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Assessment of materials from James House, Chudleigh, Devon

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Abstract

The submitted assemblage comprised 38.6kg of picked fragments of residues and sieved samples from 13 discrete archaeological contexts.

The residues derive almost entirely from a pair of overlapping furnaces [1010] and [1014]. Field evidence suggested that Furnace [1010] was the earlier. The residues retained from both furnaces were dominated by material collected as furnace lining, but which included not only the inner parts of the furnace wall, but substantial quantities of adhering slag. The furnace materials were diverse including at least four different materials.

The retained structural materials from Furnace [1010] are disparate and no detailed description of the structure can be made. Those from Furnace [1014] are extremely complex. There is evidence for a substantial reconstruction of the furnace, with an early vitrified surface and associated dense slags overlain by a layer of gravelly sand, in turn overlain by a second layer of vitrification and slagging. This second layer can be seen in some pieces to turn through a right-angle compared with the underlying vitrified surface. In other pieces the wall is overlain by thick accumulations of lining slag suggestive of wall failure.

Fine slag materials characteristic of formation on the very base of the slagpit of a non-slag tapping furnace were recovered from the basal fill of Furnace [1014], but overlying fills contained little evidence for the 'furnace bottom' that would be expected to have formed higher in the pit.

The character of the evidence shares marked similarities with that of other sites in the region, hinting at a local technological tradition that differs from that of Middle Iron Age sites in Cornwall. Whether that difference is due to geography or chronology remains to be determined.

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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 August 2023 and was commissioned by Naomi Payne of AC Archaeology. The materials derive from excavation work undertaken at James House, Chudleigh, Devon (ACD2677) centred on NGR [SX 8713 7994].

Results

General nature of the assemblage

The submitted assemblage comprised a total of 38.6kg of picked fragments of residues and sieved samples from 13 discrete archaeological contexts. The catalogue of the assemblage is present in Table 1.

Tables 2 and 3 illustrate the distribution of the 36.5kg of discrete residue fragments by class of residue and context.

The collection includes approximately 22.5kg of fragments of the furnace structures. Of this 12.1kg appear to have been collected in situ in Furnace [1014] and 2.0kg in Furnace [1010] (as contexts (1017) and (1018) respectively. This appears not to include all the furnace lining left in these structures and it has not been possible to reassemble the fragments (the

furnace linings should theoretically be 100% of these contexts). 4.5kg and 2.7kg of furnace structural material were present in the collections from contexts (1015) and (1011), the main fills of Furnace [1014] and Furnace [1010] respectively. The main fills were the main source of isolated wall/lining slag fragments with 08.kg and 0.3kg respectively.

Also associated with the furnace structure are those dense slags identified as 'burrs' – the dense slag that forms in reaction with the wall where the hotzone impinges on the wall, typically with the slag forming a bulbous protrusion into the wall. 1.8kg of burr (and attached wall) were recovered from context (1011) and 1.5kg from (1017) (where it was apparently in situ).

The basal fill of Furnace [1014] contained a small slag assemblage of 266g of rather indeterminate iron slag fragments, 143g of flow slags (with an additional 82g of slag droplets) and 150g of rough-textured material (possibly including may include sinter). This assemblage is typical of the residues found in the basal parts of a slagpit in furnaces where substantial flows did not descend to the pit floor. This assemblage is likely therefore to be in situ. Similar materials also occur in the higher fills of both furnaces, but in mixed assemblages, suggesting they were derived from the dumping of mixed waste back into the furnace and/or degradation of the furnace.

Minor quantities of slag occurred in other contexts, with 5kg of slag in the fill of pit [1008] being the most significant.

Iron smelting residues

The 'clays' employed for furnace construction were very variable. For the purposes of the catalogue, four types were recognised:
Type 1 ceramic – pale kaolinitic gravelly sand
Type 2 ceramic – fine-grained, strongly foliated
Type 3 ceramic – pale, fine-grained with lithic clasts
Type 4 cermaic – fine-grained with organic temper

The in-situ remains od furnace [1014] ought to be the most informative about the manner in which these different materials had been employed, but the there is no documentation of the original location or orientation of the fragments. Reconstructing the sequence of events is very difficult. In some areas the early wall material appears to be fine grained (with or without lithic clasts; types 2 and 3) and the coarse, sandy material (Type 1) appears to have been used in a major repair/relining of the furnace, for it overlies one vitrified surface and underlies the latest slagged and vitrified surface.

