Forges. 4ème Section. Pl. IV. Refouler le Renard [i.e. Shingling the Loop], from D. Diderot et J. d'Alembert, *Encyclopédie Vol. 21* (Paris, 1765)

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FIELD NOTES

A bloomery in Bexhill, East Sussex

Substantial remains of a domed bloomery smelting furnace have been discovered by a team from Archaeology South-East during excavations in advance of industrial development north-east of Sidley. The site, at TQ 7443 0966, lies to the west of the A2691, Haven Brook Avenue, in a field on ground sloping down to a small stream, a tributary of the Combe Haven. The subsoil is Tunbridge Wells Sand, with Wadhurst Clay capping Ashdown Beds immediately to the east. An absence of tap slag suggests a non-tapping process. Blocks of sandstone were used to key the material of which the furnace was constructed into the sandy subsoil. This practice was also noted with the bloomery excavated in Little Furnace Wood, Mayfield.[1] Samples for dating have been taken.

Straker noted nearby bloomeries at Buckholt South (Little Henniker Wood) about 600m NNE of the site, and at Sidley.[2]

Possible Saxon iron slag in Crawley, West Sussex

An archaeological evaluation carried out by Wessex Archaeology in the grounds of Northgate Primary School, Green Lane, Crawley, in advance of a proposed extension to the school, revealed a single pit (TQ 2730 3749). Its contents included three pieces of 'very abraded, undiagnostic ironworking slag' and a fragment of roundwood charcoal from which a radiocarbon date of AD 670-865 was obtained.[3]

1. C. Butler, 'Excavation of a Romano-British Ironworking site at Little Furnace Wood, Mayfield', *Sussex Archaeological Collections*, forthcoming.

2. E. Straker, *Wealden Iron* (London, Bell, 1931), 357, 354.

3. Northgate Primary School, Crawley, West Sussex - Archaeological Evaluation (Wessex Archaeology, Unpublished Report 117610.04, 2018).

A MIDDLE IRON AGE BLOOMERY AND OTHER FEATURES AT HEARTENOAK ROAD, HAWKHURST, KENT

Simon Stevens

With contributions by

Lucy Allot, Luke Barber and Stephen Patton

INTRODUCTION

This article provides the results of a programme of archaeological work carried out by Archaeology South-East (ASE, UCL Institute of Archaeology) on a site on the Heartenoak Road, Hawkhurst, Kent (TQ 76356 30980; Fig. 1). The fieldwork was undertaken in advance of residential development, as a condition of planning, and was commissioned and funded by Millwood Designer Homes Ltd.

The site lies on the eastern side of Heartenoak Road, to the north of the centre of the Wealden village of Hawkhurst. An archaeological evaluation of the site undertaken in October 2019 revealed a limited range of archaeological features. Subsequently, an archaeological watching brief was maintained during the construction of a compound, and a subsequent strip, map and sample (area excavation) was carried out in January 2020 (Fig. 2).

Full details of the site including descriptions of all features and specialist reports on finds are available (Stevens 2019; 2020).

THE TOPOGRAPHIC AND GEOLOGICAL SETTING

The site lies in a rural location, with extensive views to the north. The land drops steeply away from Heartenoak Road into a deep stream valley to the east, part of a network of such valleys in the area.

According to the latest data available from the British Geological Survey, the underlying geology at the site consists of the siltstones and sandstones of

