might be interpretable as either a friable upper layer from with a FB (the reserved top of both relatively complete FBs was somewhat fragmental and did not extended far from the wall – suggesting substantial damage during bloom removal), or as an unusual poorly consolidated smithing hearth cake (SHC). These materials were unfortunately rather weathered (perhaps indicating that they had contained some metallic iron) ad their origin cannot be confirmed on visual inspection alone.

Iron smelting furnace ceramics
The assemblage contained a moderate amount of furnace ceramic and associated materials, with a total weight of almost 16kg (over 10% of the assemblage). The majority of the vitrified materials showed an almost planar face of vitrified material backed by dominantly grey furnace cermaic. A few pieces showed a more oxidised vitrified ceramic, interpreted as deriving from close to the air supply.

One fragment, from context (14011) preserved part of the margin of an 18mm diameter blowhole. The axis of the blowhole was at approximately 60° to the plane of the wall face in the fragment (though the orientation of the wall face itself is unknown).

Although the majority of vitrified hearth wall fragments showed a planar face, a few pieces showed evidence for the erosion (and relining) or large hollows worn back into the wall (probably above the blowhole). Some pieces had complex textures apparently showing blocks of the vitrified surface layer sloughing off the wall and sliding down over the face below (although an alternative interpretation might be that these represent heavily heat eroded surfaces cutting back into a relined wall area).

Several specimens (both in situ and dumped) showed dense smelting slag penetrating into the pit/superstructure wall along narrow fissures, sometimes probably in a reticulate pattern.

Iron ore
A very small quantity of ore (total 30g) was recovered from two fills of features in Area 13 (contexts (13023) and (13071)). These fragments were from box-stones, in one case showing secondary iron oxides (probably goethite) in a fibrous habit between the dense, fine shells of the box-stone. The fragments show some surficial reddening, probably, but not certainly from roasting.

Concretions and iron
Various examples of slag, particularly from the dumps into the low-lying wetter areas, showed concretionary material adhering to their surfaces. Only a few examples showed this developed to any significant extent, and this was interpreted as the result of those slag pieces having contained metallic iron. A single concretion weighing 126g from context (15013) appeared to have been formed around a discrete piece of iron.

Distribution of the assemblage

The submitted assemblage comprised approximately 151g of material (approximately 350 pieces) derived from the smelting of iron in non-tapping furnaces. In addition to the present assemblage, 14kg of residues were recovered during an earlier Archaeological Evaluation.

Furnace [14006] contained a large slag block (a 'furnace bottom') and some smaller fragments (total weight 25.4kg), probably representing most of the slag from its last smelt. The upper part of the fill of the pit above the FB contained much material derived from the superstructure of the furnace, including pieces of the planar blowing wall, an eroded hollow in the wall, and part of a blowhole 18mm in diameter (along with a large amount of red clay from the unfired outer parts of the shaft, visible in photographs but not present in collection).

Furnace [15004] contained very little slag, suggesting it had been cleared after its last smelt. It did contain a moderate quantity of detritus from the superstructure as well as several blocks of very dense slag, suggesting that fluid slag had descended towards the bottom of the pit to form a 'puddle' below the main FB.

Close to furnace [15004] lay pit [15009]. During fieldwork this was described as a furnace but, if so, its elongate shape must indicate a very different type of structure to furnaces [14006] and [15009]. It seems more likely it was a pit of uncertain purpose, that was used to dispose of 58kg of slag and furnace material (including 42.7kg comprising one complete fresh FB and at least three very worn substantial fragments of FBs). The FB of fresh appearance (weight 23kg) was of remarkably similar structure to the example from [14006] and must have been produced in an almost identical manner. In the context of Area 15, it seems likely that this FB may have been produced in furnace [15004].

Further north, pit [15017] was similar to pit [15009], and also interpreted as a furnace; its upper fill yielded 25kg of residues.

Areas downslope of furnaces [14006] and [15004] contained small slag dumps (contexts (14013) and (15013)), yielding 5kg and 40kg of residues respectively, broadly of similar character to that closer in and near the furnaces, but more highly comminuted.