One phase of the furnace appears to have resulted in the sloughing of large amounts of the wall, as angular clasts, that became re-consolidated. These materials are almost black and form a very unusual component of the assemblage, possibly indicating a poorly-built section of the furnace or a poorly applied-repair.

The wall section appears to drop vertically to a level below which the sides of the basal pit curve inwards. This angle appears to have accumulated large amounts of lining-derived slag -as well as being close to the level that the 'furnace bottom' within the furnace abutted the wall.

The 'furnace bottoms' are rather poorly represented in the collection. The largest assemblage of fragments was from context (1009), the fill of pit [1008], with context (1004) in posthole [1003] also containing a small number of fragments. The burr region where the FB met the blowing wall is represented by several fragments and a single fragment of dense slag containing metallic iron (from context (1015)) is suggestive of the upper dense part of a FB just below the level of the bloom.

The basal residues from the furnace pit are well represented, with small flow slags and abundant isolated slag droplets. These indicate that the FB did not reach the bottom of the pit, or that there was space forward of the FB, where slag could descend into the fuel bed and pit packing in small quantities.

The final form of smelting residue, also from the base of the pit, is a rough, rusty material with abundant very fine charcoal and tiny slag prills/droplets. This material resembles the 'sinter' seen in some other furnaces (e.g. Folly Court, Young 2018, Young and Anelay in press)) but it is unclear if the present material is a true sinter. Nonetheless, an origin similar to that of the sinters seems likely, with the material arising from fine particulate material (slag, charcoal dust, partly reduced ore, iron…) accumulating on the floor of the furnace either beyond the footprint of the furnace bottom or forming before the furnace bottom grew.

Interpretation

The assemblage indicates iron smelting in non-slag tapping furnaces. The evidence for the furnaces themselves is complex, and considerable uncertainty exists over the relationship between the various ceramic materials and the superimposed vitrified surfaces.

There are several pieces of furnace structure that might be indicative of the margin of ceramic tuyères, but the presence of tuyères could not be confirmed.

If the field evidence for the superstructure is not easily interpretable, the nature of the basal pits of the two furnaces appears clearer. They are sub-circular pits, without evidence for external ramps into an arch. This suggests that the furnaces belong to a different tradition to the Middle Iron Age furnaces from Cornwall (Young 2016a, 2016b, 2022a, 2023) which show wide furnace arches with external ramps.

Discussion

The James House site adds to the body of evidence for Iron Age iron smelting to the east of Dartmoor. In the immediate area the site at Twinyeo (Farnell 2015) provides a direct comparator.

It was argued that the ore source for the Twinyeo furnaces may have been a bog iron ore from the Teign/Bovey floodplain.

Slightly further afield there is some very slight evidence of smelting from Ipplepen (Young 2022b), although this is currently undated and furnaces have also been described at Tigley A and Lower Velwell (Mudd & Joyce 2014).

The Lower Velwell furnaces were shallow and the Tigley A examples much deeper, but all appeared sub-circular to oval, with no evidence for a ramp/arch

identified. The furnaces on each site were clustered, with those at Tigley A intercut. At Twinyeo, the furnaces were also clustered in 2 (or possibly 3) groups.

The similarity of evidence from these sites to each other and to the present site hint at a discrete local approach to smelting,

Crew & Quinnell (2022) have argued that the Coffinswell currency bar hoard had a local origin and provide a review of the evidence for early iron working in the area.

Despite this progress, present understanding is rather superficial.

Further work

The nature of the early iron production to the east of Dartmoor is not yet well characterised and the sources of iron ore undefined.

Detailed analysis of the Chudleigh residues would be capable of providing further evidence for the nature of the ore being exploited. However, the furnace bottoms that would have been the major accumulation of slag in these furnaces are not well represented in the assemblage, so analysis will not be able to address adequately questions of the productivity of the furnaces.