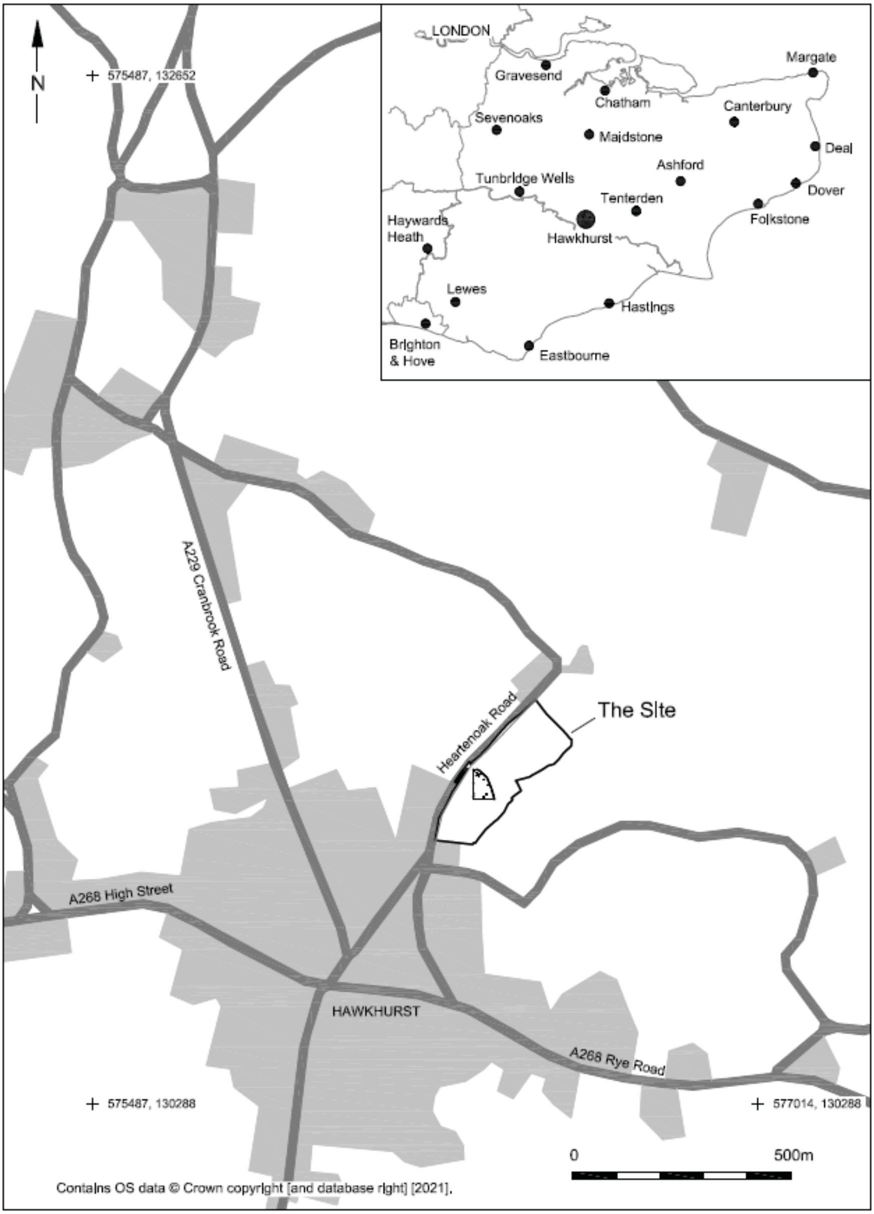


Figure 1: Site location

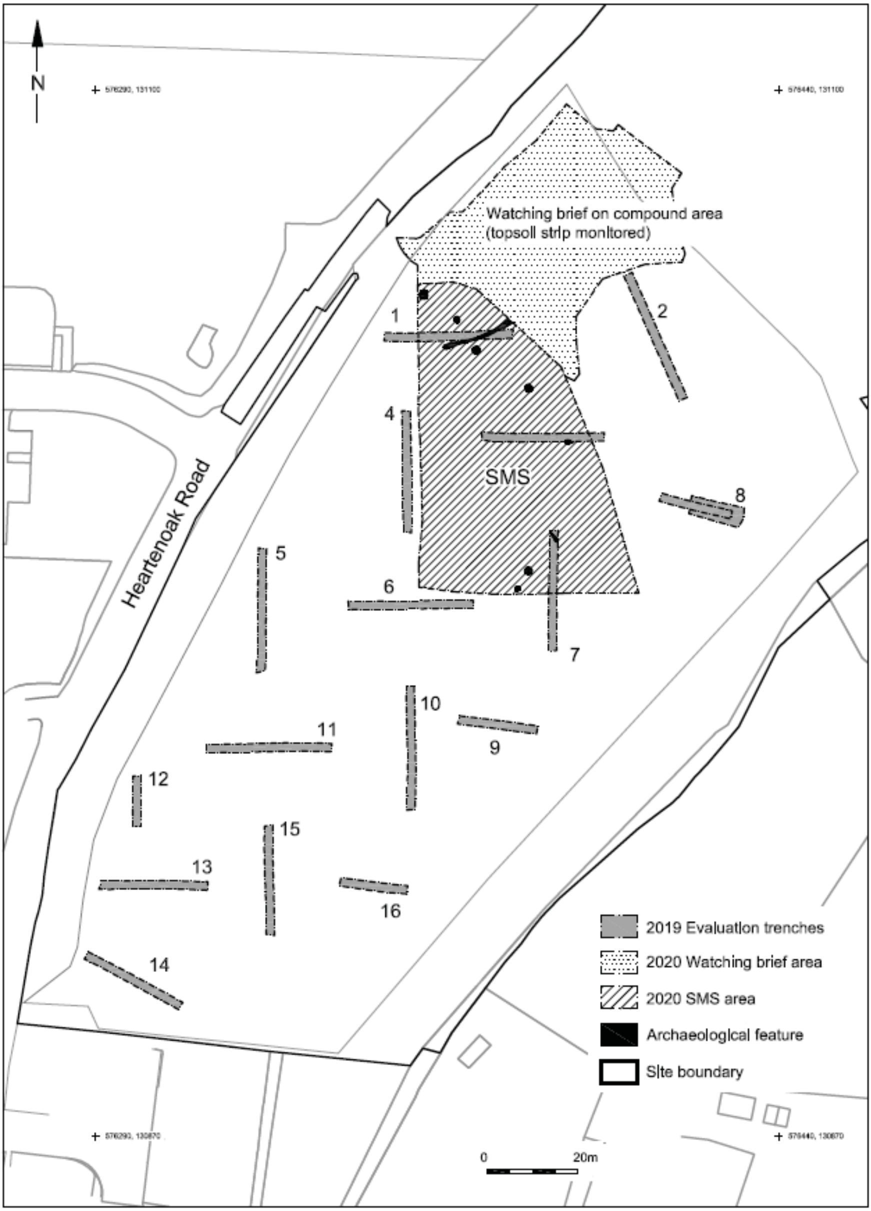


Figure 2: Site plan showing area of archaeological intervention

the Tunbridge Wells Sand formation. There are deposits of Wadhurst Clay in the vicinity. There are no recorded superficial deposits (BGS 2020).

RESULTS

Watching Brief

An archaeological watching brief was maintained during the establishment of the site compound. The area was not excavated deep enough to reach the surface of the underlying 'natural' Tunbridge Wells Sand and no archaeological deposits, features or finds were encountered.

The Strip, Map and Sample (Area Excavation)

Introduction

Following the mechanical removal of topsoil and subsoil, the surface of the underlying natural geology of Upper Tunbridge Wells Sand was exposed over a c.0.45ha area. A small assemblage of post-medieval material and a single prehistoric flint flake were recovered from the topsoil.

This geology varied from brownish yellow to brownish orange, with areas of clay, sandy clay and occasional outcrops of sandstone especially up the valley sides towards the Heartenoak Road street frontage. Similarly, in the highest, south-western, corner of the site there was an outcrop of siderite (iron ore).

The Bloomery Furnace

The most archaeologically significant deposits were the remains of an iron-producing bloomery furnace, context [103]. This feature was partly exposed in evaluation Trench 3, where it was recorded as pit [3/004] (Figs. 3 and 4). On full exposure it became obvious that the feature was not in fact a pit, but the remains of a bloomery furnace. It had apparently been truncated by ploughing.

Bloomery furnaces are usually relatively simple, broadly cylindrical clay structures, with an opening to place iron ore and charcoal into the chamber. One or more holes in the walls are made to pump air into the furnace using bellows to heat the furnace to a temperature in the region of 1,000°C. Metal created in this process could then be extracted, leaving a 'bloom' or cake

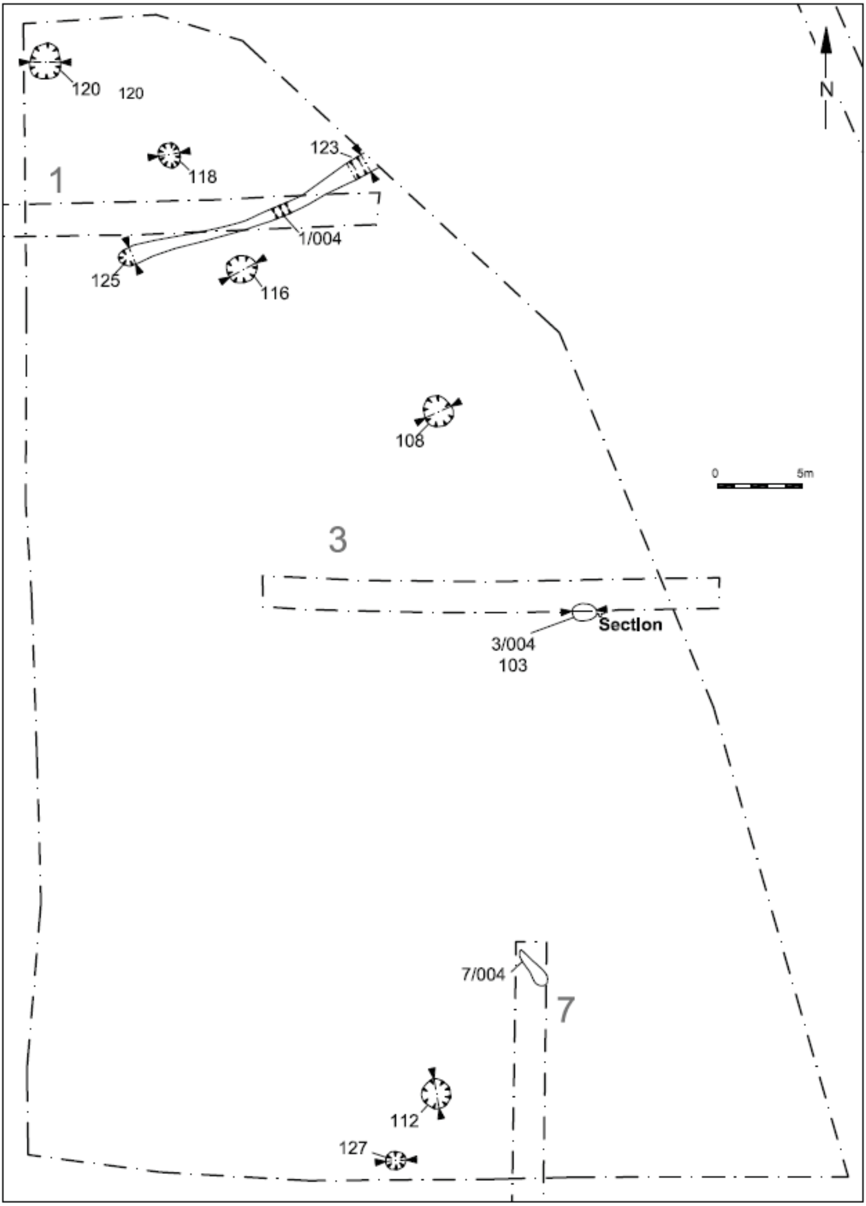
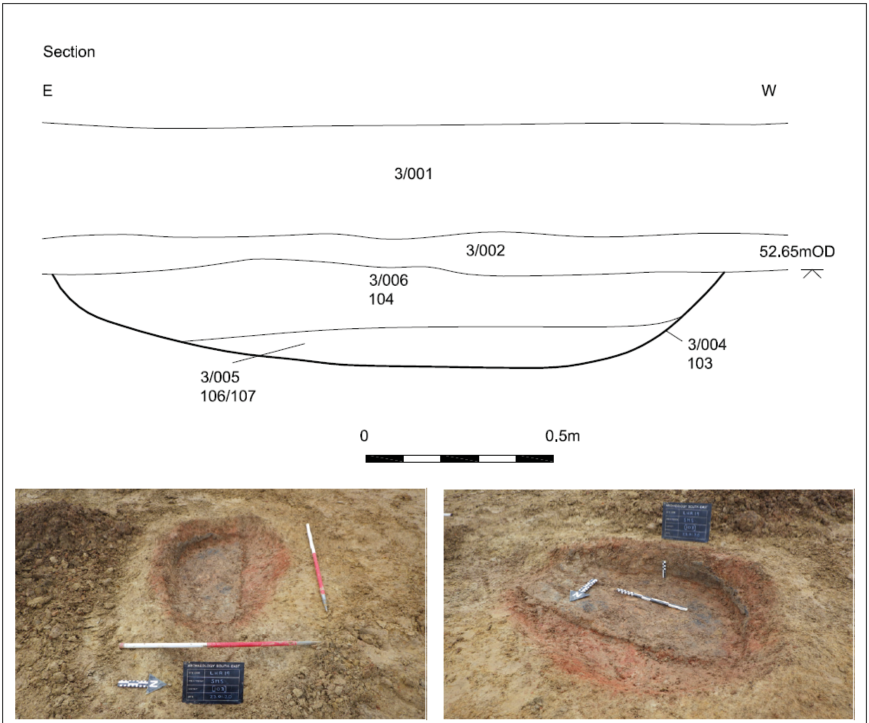


Figure 3: Site plan showing all features



Furnace [103] looking west

Furnace [103] looking south-east

Figure 4: The Middle Iron Age furnace

of iron, with molten or semi-molten slag as a waste product (Cleere and Crossley 1995, 43–7).