In addition to the furnaces and associated features/ dumps in Areas 14 and 15, several features in Area 13 also produced residues. Prominent amongst these is the upper fill (13020) of pit [130] (approximately 4kg from the evaluation and excavation), context (13069) producing 1285g. In both cases the slags were very dense flow surrounding wood moulds. A small fragment (8g) of a dense flow slag with fuel moulds also occurred in (13023), accompanied a small quantity of iron ore (26g). Further iron ore (4g) occurred in (13071).

Interpretation

Identification and location of furnaces

The excavation revealed the basal pits of two non-slag tapping furnaces ([14006] and [15004]). These were of rather similar dimensions (shaped like an inverted cone, 0.7m by 0.6m in plan and 0.5m in depth). The slag from the last usage of furnace [14006] was remaining inside the pit.

The similarity of the 23kg FB from fill (15010) of pit [15009] to the *in situ* FB in furnace [14006] provides strong evidence that they were produced during a very similar smelting technique in similar furnaces. Although interpreted as a furnace during fieldwork, pit [15009] is of a completely different form to [14006] and [15004]. Its elongate shape, steep sides and flat floor, would indicate that any interpretation as a furnace would probably require the furnace shaft to be located over the northern end of the pit, where the upper fills contained much furnace superstructure material, together with the 23kg FB. Such a model would allow the southern half of the pit to be an external working hollow for accessing the base of the furnace via a furnace arch.

Images of the pit appear to show the FB the right way up, but resting within the centre of the pit, not against the wall as would be required for the formation of the burr and wall contact. The flow of slag from the mid-part of the FB can also be seen to be directed into the north end of the pit, not towards the putative arch as might have been expected. The evidence seems to point towards pit [15009] not being a furnace, but to have had furnace waste dumped into it after its disuse.

The photographs appear to show pit [15009] as having a burnt floor, and alternative interpretations might be that this was employed as an ore roasting structure (for which there is no evidence in terms of ore finds), or that it was a charcoal production pit. The dimensions of [15009] were 1.15m in length, 0.8m in width and 0.32m in depth (i.e. with a length:width ratio of 1.44). These figures are comparable with the smaller examples of broadly contemporary charcoal-making pits recorded in central Ireland (Young 2005, 9-10).

Closely associated with furnace [15004] was also a second pit [15007] which was 1.15m in length, 0.8m in width and 0.18m in depth. Thus, this pit was of similar dimensions and shape to [15009], but 0.14m shallower. It was suggested during excavation that pit [15007] might be a hollow associated with the use of bellows for furnace [15004]. That suggestion can now be strengthened with the observation that the structure of the FB shows that the furnace appears to have been blown from the NW

Pit [15021] similarly lay close to pit [15019] and measured 0.85m in length, 0.6m in width and 0.15m in depth, and featured a single, charcoal-rich fill. It was suggested likewise that [15021] might have been the bellows location for a furnace over pit [15019]. That remains possible, but the evidence for pit [15019] being a furnace is not conclusive. Pit [15017] was 1.1m in length, 1m in width and 0.28m in depth; this is very wide and shallow compared with the pits of furnaces [14006] and [15004].

In summary, the evidence for two furnaces ([14006] and [15004]) is strong, but the interpretation of the other features of areas 14 and 15 require further interpretation after detailed interrogation of the field records.

Smelting technology

The evidence indicates iron production in non-slag tapping furnaces. The two more-or-less intact FBs show a wide burr, with the surviving furnace ceramic indicating a planar blowing wall above an eroded embayment around the 18mm diameter blowhole. The slag pit was deep (0.5m), and as dug, conical and 0.7m by 0.6m in plan. The width of the FB suggests the internal working width of the furnace at FB-top level was perhaps 450mm. The above ground superstructure of the furnace appears to have been carried down into a placed pit clay pit-lining, although this may not have been entire.

If the two other pits claimed as furnace pits during fieldwork can be substantiated, then they must be rather different – in both cases shallower and in the case of [15009] an elongate shape, which would probably indicate the presence of a furnace arch.

The pits of furnaces [14006] and [15004] were packed with split wood prior to smelting, with the wood extending to approximately ground level.