Consequently, some limited investigation is recommended, but short of full characterisation of the residue suite. The emphasis of the analysis should be on elemental analysis of a small number of representative slag and fired clay specimens sufficient to provide evidence for the likely ore composition.

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Table 1: summary catalogue, weights in g,

c	s	label	s wt	Item wt	Item no	Item notes
1001			1625	424	1	large piece of concave furnace lining with smooth, maroon-surfaced slag coat, rests on 7mm of bright orange gravelly sand, over 7mm of green grey sand (Type 1 ceramic), then poorly preserved vitrified/slagged surface over variegated pink/cream fine laminated clay (Type 2 ceramic)
				228	1	angular block of burr/intrusion, large vesicles, fresh breaks, coated with sandy gravel (Type 1 ceramic) on all sides?
				138	4	fragmental shaley ceramic, not vitrified (Type 3 ceramic)
				200	11	dark fragmental material passing forward into lobed black flowed material
				154	1	dense dark flow slag with brownish tapslag-like surface
				386	1	burr material in two layers, sand (Type 1 ceramic) between, flow slags on inner face suggesting possible overhang
				6	2	fine grey fired clay (Type 2 ceramic?)
				62	3	small fragments of vitrified sandy wall cf 424g piece above (Type 1 cermaic)
				54	4	dark sandy lining slags lying on and moving down sandy wall (Type 1 ceramic)
1004			338	294	16	amalgamated flow slag fragments, very fresh fractures, coarse (sugary) textures, moulds
				44	1	partially melted and glazed ceramic - coarse gritty sand (Type 1 ceramic)
1009			5045	4525	19	fragments of amalgamated flow slag mass with large wood moulds
				68	1	rather massive low-density lag with maroon surface flow lobes on surface
				446	2	pieces of dense burr, probably formed into gravelly substrate (Type 1 ceramic), top shows raised flow lobes
1011			2230	252	7	laminated grey fired clay, no certain surfaces (Type 2 ceramic)
				104	2	dense thin slag coats, maroon surface, on gravelly sand rear (Type 1 ceramic)
				92	1	tapslag like flow slag
				268	5	laminated clay wall (Type 2 ceramic) passing into thick lining slag
				314	1	laminated clay (Type 2 ceramic) passing into wedge of very dense slag, probably on the margin of a burr
				538	1	dense burr block, eroded back into gravelly sand (Type 1 ceramic)
				432	1	dense prilly flow slag descending onto indurated gravelly sand (Type 1 ceramic)
				48	1	thick lining slag over laminated material with a rounded shale pebble (Type 3 ceramic)
				54	3	sandy black ?fragmental lining slag
				124	1	very dense cuboid of slag - probably near burr, but no original surfaces
1011	7	fired clay	2090			fired clay, sometimes with vitrification on concave surface, notably coarse-grained quartz temper
1011	7	2 - 4 mm	7	8	assm	mostly stone and fired clay, but a small number (but wide variety) of slag grains