Hand excavation of the surviving remains of the furnace revealed an elongated construction cut [3/004]/[103] measuring 1.37m long by 0.98m wide by a maximum depth of 0.22m (Fig. 4). This 'elongated bowl' shape is characteristic of other known examples of early Wealden bloomery furnaces (Hodgkinson 2008, 24).

The clay lining of the furnace, context [106], was only 0.06m thick at its thickest point and only survived to a height of 0.15m on the southern side, and partially up the western side of the cut. The intense heat of the furnace caused the surviving clay lining to be very friable in texture and also created a 0.09m wide 'halo' of baked natural sandy clay around the furnace, recorded as context [107].

It seems likely that the lowest fill (evaluation context [3/005]) shown in section (Fig. 4) equates to the furnace lining [106] and some of the burnt halo [107].

The furnace was apparently backfilled at some point with material mostly made up of elements of the upper superstructure of the furnace and slag, set in an orangey-brown silty-clay matrix, context [104]/[3/006]. An environmental sample from this contained a small quantity of cherry/blackthorn charcoal in addition to fired clay from the collapsed superstructure, and slag.

A small 'pocket' of charcoal-rich, mid-grey silty clay, context [105] (not illustrated), survived in the south-western quadrant of the feature. This might represent an in-situ deposit from the last use of the furnace, and was retained in its entirety as an environmental sample. It was made up of oak, alder and hazel charcoal with fired clay and slag.

Two pieces of hazel/alder charcoal from taken from context [105], environmental sample <4> were submitted for C14 dating. They returned Middle Iron Age dates of 328–204 cal. BC at 74.6% probability (Beta-562121) and 361–177 cal. BC at 95.4% probability (Beta-562122).

The Pits

A group of six pits, all remarkably similar in shape, size and form were encountered, along with one more elongated feature (Fig. 3). The six pits were sub-circular in plan and varied in diameter between 1.21m and 1.73m. All were noticeably shallow and flat-bottomed with a maximum depth of only 0.20m, suggesting that substantial truncation had taken place – most likely from agricultural activity. All of the pits were fully excavated, but none produced any datable artefactual evidence, although the majority contained oak charcoal, some with some quantities of magnetic material, not thought to be associated with the iron industry. None of the charcoal proved suitable for C14 dating.

The Gully

A shallow gully initially encountered in evaluation Trench 1 was found to continue a short way across the stripped area and to continue beyond the northern limits of the excavation area (Fig. 3). No datable artefacts were recovered from the gully.

RELEVANT FINDS

FIRED CLAY by Stephen Patton

The fired clay assemblage consisted entirely of fragments from the bloomery feature. The total recovered is 24,675g. Fragments of fired clay in the backfill have wattle impressions visible indicating that the bloomery was constructed as a wattle and daub clay structure, and parts of the lining were covered in a very thin, dark-green/black glassy layer of slag. The C14 dating of the bloomery to the Middle Iron Age means that this fired clay structure is relatively rare and provides a unique research opportunity.

The fragments were examined with the naked eye for diagnostic characteristics indicating form and/or function and recorded on pro-forma archive sheets. Fabrics were identified using a x20 magnification binocular microscope. Only one fabric was identified: a fine silty clay with very rare argillaceous inclusions. Some fragments also contained small ferrous inclusions, but these were not typical of the fabric.

Whilst the fired clay is from one structure, contexts were assigned to the lining material [106] and the backfilled material [3/006], [104] and [105]. It should be noted that the fired clay from the three backfill contexts are essentially the same in that they are parts of the structure that has been included in the fill of the pit. Table 1 shows the fired clay quantification by context.

Context	Description	Count	Weight (g)
104		206	5604
	Fragments with glassy slag surface	10	1095
	As above but without glassy slag surface	196	4509
105	Charcoal rich sample	24	40
106	Clay lining of furnace	90	8127
3/006	Upper fill of pit 3/004 (actually furnace)	250	10,904
Total		**570**	**24,675**

Table 1: Quantification of fired clay by context

Form

The oval shape of the Hawkhurst bloomery pit indicates that the bloomery would probably have been a domed furnace as outlined by Cleere and Crossley (1995, 41), and similar to the later Iron Age furnace identified under 20 miles away at Minepit Wood (Money 1974). A number of pieces of fired clay from [104] have flat sides, two joining flat sides or wattle impressions suggesting that the bloomery was constructed as a wattle structure which then had clay pressed over. The wood would then burn away leaving a ceramic structure. All of the fragments in the assemblage are oxidised, and the pieces with the thin layer of slag on have been heated beyond the temperature required for the ceramic change resulting in them being very hard and externally oxidised to a rich red orange colour. The clay lining of the pit [106] and the more intact wall fragments [104] indicate that the base and wall thickness was between 40mm and 50mm.

Of particular note is a large fragment with the remains of a curved opening. This hole has been identified by Hodgkinson (pers. comm.) as being too wide for a tuyere through which air would have been pushed into the bloomery and is instead most likely part of the tapping arch. Around this arch are extraneous lumps of clay which could potentially be the remains of packing from when the opening was sealed during smelting, but this interpretation remains somewhat speculative (J. Hodgkinson pers. comm.).

Hodgkinson (2008, 23) refers to bloomeries as 'sandy-clay structure(s)' and Paynter (2006, 285) states that most Iron Age and Romano-British bloomeries were made from quartz rich clays. It has been noted that very high sand proportions work well during modern experimental smelting (10% clay / 90% sand) (J. Hodgkinson pers. comm.), but Beswick (2003) describes the fabric of a first century AD bloomery as being 'a creamy-white clay free from inclusions'. However, in the context of his discussion this lack of inclusions could refer to a lack of grog or other temper being used rather than the clay necessarily being free from sand.

Dr T. Young (pers. comm.) has considered this issue and suggests that it is most likely that bloomery fabrics are silica rich due to silceous clays being selected rather than quartz being added as temper. It has been noted in some Roman period bloomeries that there was evidence of recycled clay being used within the fabric, but this does not necessarily mean this was exclusive to historical smelting rather than prehistoric too (T. Young pers. comm.). It appears then that the knowledge of local clays and selection of appropriate material rather than tempering with sand was important when constructing prehistoric bloomeries.

Closer analysis of the clay fabrics of bloomeries would therefore be an area for further research as more sites are discovered; currently this is a lacuna and whilst it does not appear that there are time period specific choices a larger data set would provide firmer evidence one way or the other.

METALLURGICAL REMAINS/MAGNETIC MATERIAL by Luke Barber

A moderate-sized assemblage of slag was recovered from the site during the evaluation (2,508g) and subsequent excavations (7,508g). The combined total includes 78 pieces of slag collected by hand on site, with the remainder being recovered from the residues from seven environmental samples. The latter was carefully scanned at x10 magnification to establish the presence/absence of micro slags. Due to the small size of most of the residue material it was recorded by weight alone. The assemblage is fully listed in Table 2.

Although all the slag from the furnace relates to iron working much of it is not diagnostic of actual process. However, the tap slag from contexts [3/005]/[104] and [105] is diagnostic of smelting iron using the bloomery process and it is almost certain that the whole slag assemblage relates to this, with the notable exception of the material from the topsoil (see below). None of the magnetic fractions from the environmental residues contained hammerscale from smithing – only magnetic fines composed of burnt/magnetised clay and stones that could easily be formed through any high temperature process. The quantities of slag involved are small so all could derive from a single smelt by the excavated bloomery furnace.

Although it is impossible to intrinsically date bloomery slag with any certainty beyond the Iron Age to medieval period the current tap slag exhibits a partial viscous flow suggesting that much of the waste was not hot enough to flow in true 'liquid' form. This is more a trait of pre-Roman slags and would be very much in keeping with the Mid Iron Age date obtained from the current furnace. Similarly, viscous slags were noted at the roughly contemporary bloomery recently excavated at Haywards Heath (Barber 2020). The fact that the slag contains a number of plano-convex-sectioned runnels free of adhering undiagnostic slag suggest these flowed out of the furnace rather than being formed inside it. This would indicate deliberate tapping of the furnace though the nature of the slag would have rendered this process a little haphazard and not particularly effective at drawing off the majority of the slag.

The slag from the topsoil is all from smelting of iron using the blast furnace, a process introduced at the very end of the 15th century. As such, this material can broadly be dated to the 16th to early 18th centuries – the period when the blast furnace was in common use in the Weald. Such slag was frequently re-used, both at the time and as late as the early 20th century, for road/track metalling and was transported away from the actual production sites accordingly. It is a common find across the whole Weald. The remaining magnetic fractions from other contexts produced solely magnetic fines and no true slag.