The superstructure was of uncertain form. Although there is no surviving evidence from the sides away from the blowing wall, an enclosed furnace is much more likely than a hypothetical type with a wall solely on the blowing side (as suggested for Burlescombe; Reed *et al.* 2006). Indeed, the evidence for both fired and unfired clay entering the tops of the abandoned furnace pits suggests a substantial superstructure. The evidence forms a tight group with the evidence from Culmstock Road S (Young 2014; Rainbird & Young 2015) and at Burlescombe (Reed *et al.* 2006), as well possibly as those at Ramsbury (Wiltshire) (Haslam 1980) and Millbook (Sussex) (Tebbutt 1982). This group of furnaces includes a few examples at around 0.5m diameter, but most are larger, ranging up to 1m diameter and have a broadly splayed prolife and a planar blowing wall.

The sole difference between the present assemblage and the comparative example at Burlescombe is the rare occurrence at Culmstock Road N of dense slag puddles from low in the pit. These were also recorded amongst the assemblage from dump (C4) at Culmstock Road N. They are a minor component of the slag assemblage at both Culmstock Road N and Culmstock Road S and may have been overlooked at Burlescombe. Substantial slag puddles are a common feature of non-tapping furnaces with a cereal packing (e.g. at Churchills Farm in Hemyock (Young 2015b; Smart *et al.* 2018) and at Camlin, Ireland (Young 2011). It may be that puddles are able to form in situations were voids form within the pit packing of whichever composition.

Where dated, these comparative examples also have given 7th-9th century dates (Table 3). It would thus appear that this technology may have been in wide use in late Middle Saxon Wessex, before becoming supplanted by other technologies in the Late Saxon period (Young 2015b; Smart *et al.* 2018).

Ore source

The very limited evidence of ore fragments from area 13 is significant. These pieces are of very similar morphology to the ironstones known with the 'clay-with-flints' on the top of the Blackdown Hills (Reed 1997; Young 2015a). This is presumed to have been the major ore source for the Hemyock iron smelting of the early medieval and medieval periods, but direct evidence has proved elusive on the other excavated sites. The provenancing evidence from other sites in Hemyock was discussed by Young (in Smart *et al.* 2018, 94-96). Although the evidence points to a general 'clay-with-flints' source, the slags at Culmstock Road S and Churchills Farm indicate slightly different ore sources, with that at Churchills Farm most closely resembling an analysed ore from Dunkeswell (Young 2015a).

The finds of box-stone fragments on the present site present a rather more convincing potential model for the ore employed than did the poor ores recovered from Culmstock Road S and Churchills Farm.

Topographical considerations

The location of the site adds to understanding of the topography of early ironmaking in Hemyock. The smelting in areas 14 and 15 lay on ground to the east side of a low wet area. The low ground provided an opportunity for waste disposal and the location may have been marginal to any agricultural land. The variety of cut features in area 13 suggest this area may have been treated differently, with the ore and ash

dump perhaps suggesting materials were prepared in this area. The smelting site at Culmstock Road S was probably also on the margins of a damp area used as a waste dump, but here groundwater appears to have been such a problem that drainage was employed for some of the slag pit furnaces.

The site has produced no evidence for bloom smithing, as neither did the Churchills Farm nor the Culmstock Road S sites. The raw iron produced must have been worked into usable iron elsewhere. A model of dispersed iron smelting (perhaps dependent on woodland resources) with centralised bloomsmithing seems likely. No centralised smithing facility has yet, however, been discovered in Hemyock. A possible example of this site-type has recently been discovered near the nearby smelting area at Burlescombe (Young 2018).

Further work

This assemblage includes excellent examples of intact FBs, including the *in-situ* example from furnace [14006]. This resource is supplemented by isolated pieces of other FBs, together with furnace ceramic and probably-related ore fragments. The smelting sites are compact with a volume of residues, suggesting they are likely to have been relatively short-lived and hence the materials within them have a higher chance than typical of being directly related. They are likely to provide evidence that is much more straightforward to interpret than that of larger sites.