1011	7	0.5 - 2 mm	7	16	assm	mostly stone and fired clay, just small proportion of probable slag grains
1011			1245	274	19	flow slags
				362	4	dense slags from burr region - two separate dense contact slags separated by sandy material (Type 1 ceramic)
				412	1	dense slag from burr region, grey gravelly indurated wall to rear, sheet of dense slag curves away from it in the front
				96	11	thin sheets of slag, pealed from gravelly ceramic rear (Type 1 ceramic)
				12	3	indurated ceramic fragments
				80	assm	small indeterminate slag fragments and dust
1015	8	0.5 - 2 mm	8	8	assm	about half stone, half slag debris, just a few spheroids
1015		fired clay		958	assm	fired clay, mostly oxidised fired
1015	8	slag	2740	916	299	rusty ?sinter
				82	6	sheets - peels from wall
				238	1	dense slag cake with abundant iron
				634	55	lining-related ceramics
				98	7	miscellaneous larger slag pieces
				108	241	miscellaneous small slag pieces
				676	134	flow slags
1015		1 of 2	1765	1765	1	large bock from slag/wall contact, 90mm height of indurated sandy side (Type 1 ceramic), moving in 50mm upwards, inside shows overhanging rusty slag, where bloom and its attendant slag pulled out, with pendant flow slags below and above step the inner face drops back to near wall in smooth embayment 150mm wide and 60mm deep. Lower slag hangs 40mm below lowest preserved side. Suggests blowing wall had an overhang (note similar fragment in 1017)
1015		2 of 2	2190	348	1	dense slag with a dimpled surface at an acute angle to a contact between shiny dark flow lobes and sand (freshly broken)
				554	8	shale rich ceramic (Type 3 ceramic), pale grey, locally with grey slightly concave smooth surface,
				390	4	vitrified and slagged surfaces over sandy substrate (Type 1 ceramic), small pieces show oxidised firing, larger pieces ore reduced
				36	1	dark brecciated material
				106	1	gently curving vitrified slagged material over pale grey ceramic rich in small grey shale clasts (Type 3 ceramic)
				714	4	substantial slag accumulation (of varying density) on sandy substrate wall
				26	1	vitrified /slag layer over oxidised fired clay with shale fragments
				12	1	prill of flow slag
1015	8	2-4mm	6	6	assm	mixture of slag and stone. The slag appears mostly wall-related

1016	9	2-4mm	18	18	ass	dark material, mostly slag of various types.
1016	9		1255	82	143	slag spheroids
				748	162	flow slags
				150	113	rusty rough material
				118	26	larger pieces of indeterminate slag
				148	assm	fine indeterminate residue and dust
1016	9	fired clay	32	32	assm	all reduced fired except for one tiny flake, very fine clay, organic moulds (Type 4 ceramic)
1016	9	0.5 - 2 mm	16	16	assm	dark coloured granular residue, unclear if slag debris, black wall material etc. just a few grains of stone, a few slag spheroids
1017		bag 2 of 4	3745	868	1	curved dense slag block from below tuyère, 90mm tall, side curves in 45mm, chord 150mm. 70mm from one side may be base of tuyère, flow slags extend laterally from this, slag extends up to 60mm from rear, hollowed by probable fracture out of slag cake
				88	1	block made of fractured indurated wall? Black surfaces, oxidised in one corner - could this be mechanically fractured rather than stoped?
				294	1	block grading from reduced fired gravelly clay, through oxidised material into fractured black
				694	1	looks like lateral margin of rectangular tuyère bock in gravelly cermaic (Type 1 ceramic) with dense beard material attached to lower face
				588	1	block probably from same setting as 294g piece, top suggests rounded top to hearth wall?
				384	1	block of fragmented hearth ceramic and indurated material, purple lining below, then black fragmental, then skim of fresh sandy (Type 1 ceramic) lining (tuyère base?) on top
				322	1	block of black fragmental material, probably resting on less altered purple ceramic and containing a 40mm white vitrified pebble
				384	8	smaller fragments of the purple-black fragmental indurated ceramic
				18	1	grey shiny surfaced flow slag with fuel impressions
				18	1	grey/white fired clay with organic temper plus sand and gravel (Type 3 ceramic)
				42	1	extremely sandy greenish grey fired ceramic (Type 1 ceramic)
				34	1	vitrified and slagged oxidised hearth ceramic
				10	1	black slag with fractured white pebble
				4	1	prill of lining slag
1017		4 of 4		3125	1	large complex block of slagged furnace wall, looks as if material may have sloughed down over overhang possibly, curved failure towards base hints as possible tuyère location. Alternatively, the orientation may be other way up and the slagged surface lies below tuyère, 230 tall, chord 200mm, towards base 'slag' appears 100mm thick over ceramic contact. ceramic grey, pale, moderately sandy