Context	**Fraction**	**Type**	**No**	**Weight (g)**	**Comments**
3/005		Tap slag (iron smelting)	14	976	Dark grey, dense, with slight aeration. Viscous, semi-flow including runnels.* x4 retained
3/005		Undiagnostic iron slag	3	214	As the tap slag but no signs of 'flow' – irregular. * x1 retained
3/005		Tapping pit/furnace base	1	1026	Dense mid/dark grey, slightly aerated slag mass fragment of plano-convex form with adhering grey burnt silt clay on convex/basal surface. * x1 retained
3/006	>2mm	Undiagnostic iron slag		240	X14 pieces
3/006	>2mm	Furnace lining		14	X1 burnt orange silt clay fragment with adhering undiagnostic iron slag
3/006	Magnetic	Magnetic fines		38	Burnt clay and sandstone granules only

Context	Fraction	Type	No	Weight (g)	Comments
100		Blast furnace slag	41	1503	Light to dark grey/green-grey. Worn
104		Tap slag (iron smelting)	4	489	Many runnels as [3/005]. * x1 retained
104		Undiagnostic iron slag	12	1494	Very irregular with slight flow. As [3/005]. * x1 retained
104		Tapping pit/furnace base	2	1911	As [3/005]. Irregular, dense rusty with adhering grey silt clay lining. * x1 retained
104		Hearth lining	1	78	Vitrified flat face. * x1 retained
104	>2mm	Undiagnostic iron slag		551	x20+, to 80mm across
104	>2mm	Tap slag (iron smelting)		81	x8 small runnels
104	>2mm	Undiagnostic iron slag		403	Slightly lighter weight - more mixed with clay. Irregular
104	Magnetic	Magnetic fines		261	Mostly irregular burnt clay and ferruginous stone granules. Occasional undiagnostic iron slag but no hammerscale
105	>2mm	Undiagnostic iron slag		339	x20+, to 65mm. Quite dense
105	>2mm	Tap slag (iron smelting)		273	x14 runnels
105	>2mm	Undiagnostic iron slag		42	Lighter weight than most
105	Magnetic	Magnetic fines		31	No slag

Table 2: Quantification of the slag assemblage associated with the furnace

CHARCOAL by Lucy Allot

Although charcoal assemblages from the furnace were small they provided an opportunity to date iron smelting activities at the site, as well as to identify the species used.

Oak fragments are prevalent in each of the deposits when both fragment count and weight are taken into consideration and oak appears to have been favoured as fuel with only limited evidence for the use of other taxa. Oak fragments displayed both tight and wide-spaced growth rings suggesting wood deriving from a mixture of both slow and quicker grown specimens which implies the use of wood from different parts of the tree.

Large quantities of fuel would have been required in the smelting process and it is likely that much of the fuel was sourced locally, probably from the immediate surrounding woodland which may have been managed to some extent to maintain this supply. The availability of both wood and ore resources played an important role in determining the location of smelting industries (Edlin 1973), and oak is therefore likely to have been a prominent component of the Weald at this time. Assemblages from Birchen Lane, Haywards Heath (Adams 2020) reveal similar assemblages associated with furnace pits in which oak wood predominates. There is also some evidence for hazel and cherry/blackthorn at Hawkhurst which could have grown in the understorey, at woodland margins or in hedgerows, while lime is also a woodland tree that thrives on rich soils. These trees do not appear to have played a prominent role in contributing fuel. However, they may have been incorporated with the oak fuel, collected as kindling or have served another unknown purpose at the site.

DISCUSSION

The Bloomery Furnace - a rare discovery

The remains of the bloomery furnace lie in a geographical and geological position that offers highly favourable conditions for ironworking. Siderite (iron ore) outcrops on the hillside above the furnace, which lies on the slope above a stream, offering a place to tip the inevitable build-up of slag, and providing a source of water, which although not vital to the actual bloomery process, was necessary for the construction and potential repair of the furnace, and would have undoubtedly been welcome to the ironworkers, not least for drinking (cf. Hodgkinson 2008, 32).

Furnaces of this general type were in operation across the Weald from the 1st millennium BC through to the late medieval period (Hodgkinson 2008, 23). Despite the poor preservation of the actual furnace structure, the C14 dating provides clear evidence that the Hawkhurst furnace was in operation in the Middle Iron Age, significant not only because of this relatively early date, but owing to the fact that it is accepted that 'it is rare that industrial remains are closely dated' at all (Paynter 2007, 202). Only 29% of over 600 known possible bloomery sites had been positively dated in the last published survey (Hodgkinson 2008, 27), mostly from pottery recovered from associated slag heaps, which were not encountered in the excavated area at Hawkhurst, probably owing to tipping of the material into the deep valley to the east.

A bloomery furnace which provided remarkably contemporary Middle Iron Age C14 dates to that at Hawkhurst has recently been excavated at Birchen Lane, Haywards Heath, West Sussex (Sheehan 2020). Dates for material apparently raked from the furnace provided dates of 370–180 cal. BC and 380–200 cal. BC (both at 95% probability). The Hawkhurst dates were 328–204 cal. BC at 74.6% probability and 361–177 cal. BC at 95.4% probability

Although furnaces positively dated to the period remain comparatively rare, there is a thin scatter of probable Middle Iron Age sites across the Weald listed by Sheehan (2020), such as at Tablehurst Farm, Forest Row, East Sussex (Hodgkinson 2004, 28) or at Rathlin Road, Crawley, West Sussex (Pine 2013), both based on C14 dates from furnaces. In addition, a site near Hartfield, East Sussex has been dated to the Middle/Late Iron Age from pottery finds associated with ironworking slag (Stevens 2013), but such sites lack the tight date ranges of both Birchen Lane and the current site. Single C14 dates for sites at Brokes Wood, Southborough, Kent (Hodgkinson 2015) and at Cullinghurst Wood, Hartfield, East Sussex (Hodgkinson 2008, 28) suggest Middle Iron Age dates, but both sites await full investigation and publication.

The excavated evidence from the backfill of the Hawkhurst furnace shows it was of a type which was designed to be 'tapped' (i.e. there was provision for the molten slag to be run out of an aperture in the furnace wall rather than being collected in a pit below the structure or left in the furnace). The presence of the resultant characteristic 'wormlike' tap slag in the furnaces backfill is clearly indicative of this technique (Hodgkinson 2008, 26), at one time thought to be the only method in use in the Weald during the Iron Age (Cleere and Crossley 1995, 39). This technique stands in stark contrast to that in use at the Birchen Lane furnace, which the excavator considered to have been the non-slag-tapping type (Sheehan 2020, 25).

As is usually the case, the 'front' of the furnace (facing downslope eastwards into the river valley) had not survived, usually explained as damage from extraction of the iron bloom and/or weakening by holes for tapping or from the holes used to blow air into the furnace (Hodgkinson 2008, 24). A possible fragment of the collapsed tapping arch was recovered, although this identification should be handled with care (J. Hodgkinson, pers. comm.).

Given the paucity of previously excavated remains of bloomery furnaces in the Weald, in general 'reconstructing their likely form and mode of operation is very difficult' (Paynter 2007, 202), especially with the usual 'poor survival of the upper parts of the furnace structure' (Hodgkinson 2008, 24), and this is certainly the case at the current site. Beyond the fact that the furnace was designed to be tapped, little can be said about the superstructure of the Hawkhurst example, except that it was broadly oval in plan, and arguably similar to the Cleere and Crossley's later 'domed' type (1995, 41).

Examples of excavated bloomery furnaces with a broadly similar shape in plan to Hawkhurst include those at Minepit Wood, Rotherfield and Little Furnace Wood, Mayfield, the latter excavated by the Wealden Iron Research Group, in East Sussex (Hodgkinson 2008, colour plates 5 and 6). The latter has been dated to the Late Iron Age/Roman period, while the former is thought to be more firmly Roman in date (*ibid.*). Another oval Romano-British example from Pippingford, East Sussex, where 'the reddened nature of the clay around the pit and its hard-burned base' was noted (Tebbutt and Cleere 1973, 33) sounds remarkably similar in character to the Hawkhurst furnace. This suggests some longevity/conservatism in bloomery form given the date of the Hawkhurst furnace, although the example of the non-slag-tapping furnace at Birchen Lane hints at a more complex picture.

A Scatter of Associated Pits?

The thin scatter of shallow pits across the site, all virtually circular, with one exception (elongated pit [7/004]; Fig. 3) are presumed to be contemporary with the furnace, given the paucity of other features of different periods, and the presence of charcoal and limited quantities of possible roasted ore in some of their fills.

However, their function, or functions remain unclear. The absence of *in situ* burning strongly suggests the features were not used for the roasting of ore, a pre-smelting process which alters the chemical composition of the material, drives off water, and breaks it into more manageable pieces (Hodgkinson 2008, 15–17). Similarly, they do not appear to be minepits for the extraction of siderite iron ore, as this would be unnecessary given surface exposures of this mineral at the site.