These residues are presentative of a smelting technique that appears widespread across Wessex in late Middle Saxon period. The most complete description of such materials and furnaces is that of the site of Burlescombe (Reed *et al.* 2006), but no detailed analysis was undertaken there. Some analysis was undertaken for the site at Culmstock Road S (Young 2014; Rainbird & Young 2015), but the analysed materials were all *ex-situ* from the slag dump (estimated as a total of 22 tonne) and there was a wide variety of furnace forms of uncertain age range. The sites at Ramsbury (Haslam 1980) and Millbook (Tebbutt 1982) before the advent of modern analytical techniques and their theoretical frameworks.

The present material is thus ideally suited to provide detailed evidence for the nature of this particular style of iron making, and should be capable of shedding important light not only on the operation of this particular site, but also of the other, larger, sites in Hemyock and also of similar sites further afield across southern England.

Accordingly, detailed laboratory analysis is recommended. If possible, this should be undertaken through detailed dissection and analysis of sub-samples from a single FB (to ensure coherency of raw materials between sub-samples), supplemented where necessary by additional isolated material from the secondary deposits (including furnace ceramic and iron ore). Interpretation of bulk elemental analyses may be made through the mass-balance modelling approaches of Thomas & Young (1999a,1999b), as modified by the graphical approach of Young (2016). This should enable understanding of the local mass balance (i.e. how the various inputs of iron ore, fuel ash and furnace clay combine to produce slag and iron) for the various components of the FB (to understand how the FB forms), as well as the overall balance that enables calculation of output and efficiency. Microstructural investigations by SEM on a smaller suite of materials characterise the mineralogy of the slag (allowing investigation of such features as the ability of the slag to capture phosphorus and prevent it entering the iron) and the crystallisation history of the slag (providing further evidence for the evolution of the FB).

By following similar methodology to that employed on comparative material at Churchills Farm (Smart *et al.* 2018), then the functioning of the deep wood-packed furnaces may be directly compared with the later Saxon cereal-packed non- slag tapping and the slag tapping technologies as employed in later operations at Hemyock.

The post-ex laboratory analysis of the materials should be accompanied by a thorough review of the field evidence for the nature of the various pits and by a comparison of the nature of those pits with the multiple pits forming the various ‘groups’ at the adjacent site of Culmstock Road S (Rainbird & Young 2015), with the aim of differentiating the various possibilities of clay extract, charcoal burning, ore roasting, additional furnaces, working hollows outside a furnace arch, and hollows associated with the blowing apparatus.

Irrespective of commissioning of further analysis, this assemblage is important and as much as possible of the assemblage should be deposited with the institution receiving the site archive. As an absolute minimum this should include one of the two intact FBs and a selection of the other components of the assemblage.

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Table 1: summary catalogue of materials submitted as archaeometallurgical residues. Weights in g, assm = assemblage of pieces, FB = furnace bottom.

context		Item wt (g)	Item no.	notes
				Area 13
13020		452	1	dense lobate slags apparently intruding into furnace wall, inner face of block is fragmental and accretionary
		1565	9	very dense slags with very large wood moulds
		1315	2	very dense slags with large wood moulds, but massive on one side with non-wetted contact, one appears to grade into possible burr area too
		306	1	very dense slags with large moulds showing intense surface reddening and smoothing, suggestive of secondary blast influence
		70	4	FB fragments
		4	1	heated and vitrified pebble fragment
13023		8	1	small fragment of dense slag with fuel moulds, secondarily reddened
		26	3	fragments of a small box-stone nodule - shows fibrous goethite within the cracks between the concentric fine dense shell layers, some superficial reddening, so possibly roasted
13069		1285	8	dense flow slag with wood moulds
13071		4	1	tiny fragment of possibly roasted box-stone
				Area 14
14007		374	5	dense flow slag with wood moulds
		674	1	very dense lobed slag with non-wetted wall contact, approximately 35mm thick, thickening to 50mm, inner face covered with brecciated accretion, possibly with included discrete slag droplets - could be bloom removal surface?
14009	1 of 2	18000	1	large vertical FB, 200x420x280mm, burr most of width (1 side fractured away) and 120mm deep, rest of wall contact non-wetted, one end gently curved, the other side bends through almost right angle, possibly deformed but probably original, from edge extends to 200mm below top with top surface angling down , if burr section is vertical then 250mm front-back and 250mm top-bottom with flat top. Large wood impressions on base but moulds elsewhere dirty so detail not seen
14009		846	1	block of prilly charcoal-rich slag with wood and a non-wetted surface near one side