1017		1 of	3645	3645	3	large blocks from furnace wall. Derive from an angle - an earlier more oblique angle appears covered in sand (Type 1 ceramic) to make a more right -angled structure
1017		3 of 4	3430	920	2	conjoining large blocks, fragmental black material capped by flow lobes of black glass
				268	4	fragments of dark material, some with glassy surfaces, associated with above
				596	1	dense rusty slag passing into prilly flow slag, overlying brown sand (Type 1 ceramic) - as seen material from bag 1
				206	1	open flow slag block
				558	1	gravelly grey ceramic passing into stone rich red material (Type 1 to Type 3?)
				66	1	gravelly grey ceramic (Type 1 ceramic) overlain by black vitrified surface
				124	1	complicated low-density block containing both fragmental material and a basal layer of flow lobes
				60	1	dull dark fragmental material
				214	1	grey-pink gravelly fired clay - external convex surface like margin of tuyère?
				32	1	buff-grey gravelly material - possibly broken from above
				376	3	complex pieces of variegated orange-white fired fine clay), passing to dark surface and dark fragmental slag. Fine clay is full of organic temper - large fragments of reeds maybe? (Type 4 ceramic
1018			1975	276	1	dense concave slag with maroon surface on strongly heat altered type 3 ceramic, convoluted banding, locally rich in gravel, some intrusive slag lobes
				316	6	Type 2 ceramic with a black slag/vitrified surface, surface appears vey irregular
				16	1	small scrap of flow slag with possible partial wood moulds
				798	16	Type 4 cermaic without surface slag/vitrification, grey/off white banded clay, dark flecks suggest organics, plenty of lithic inclusions, just one piece grades into oxidised fired on one face
				66	2	type 2 ceramic with tight curved surface (250mm diameter?) with black on surface - probably relict of original glass
				34	1	type 2 ceramic deeply vitrified or slagged to 35mm or so
				464	13	type 1 ceramic - pale kaolinitic sand/gravel, fired grey in places, mostly more friable
1019			46	46	1	flow slag prill
1023			62	62	1	amalgamated flow slag fragment - probably slightly worn
1028			300	300	1	flow slag chilled around large rounded wood fragment, 40mm radius
2008	2	0.5 – 2mm	6	6	assm	pale reddish brown sample, granules of a wide variety of stone, mostly brownish siltstone
2008	2	2 - 4mm	8	8	assm	mostly stone fragments, some of the stones are moderately iron rich

2008	2	fired clay	332			Includes possible 4-sided spike like piece
2009	3	fired clay	310	310	assm	fired clay, larger pieces mostly reduced fired, small fragments mostly oxidised fired
2009	3	0.5 - 2mm	4	4	assm	dark red brown material, mostly fine gravel, but plenty of fired clay
2009	3	2-4mm	4	4	assm	dark red brown, mostly stone

Table 2: residue types by context (excluding material in processed samples, except where indicated by 'y' = present in sieved sample)

c	furnace structure	lining/wall slag	burr	dense with iron	indeterminate slag	flow slag	sinter	slag spheroids	context notes
Area 1									
1001	884		614			154			topsoil?
1004	44					294			fill of p/h [1003]
1009		68	446			4525			fill of pit [1008]
1011	2670	254	1750			798			main fill of furnace [1010]
1015	4469	796		238	554	688	299	y	main fill of furnace [1014], brown silty clay
1016					266	143	150	82	basal fill of [1014]
1017	12112	138	1464			224			furnace lining of [1014]
1018	1954					16			furnace lining of [1010]
1019						46			secondary fill of [1014], charcoal rich
1023						62			upper fill of terrace
1028						300			upper fill of terrace
Area 2									
2008	332								fill of [2003]?
2009	310								fill of [2003]?

Table 3: residue types by context (excluding material in processed samples, except where indicated by 'y' = present in sieved sample). Contexts sorted by feature.

c	furnace structure	lining/wall slag	burr	dense with iron	indeterminate slag	flow slag	sinter	slag droplets	context notes
1001	884		614			154			topsoil?
1004	44					294			fill of p/h [1003]
1009		68	446			4525			fill of pit [1008]
1015	4469	796		238	554	688	299	y	main fill of furnace [1014], brown silty clay
1019						46			secondary fill of [1014], charcoal rich
1016					266	143	150	82	basal fill of [1014]
1017	12112	138	1464			224			furnace lining of [1014]
1011	2670	254	1750			798			main fill of furnace [1010]
1018	1954					16			furnace lining of [1010]
1023						62			upper fill of terrace
1028						300			upper fill of terrace

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