A Field Boundary

The gully originally encountered in evaluation Trench 1 remains undated from artefactual evidence, but appears to be agricultural in origin, arguably marking the edge of a field or enclosure adjacent to Heartenoak Road. It is tentatively dated to the medieval or post-medieval period, given this possible arrangement, but this is far from certain.

The Topsoil

An interesting collection of post-medieval material was recovered from the overburden at the site including pottery, brick and tile, clay tobacco pipe, glass and a small quantity of blast furnace slag. A single prehistoric flint flake was also recovered from the topsoil.

Mostly a dump of domestic material arguably from a nearby property, it shows the quality of material, including imported pottery, available in this part of the Weald in the 17th and 18th centuries. Broadly contemporary blast furnace slag also recovered from the field is not in itself indicative of the location of a blast furnace in the vicinity, given the notorious mobility of this material across the Weald (Cleere and Crossley 1995, 175).

CONCLUSION

Archaeological work at the site to the east of Heartenoak Road uncovered a limited range of plough-truncated archaeological deposits, the most significant of which was the remains of an iron producing bloomery furnace, dated to the Middle Iron Age from samples submitted for C14 dating. Other features included a scatter of shallow pits and a probable boundary ditch.

The former locations of bloomery furnaces are usually only detected from the identification of associated heaps of slag, which are usually undatable, and the excavation and dating of a furnace is a rarity, with those of Middle Iron Age date even rarer (Hodgkinson 2008, 27). Clearly this makes comparisons with other closely contemporary Wealden sites difficult, with only Birchen Lane, arguably a quite different furnace/site fully published in detail (Sheehan 2020). This offers little scope for placing the current site in context with other local or Wealden sites, especially in regard to the scatter of pits, presumed contemporary to the furnace, but still somewhat enigmatic.

Sheehan (2020) looked further afield for parallels for the non-tapping Birchen Lane furnace, but the technique of tapping the slag indicative at the current site places it firmly in the 'traditional' Wealden class of furnaces (Cleere and Crossley 1995, 39). Further sites will need to be investigated to prove if the long-accepted, and arguably somewhat parochial model of Wealden iron exploitation needs amendment, and to possibly offer some explanation for the other features at the current. site, more clearly proving (or disproving) their association with the furnace.

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A ROMANO-BRITISH IRONWORKING SITE AT THORP'S WOOD, SEDLESCOMBE, EAST SUSSEX

Chris Butler & Dr Caroline Russell

The site is situated at the south-east end of Thorp's Wood at Brede High Woods, and is centred on TQ 7839 2016 (Fig. 1). The site was initially found by members of WIRG who surveyed the area in March 2009,[1] and was excavated as part of a community archaeology project commissioned by the Woodland Trust and directed by Chris Butler Archaeological Services Ltd.

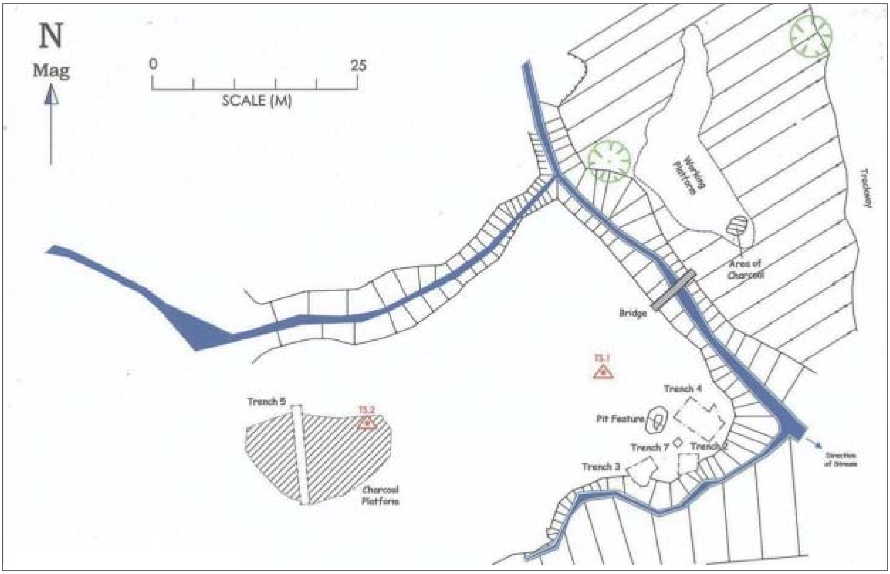

Figure 1: Location and site plan

The Powdermill Stream at this point runs through an increasingly steep-sided gill. Slag began to be found in the stream from TQ 7847 2011 and at TQ

1. J. Prus, 'A bloomery site in Brede, East Sussex', *Wealden Iron*, 2nd ser., **28** (2008), 7.

7839 2014, at the junction with a side stream. Most of the area is underlain by Ashdown Beds, but in Thorp's Wood there is an intrusion of Wadhurst Clay associated with faulting, the line of which is assumed. This bed crosses the line of Powdermill Stream in a narrow east-west band. Iron ore used in the iron making process derives from these outcrops of Wadhurst Clay, so the presence of an iron working site adjacent to an outcrop of Wadhurst Clay and a stream is not unexpected.

Initially five 1m-square test pits were excavated over two days in March 2012 to investigate hotspots identified by an initial magnetometry survey carried out by David Staveley. The test pits encountered a shallow topsoil c.120mm deep over the site. Below this was a much darker grey-black sandy clay with pieces of iron slag, and then below this was a more compact layer of dark soil with large quantities of iron slag and burnt clay, which were interpreted as being either parts of in-situ furnaces or the slag heap. We then returned to the site for 18 days between the 8th April and 3rd May 2013 for a more detailed investigation, excavating three trenches (Trenches 2 - 4). Two furnaces and a linear cut were excavated in Trench 4 whilst Trenches 2 and 3 each contained the slag heap.

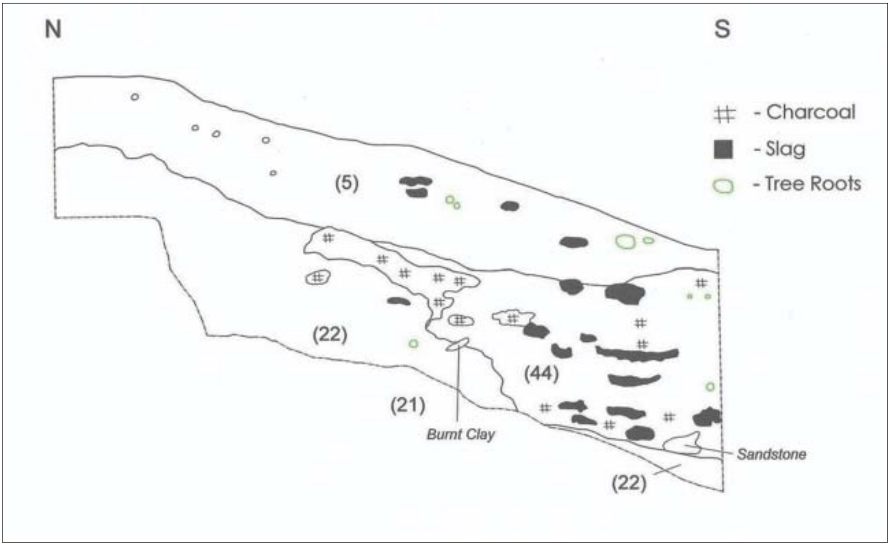

Figure 2: Section through the slag heap in Trench 2

In Trench 2 the stratigraphy comprised a topsoil and subsoil above a 530mm thick deposit of dark black or brown silty clay with quantities of slag, resting over the natural (Fig. 2). This deposit of burnt material is the slag heap, which had been dumped downslope from the furnaces and had slipped down towards the stream. Some of the more embedded slag, including what may have been half a slag furnace bottom formed an arc that rested partly up against the upper slope of the bank.

Trench 3 had a thin humic layer overlaying a topsoil which contained some slag pieces. A dump of ironworking debris ran downhill beneath the topsoil to form the slagheap. It was not seen in the east end of the trench, where the topsoil overlay the natural. The dump was a dark brown silty clay with charcoal flecks, slag and burnt clay and sandstone. Rooting disturbed all layers in the trench.

The remains of two ironworking furnaces were discovered in Trench 4 (Figs. 3 & 4). Both Furnace 1 (upslope) and Furnace 2 (downslope) were cut into the natural slope. Furnace 1 was horseshoe shaped, as may have been Furnace 2, with the straight side facing south in both instances.