context	Item wt (g)	Item no.	notes
	144	1	lobate slags around wood moulds with some very shiny fragmented material
	44	1	FB fragment with wood impression
	126	6	fragmented FB piece
14010	454	7	fragments of vitrified surface of lining, some pieces appear to show layered structure within rear clay - built with clay roll, all reduced grey to rear
	290	1	dense slightly irregular slag with rough surface attached to flat face of reduced-fired wall
	58	1	sheet of dense slag with one bright shiny dark non-wetting face, other side irregular
	12	1	slightly lobate slag scrap
	394	1	porous dark FB material in mostly finely prilly structure, one face shows shiny dark non-wetted surface
	274	1	dense irregular porous FB material, locally accreted and brightly reddened, possibly just rust but may be localised reheating?
14011	2890	1	very dense slag block, obscured in part by accretion, 80mm thick, slightly reddened top with localised flow lobes near margin, also trace of wood impressions on top, base convex with descending prills, probably a basal slag puddle, just very possibly a dense SHC
	44	1	margin of blowhole at approximately 60 degrees to preserved face, 18mm diameter, preservation of vitrified layer identical to that of the planar fragments from same context
	470	11	fragments of planar variously oxidised and reduced fired vitrified wall, some with very slightly oblique lamination within wall
	122	1	part of margin of hollow (presumably obliquely above b/h) , reduced fired descending stalactites, resurfaced apparently
	346	1	sloughed wall with trapped iron now forming rusted concretions
	82	1	breccia of slag, oxidised ceramic and rust with lining slag, contains iron
	494	5	fragments of porous hard rough FB fragments
14012	5050	19	masses of grey clay intruded by dense fine slag, faced by vitrified surface in slight hollow, then resurfaced with planar surface
	114	1	dense angular slag fragment, resembles slag attached to face in large blocks
	202	1	dense slag piece, probably a fragment of burr
	398	1	burr fragment
14013	1090	1	very rusted and slightly exploding mass of lumpy greenish weathering slag, plano convex shape suggests a highly weathered SHC, 150x120x70mm (100mm with 'spike' on base), charcoal-rich
	582	1	dense flow lobed slag around fuel moulds, very weathered
	288	1	wall slag contact on margin of burr with wood stick running along wall
	418	1	extremely dense burr fragment
	2050	16	weathered ochreous fragments of FB

context		Item wt (g)	Item no.	notes
		170	assm	bits and dust
				Area 15
15006		474	1	vitrified surface to oxidised fired planar wall
		206	5	small pieces of planar reduced lining
		108	1	grey vitrified lining with approximately 100 degree angle - presumably an overhang
		676	1	large block of sloughed furnace wall, potentially with embayment to one side originally?
		340	16	grey vitrified wall fragments
		134	5	grey wall debris with dense dark slag adhering and/or intruding
		46	1	dense massive slag fragment
		86	1	finely porous FB fragment
		2	1	isolated prill
		132	2	rusty fine FB type material
		1775	3	blocks of very dense slag with flowed tops and wood moulds, largest indicates slag puddle more than 90mm deep with wood moulds on top and on base and non-wetted wall contact
15008		72	2	concretionary material, probably accreted piece of charcoal-rich slag
		28	1	vesicular slag with large mould moulds, accreted
		46	1	slightly lobate flow slag with accretion
		104	1	unusual flow lobed slag apparently confined to subcircular tunnel - 25-30mm diameter - could be from mole hole/root or even a secondary fill in wood mould
15010	1 of 4	12000	1	rather worn deep FB. Top surface very well blown, RHS shows strong foliation through to upper surface - vertical wood or deformation, 210mm front-back, 300mm wide, 210mm from blown top to base, slag rises 30mm above flat top either side of central notch. No good wall contact preserved and no certain wood moulds - just lots of charcoal inclusions - though foliated side might indicate wood
15010	2 of 4	7700	1	200mm x 270mm x 160mm (front-back, width, top-bottom) rounded worn FB, right side angled and fragmented, worn down so no large wood moulds
		634	assm	fresh FB material with slags penetrating between large wood moulds
		246	2	FB fragments, rounded, larger one contains some iron

context		Item wt (g)	Item no.	notes
15010	3 of 4	3380	2	large blocks of porous FB material, larger block as basal ridge filled with pieces of brecciated non-wetted dense shiny surface, otherwise all finely prilly
		50	assm	bits from above
15010	4 of 4	23000	1	large FB, 280mm front-back, 400mm wide, 240mm from flat top to base, burr approximately 240mm wide and 150mm deep, flat triangular top to mass, RHS bends through right angle and has foliated structure to top - partly altered wall but also wood? Large wood showing near base, LHS shows prominent basal flat-topped flow 130mm below top; base appears to mould base of furnace pit
15011	1 of 2	288	14	small FB fragments and debris
		824	1	slag with split wood- face of largest 80x95mm, other side of slab is rough, concave and perhaps fragmental, slag dense where in contact with various wood pieces
		394	1	finely prilly FB fragment
		2210	1	charcoal rich FB fragment, with some mineralised wood, one face is fine dark shiny non-wetted contact
		642	2	round rusty lumps of FB material, just very small chance these could be charcoal-rich SHCs
		1415	1	wedge-sectioned rounded slab, suggesting origin on lateral part of FB, porous charcoal-rich slag, as with above, just very slight chance this is porous SHC
		50	1	twisted slag sheet from slag wall interaction
		156	1	oxidised fired wall with slag lobes sliding down surface
		1583	1	wall with gently curved face with broad 80mm deep embayment in it, repeatedly relined?
15011	2 of 2	3215	1	rusty rounded large FB block, mostly charcoal bearing and prilly, a few areas of lobes and possible wood
		850	28	variable FB debris
		108	4	indurated grey slag wall intersection
		10	1	isolated slag prill with fuel/wood contacts
15013	1 of 2	1220	1	rounded mass of porous weathered slag, probably a worn FB fragment but low density SHC just possible
		2030	1	large fragment of coarse porous FB, abundant moulds after charcoal
		2070	1	part of bowl-shaped FB block with fine charcoal - forms shallow bowl up to about 100mm thick
		20	1	vitrified and glazed grey lining fragment
		126	1	rounded lump containing iron
		168	4	fragments of porous slag with charcoal
		484	5	rounded worn rusted blocks of FB
		956	5	dense slags with large wood moulds

context		Item wt (g)	Item no.	notes
		136	2	vitrified indurated grey wall
		234	1	rounded fragment of slag with wood mould
		88	2	fragments of porous FB with areas of probable blown surface, very irregular and spikey
		46	2	dense slag fragments
15013	2 of 2	2325	1	block with arcuate side of FB and probable top, some strange laminated Fe-oxides on likely margin, slag mainly rich in quite coarse charcoal fragments, top weathered and slag green and powdery where crushed by contact in transport
		6265	1	rounded mass of worn and slightly accreted FB, subconical block but not original top, green weathered slag lobes on one face (top?) and wood moulds down a perpendicular face, otherwise no detail observable
		220	5	irregular FB fragments, mostly from around wood moulds
		260	1	fragment from burr with right angled cross section, appears to have worn into gravelly substrate as has lots of pale vitrified sandstone flakes included
15019		604	2	joining fragments of charcoal bearing slag with sheet of slag with tubular vesicles
		98	2	two small fresher pieces of FB containing slag sheet with tubular vesicles
		186	2	dense slags with wood impressions
		408	7	fragments of charcoal-rich FB with a few wood impressions
		48	1	complex slag sheet in dense shiny slag, lower face is full of smooth fine prills between charcoal moulds, opposite face is smooth and irregularly hollowed with possible fuel impressions
		298	5	rounded rusty slag lumps without clear surface features
		220	1	dense rounded fragment of burr
		300	1	complex very dense block with veins of slag intruding into wall
		80	1	vitrified wall fragment, probably resurfaced in silty clay over previous glaze
		88	1	thick runnels of slag detached from planar wall face
		22	1	dark lining slag detached from wall
		66	1	dense rounded fragment probably from a burr
15019	2 of 3	6685	1	rounded block of fine FB, dense, but few helpful surface features
		1585	1	rounded block of porous FB material, like similar sized blocks from (15010)
		1015	1	broken in 2, base of burr, dense shiny sheet on wall below burr - shows some fragmentation, finely prilly with small charcoal elsewhere
		626	1	very similar to 1015g block - might be from same burr but does not join
		644	1	block with horizontal flows extending between large wood moulds
		232	1	smaller fragment with dense flows between large wood moulds