Figure 3: Furnaces 1 and 2

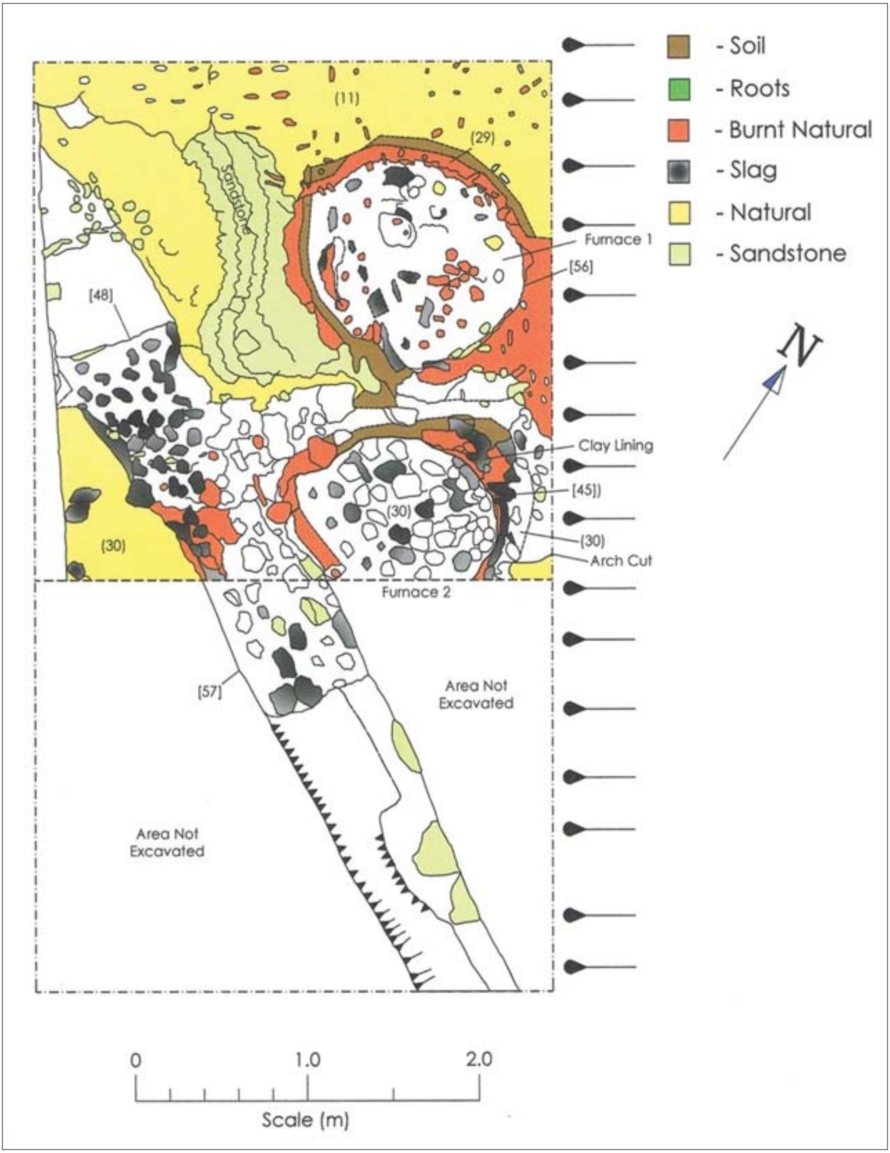

Figure 4: Plan of furnaces and gulley

Furnace 1 had a north - south diameter of 1.13m. The flat base sloped slightly down to the southwest, towards the sloping outcrop of sandstone. It was not apparently lined and showed burning in places. Use of the furnace had also burnt the surrounding natural to form a halo of mid pink red clay, 70mm - 160mm wide, around the sides of the cut. A 30mm thick piece of mid blue grey clay 'lining' survived in-situ up against the east end of the straight south side, for a length of 150mm. The only other possible fragment of 'lining' sloped down into the furnace, towards the west end of the same side.

Slag and pieces of burnt clay / furnace lining rested over the top of Furnace 1. The underlying deposit was the central fill of the furnace and comprised a dark brown clayey silt with frequent slag, 90mm thick. It rested above the basal fill and against the slag and burnt clay / furnace lining fragments. Five notably large pieces of slag were also found. The furnace was seen to contain slag and some small pieces of burnt clay in a dark brown soil, 90mm thick, and an inner layer of fragmented pink clay 'lining' with less slag. The basal fill of Furnace 1 was a dark black-brown clayey silt. This fill in the upslope half of the furnace contained abundant tap slag and was darker than that in the downslope half as it contained more charcoal. The slag in the lower half was less tap-like and lumpier.

Furnace 2 had 80-90mm of its southeast side clipped by the opening of Test Pit 4. It had a diameter of 1.12m southwest to northeast. The sides tapered down in height from 260mm at the north to virtually nothing at the south. As with Furnace 1 the base of Furnace 2 dipped slightly, slanting southeast towards a linear cut. Firing had baked hard the sides and base of the furnace. The base was baked to a depth of 20mm. It was unclear as to whether the blackened mid-grey sides and base comprised the baked natural of the cut or an added lining; no built-up layering was observed. Baked lining lay flat over the mid red-pink halo to the north of the furnace. The halo surrounding Furnace 2 was 190mm wide and met up with the halo around Furnace 1.

The upper fill of Furnace 2 was *c.*250mm thick, containing abundant slag and frequent burnt clay but sparse charcoal flecks. The burnt clay was a blue-grey colour, perhaps indicating furnace lining. This fill rested over a red layer of burning and burnt clay. In the downslope half of the furnace was a mid red-brown soil of fine silt-like composition, up to 70mm deep. It contained no slag or charcoal and was possibly contemporary with a mid-brown and orange-brown silt below it which had frequent burnt orange, but largely blue-grey, clay, occasional charcoal pieces and sparse slag. These were above a 65mm thick basal layer of charcoal, which in one place became a mid slightly black, orange-brown silty clay. A concentration of tap slag was found in the downslope half of the furnace.

A linear cut in the natural was exposed beneath the topsoil, running west - east through Trench 4, to the south of the two furnaces. The feature looked to be curving away to the southwest at the top northwest end of Trench 4. The cut was 620mm wide and 180m deep. It had a gentle sloping shelf on its north side, leading to a rounded base. The fill was a compact mid yellow-brown, dark brown and dark black-brown clayey silt containing abundant slag and frequent burnt red and blue grey clay. The slag pieces were often large, up to 220mm x 160mm x 130mm.

To the east of Furnaces 1 and 2, a section was exposed showing intense burning just beyond the northeast edge of Trench 4, where the ground fell steeply away to the stream. This small area, under 1.51m x 1.07m, was investigated to see if a third furnace was sited here, however it could not be fully excavated as a tree stump stood within it, hampering an understanding of this area.

Discussion

Unfortunately neither furnace survived to any great height, with all of the dome and chimney structure missing. The structure of the furnace above ground level had been removed, probably due to purposeful destruction when they went out of use. No true clay lining survived in-situ in either furnace because they had been cut into the natural clay of the hill slope and therefore had no need of lining here, with just the floor of each furnace surviving.

There is therefore little of the structure surviving to be able to determine the original form and size of the furnaces. It is assumed that the entrances were situated on the south side, and rather than having been caused by subsidence, the slightly angled base in each furnace may have been intentional to aid run-off. The base of Furnace 2 sloped down towards the ditch feature, thereby ensuring the site was drained, and keeping water away from the furnaces, and also aiding the disposal of ironworking debris downhill, away from the furnaces.

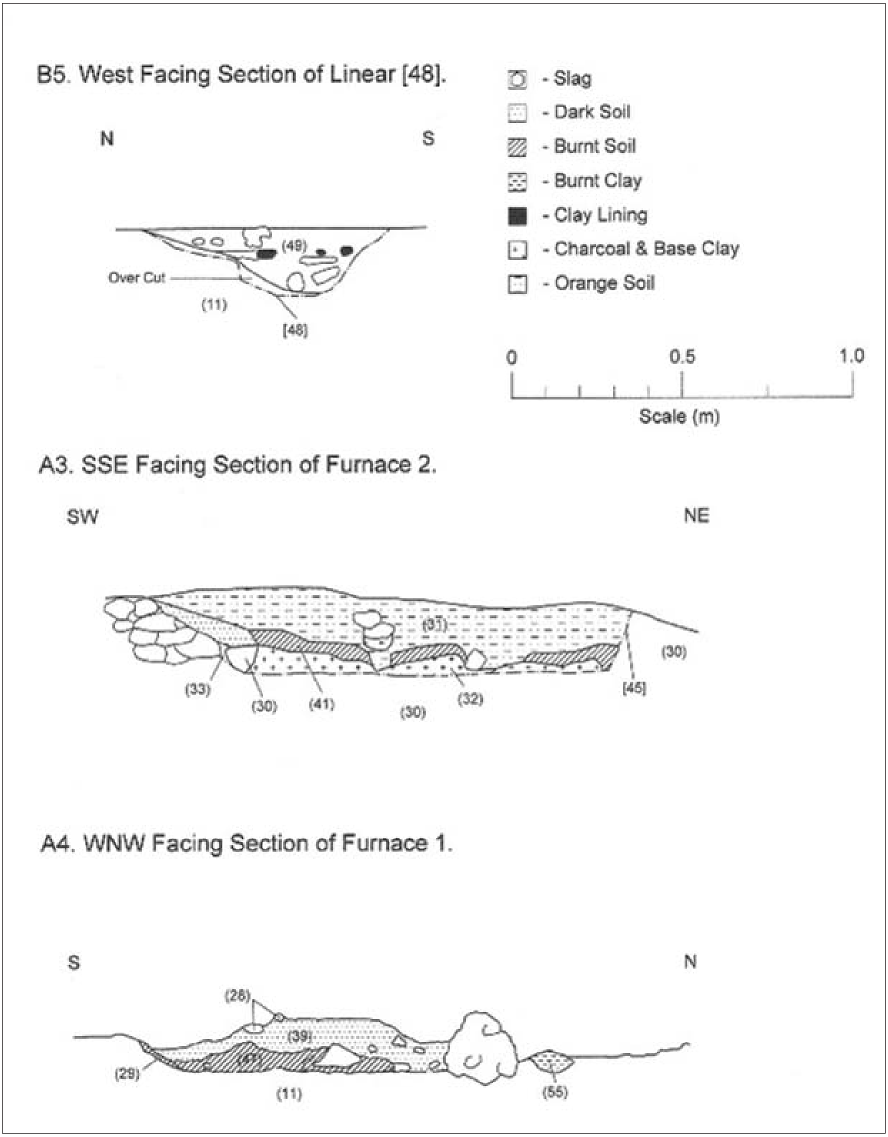

Figure 5: Sections through furnaces and gulley

The stratigraphic relationship between the two furnaces cannot unfortunately be determined, as they are both discrete features. Unlike the charcoal basal layer in Furnace 2, the fills in Furnace 1 do not appear to have derived from use. The relationship between the furnaces and the ditch was difficult to determine, however the gulley does appear to cut Furnace 2 so probably postdates it.

It is possible that the furnaces were contemporary with each other, but it seems more likely that Furnace 2 is the earlier, and went out of use first. It was reduced to ground level and the ground over and around it built up to provide a working area for Furnace 1, hence the better preservation of Furnace 2. The gulley appears to be contemporary with Furnace 1 and later than Furnace 2, and was probably dug to provide drainage.

No other evidence for furnaces was found during the excavation, with the geophysics hotspots downslope at the south end of the site probably picking up the slag heap which included the large piece of slag furnace bottom. The site is therefore quite small and probably worked out the immediate source of iron ore before being abandoned after a short period of use.

The slag waste is consistent with iron production in one or more bloomery smelting furnaces which are unlikely to have had the facility for slag tapping, although what appears to be tap slag was present, and is likely to be slag running free of the furnace, perhaps when the bloom was being removed. The charcoal recovered suggests that oak, alder and sweet chestnut was being used for fuel.

The only definite dating evidence from the site comes in the form of three sherds of pottery which can broadly be dated to the Late Iron Age to early Romano-British period. The ironworking evidence, together with the small-scale production taking place, also suggests a potential Late Iron Age date for this site, making it one of a handful of ironworking sites of this period in the Sussex Weald. A Roman coin of the Emperor Valens *c.*AD 364-378 was found a short distance upstream of the ironworking site, but clearly relates to much later activity.

Acknowledgements

We would like to thank Dave Bonsall of the Woodland Trust for arranging the excavation which was part of a much larger community archaeology project at Brede High Woods, and the Heritage Lottery Fund which funded

the project through its 'Your Heritage' scheme.[2] David Staveley carried out a magnetometer survey. Jeremy Hodgkinson provided advice and reported on the slag. Luke Barber reported on the pottery, Dana Challinor reported on the charcoal, and the illustrations were prepared by Andy Bradshaw. We would also like to thank all the volunteers who worked on the excavation.

2. C. Butler, C. Russell, A. Bradshaw and V. Blandford, An Archaeological Research and Community Project at Brede High Woods, East Sussex, unpublished Research Report CBAS0244, Chris Butler Archaeological Services, 2014.

PURCHASES OF SUSSEX IRON FOR RIEVAULX FORGE, YORKSHIRE

J. S. Hodgkinson

A collection of extracts from household and other accounts of the earls of Rutland are included in published volumes of the manuscripts in the collection at Belvoir Castle. In the fourth volume there are references to forge equipment being purchased from a source in Sussex for the earl's ironworks at Rievaulx in the North Riding of Yorkshire.[1] The suppressed Cistercian abbey at Rievaulx had been acquired by the first earl in 1539. A bloomforge using the direct process had already been established there before dissolution, and was continued by the earl.[2] An early connection with the Weald came with the employment at Rievaulx of Lambert Seimar, probably the son of Pauncelet Symart who had leased Newbridge Furnace.[3] In 1577-8 accounts show that a blast furnace and forge had been erected there.[4] They ceased to operate in about 1647.

That the probable source of the forge equipment was the furnace at Robertsbridge is evidenced by the references to carriage by water to Rye and by a connection between Rievaulx and Robertsbridge that was established when the latter had come into the possession of Roger Manners, the fifth earl of Rutland (1576-1612), as a consequence of his marriage, in 1599, to Elizabeth, daughter and heiress of Sir Philip Sidney and granddaughter of Sir Henry Sidney of Penshurst.

1. H. Maxwell Lyte and W. H. Stevenson (eds.), *The Manuscripts of his Grace the Duke of Rutland KG preserved at Belvoir Castle, vol. IV* (London, HMSO, 1905).

2. H. R. Schubert, *History of the British Iron and Steel Industry c. 450 BC to AD 1775* (London, Routledge, 1957), 148, 395-7; *see also* www.wealdeniron.org.uk/publications for online access to this book.

3. B. G. Awty, *Adventure in Iron* (Tonbridge, Wealden Iron Research Group, 2019), 210.

4. Schubert, 401-6.

The Purchases

p. 445 *Paymentes for howshold stuffe, plate, armoures, tentes, reparacions, and necessaries for iron fornace and forge.*

1602

Item for 6 hammers, 4 anvills, 2 hurstes, which wayed 2 tun xij hundreds 3 quarters, at vs. le hundred, paied to Mr. John Levet and sent out of Sussex to Helmesley, [blank], 1600, xiij*li*. ij*s*. vj*d*.

p.458 *Paymentes for howshold stuffe, plate, armoures, tentes, reparacions, and necessaries for iron fornace and forge, 1605.*

1605

Item, 21 December, paied for vj hammers, thre anvyles, and vj hurstes made in Sussex, and sent to Hull to serve at Ryvall, xiij*li*. x*s*.; the fraight to Hull, xviij*s*.– – xiiij*li*. viij*s*.

p.491 *Paymentes for howshold stuffe, plate and armour*

1612

Item for iiij tonne of sowe iron, made into x hammers and vj anviles, xvij*li*. vj*s*. viij*d*; casting of them, xiij*s*. iiij*d*.; cariage of them from the forge to the water side and thence to London, xlv*s*. viij*d*.; the wharfage and fraight from London to Hull, xxj*s*. viij*d*. – xxj*li*. vij*s*. iiij*d*.

p.494 *Paymentes for howshold stuff, plate, armour, hammers, anvyles, and reparacions.*

1613

[*inter alia*]

Item paied, 2 *Julii,* for hammers, anvyles, and hurstes before mentioned, made in Sussex and sent in December last to Ryvalx, the w[eigh]t in sow iron 4 tonne at 4. 10. the ton, 18*li*. making; and carieng by water to Rye, xxiij*s*. viij*d*. – – xix*li*. iij*s*. viij*d*. — Sent then : hammers, 8, anviles, 7, hurstes, 5.