context		Item wt (g)	Item no.	notes
		244	1	dense prilly flows with resinous lustre on ?base overlain by dense slag with wood mould
		262	1	dense 30mm sheet with tubular vesicles overlain by finely prilly charcoal mould bearing slag, probably from a burr but just possibly SHC
		26	1	small rusty weathered nub, probably detached from another piece
15019	3 of 3	3255	1	large block of fine prilly FB
		1792	5	porous prilly charcoal-rich FB with few if any wood moulds
		1570	3	blocks of FB with abundant large moulds of wood, mostly round up to 40mm
		1070	5	FB fragments, all rather rusty, 1 just possibly a very weathered SHC, 1 a curved sheet from wall?
		540	1	margin of very dense slag in tapslag-like block, from margin of cake, flow lobed and slightly reddened on top, internally massive with wood, base non-wetted prills - clearly a puddle, 65mm in thickness 80mm from margin
		1160	1	moderately dense FB fragment with two large moulds of sheet wood 12mm thick amongst other voids
		1840	1	dense worn block of FB with coarse charcoal, rusty
15022/ 15023		5520	10	reduced-fired lining in a bowl shape, with deeply vitrified surface, bowl form hard to reconcile with known furnace shape

Table 2: summary of materials in collection by area and context (weights in g).

context	notes	FB blocks	FB material	wall	ore	iron
	Area 13					
13020	upper fill of pit 13018		3708			
= 13020	(806) of evaluation		344			
13023			8		26	
13069			1285			
13071					4	
	Area 14					
14007	basal fill of furnace 14006		1048			
14009	FB in furnace 14006	18000	1160			
14010	upper fill of furnace 14006		1028			
14011	uppermost fill of furnace 14006 (rich in red clay)		3466	982		
14012	fill below tip of FB in furnace 14006		714	5050		
14013	tip from furnace		4598			
	Area 15					
15006	upper fill of furnace 15004		2041	1938		
15022/ 15023	part of furnace lining of furnace 15004 in situ			5520		
15008	fill of pit 15007??		250			
15010	base of pit/furnace 15009	42700	4310			
15011	main fill of 'furnace' 15009		9898	1847		
15013	slag dump NW of furnaces 15004 and 15009		16366	156		126
= 15013	(906) of evaluation		13983	58		
15019	upper fill of furnace 15017		24644	300		
	totals	*60700*	*88851*	*15851*	*30*	*126*

Table 3: radiocarbon dates, with those of comparative sites showing similar technology.

Site	Determination	Radiocarbon age	Age error	substrate	Context notes	2 sigma date low	2 sigma date high
Burlescombe	AA-34524 (GU-8391)	1145	50	ivy/elder	c553 in situ slag in furnace 525	720	1000
Burlescombe	AA-34523 (GU-8392)	1195	45	oak sapwood	c553 in situ slag in furnace 526	690	970
Culmstock Road S	SUERC-51250 (GU33038)	1271	35	Euonymus	c66	660	870
Culmstock Road S	SUERC-51251 (GU33039)	1197	35	Alnus glutinosa	c77	690	950
Millbrook		1220	70	oak (mature)		660	970
Ramsbury	HAR-1606	1170	70	oak, hazel	slag layer from early smelting	680	1000
Ramsbury	HAR-1704	1070	70	soil with charcoal	charcoal layer from early smelting	770	1160
Ramsbury	HAR-1609	1180	70	oak, hazel	furnace 3	680	990
Ramsbury	HAR-1626	1130	70	charcoal	hearth fill assoc. furnace 3	710	1030
Culmstock Road N	SUERC-73284	1170	29	hazel	c906 (main waste dump)	770	970
Culmstock Road N	SUERC-73283	1277	29	alder	c907 (comminuted waste at base of dump)	660	780

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