Hammers, Anvils and Hursts

Forgemasters would need to hold a stock of hammers and anvils in reserve in case of breakages as well as normal wear. The same would be the case

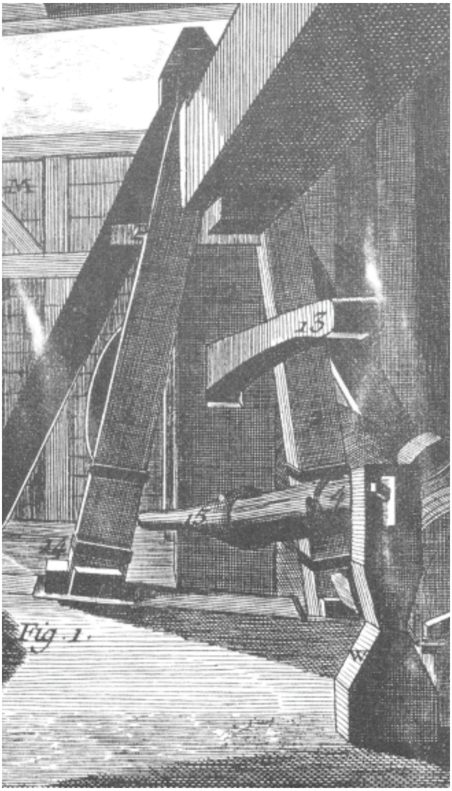

Figure 1: A forge hammer assembly showing a hammer, anvil and hurst; detail from D. Diderot and J. Alembert,* Encyclopédie, Tome 21, 4me section, Planche IV *(Paris, 1765).

with hursts. These were iron collars that encircled the wooden helves, or shafts, of water-powered forge hammers. They had trunnions on each side that were located into the legs of the hammer frame, allowing the helve to pivot (Fig. 1). The violence of the action of the hammer would place considerable strain on all of the castings. Schubert mentions the expected lifespan of hammers and anvils, quoting examples from the Forest of Dean where forges might use six hammers and two anvils a year.[5] Rievaulx Forge had two finery hearths so output would have been such that hammer and anvil use was high, necessitating regular replacements. Spare hammers, anvils and hursts as well as old ones were noted in a schedule of tools and implements at Benhall Forge, Frant, in 1652.[6] However, when the working life of these components was over they could be recycled. At Sheffield Forge in Sussex in the late 1540s the finers were paid 6 shillings to forge broken hammers.[7] Schubert notes that in 1615-16 bar iron was made at Rievaulx out

5. Schubert, 280 n.6, 281 nn.2 & 4.

6. J. L. Parsons, 'The Sussex Ironworks', *Sussex Archaeological Collections* (hereafter *SxAC*), **32** (1882), 29.

7. M. S. Giuseppi, 'The Accounts of the Iron-Works at Sheffield and Worth in Sussex, 1546-1549', *Archaeological Journal*, **69** (1912), 295.

of 40 'olde Sussex hamers'.[8] He also gives typical weights for all three castings: 4-5 cwt (203-254kg) for hammers; 5¼ cwt (588kg) for anvils; and 1¼ cwt (140kg) for hursts. Weights of the castings shipped from Robertsbridge are only given for the purchases in 1602, 1612 and 1613 but in all of those instances the totals fall within the range for the weights he gives. The published catalogue of Belvoir manuscripts includes only extracts from the household accounts, so it can be assumed that purchases of hammers, anvils and hursts will have occurred more regularly than the four extracts above suggest. Evidently, there were many more purchases from Sussex.

Figure 2: Cast-iron forge hammer from Etchingham Forge (scale 10cm); Anne of Cleves House, Lewes, Sussex.

Production of hammers and anvils had been previously noted at Robertsbridge. Charles Pulleyn, the Buxted founder, cast six anvils and three hammers there in 1555 and others are noted as being cast in 1558, 1568 and 1573. In 1555 moulds for an anvil and a hammer were being lent to Socknersh Furnace, in Brightling, before being taken on to the Sidneys' other furnace at Panningridge, and in 1567-8 hammers and anvils were being shipped to the Sidneys' ironworks in Glamorgan.[9]

Schubert, who was able to draw much information about the operation of the ironworks at Rievaulx from the archives at Belvoir Castle, noted that hammers, anvils and hursts had been cast at the furnace there in 1591 and

8. Schubert, 288 n.4.

9. D. W. Crossley, *Sidney Ironworks Accounts 1541-1573*, Camden Fourth Series Volume **15** (London, Royal Historical Society, 1975), 9, 155, 164n, 168, 239.

1592,[10] so it is not apparent why the fifth earl of Rutland did not have the same castings made there a decade and more later. One reason may have been that his workforce no longer possessed the skills to produce castings with the requisite quality of iron needed for such equipment. To make specialised castings a founder had to be sufficiently skilled to be able adjust the conditions in a furnace – temperature, amount and type of ore and charcoal – to produce iron appropriate to the use for which it was intended. Sow iron was ideally white cast iron, but the items being brought from Sussex were likely to be grey cast iron.[11] In a series of directions for the proper operation of the ironworks at Cannock Chase in Staffordshire in 1590 an unnamed writer counselled that

> *the best iron for hammers and anvils is that which runneth thick and graie specled like marble which muste bee mixed of diverse kindes of stone. To make your hammers hard you must bare the head when it beginneth to coole.*[12]

By diverse kinds of stone the writer would have meant a blend of different qualities of iron ore, and baring the head presumably speeded up the cooling of that part of the hammer, affecting the structure of the iron.

Perhaps the founder making the castings at Rievaulx in 1591-2, and presumably adept at adjusting the temper of the furnace to suit the job in hand, was no longer there in the first two decades of the seventeenth century. At that time, until 1615 when a furnace at West Tanfield, north of Ripon, went into blast, Rievaulx was the only blast furnace in north Yorkshire, and it is quite possible that furnaces further away to the south of the county might not have been able to offer a capability in making castings either. For most furnaces sow iron was the principal product, for which little specialist skill was required. Schubert observed that only at furnaces that produced cannon

10. Schubert, 402-3, 405-6.

11. In white cast iron the carbon alloyed with the iron was in the form of iron carbide. It is very hard but weak in tension and shock resistance and therefore unsuitable for hammers, anvils and hursts. In grey cast iron the carbon is in the form of graphite, making it less brittle. Production of grey iron would have been dependant, in those days, on the temperature of the furnace, the rate of cooling of the casting and the founder's empirical knowledge of the ores he was using.

12. A. C. Jones and C. J. Harrison, 'The Cannock Chase ironworks, 1590', *English Historical Review*, **93** (1978), 805.

and shot was the output of castings much higher.[13]

John Levet

John Levet (d. 1606), who is recorded as the supplier in the purchase of 1602, had, in 1577, been clerk to Michael Weston who had held the lease of the furnace and forge at Robertsbridge since 1573.[14] From 1577 Weston, together with David Willard and Robert Woddy, had also set up the furnace at Brede. Levet had, most probably, been working for Weston for a few years as he had married Weston's daughter Elizabeth and, according to Levet's post-mortem inquisition, his eldest son John had been born by 1574.[15] Michael Weston died in 1578, and details of the management of Robertsbridge are missing between then and 1609 when the ironworks were leased by the earl and countess of Rutland to Thomas Culpeper of Salehurst for 21 years.[16] Although nowhere is it explicitly stated, Weston may have collaborated with Willard at Robertsbridge as the latter had also been in partnership with Sir Henry Sidney in setting up the steel forge there in 1565.[17] The length of the lease granted to Michael Weston is not known although if it was for a period of 21 years, as was often the case, it would have expired in 1594. Whether it was Willard who continued Weston's lease at Robertsbridge, or Levet acting on behalf of his brother-in-law, Michael, Weston's son and heir, who at the time of his father's death was not quite 16 years old, is also not known. It seems likely, though, from the evidence of the 1602 purchase of forge equipment for Rievaulx that John Levet had, at least, continued as manager if he had not, himself, renewed the lease.

Levet also had interests in other ironworks. In 1588 he had purchased a moiety, or half share, of the manor of Bodiam, which included Ewhurst

13. Schubert, 246.

14. East Sussex Record Office, Brighton, RYE/146/9 c1580 - c1690, Papers of the Court of Record of Winchelsea; C. L. Kingsford (ed.), *Report on the Manuscripts of Lord de L'Isle & Dudley preserved at Penshurst Place, vol. 1* (London, HMSO, 1925), 248.

15. F. W. T. Attree, *Notes of post-mortem inquisitions taken in Sussex* (Lewes, Sussex Record Society **14**, 1912), 141-2.

16. Henry E. Huntington Library, Pasadena, HEH BA vol 71; C. H. C. Whittick, 'Wealden Iron in California', *Wealden Iron*, 2nd ser., **12** (1992), 49-52.

17. D. W. Crossley, *Sidney Ironworks Accounts 1541-1573* (London, Royal Historical Society Camden Fourth Series **15**, 1975), 34.

Furnace which he let to Thomas Glidd.[18] The following year, together with John Forrest of Etchingham, he leased Abinger Hammer in Surrey,[19] and around about the same time acquired the lease of Vauxhall or Bournemill Furnace, near Tonbridge, and Old Forge at Southborough,[20] which from 1601 were owned by Frances Sidney, née Walsingham, the widowed mother of Elizabeth, countess of Rutland.

18. M. A. Lower, 'Bodiam and its lords', *SxAC*, **9** (1857), 294; The National Archives (hereafter TNA), PROB 11/77/28, Will of Thomas Glidd of Ewhurst.

19. Surrey History Centre, Woking, 6330/3/2/4/7.

20. TNA, STAC 8/196/18.

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