Burwash Forge cottage

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FIELD NOTES

compiled by J. S. HODGKINSON

A bloomery in Dallington, East Sussex

Jonathan Prus

A sub-surface concentration of bloomery slag has been found at TQ 6717 1991 at a depth of about 75 mm, about 10m north of a stream, north-east of Wood's Corner. There is abundant bloomery slag in the stream bed and in the drainage ditch joining it nearby. The slag has voids and is attractive to a magnet. In the stream the slag pieces are up to 200mm across, flat, black and knobbly. At the concentration reported in the soil above the stream it is in small pieces and very hard with no sign of tap slag, although there is too little visible to be sure. The geology is Ashdown Beds.

Two bloomeries in Beckley, East Sussex

Jonathan Prus

A dense surface concentration of bloomery slag has been found in Burnthouse Wood, at TQ 8490 2080, on the upper edge of a very large pit, surrounded by the depressions left by pits of the small shaft type. This is about 220m from the location given for the large site previously recorded in Burnthouse Wood[1] and appears to be quite separate. Slag is of variable size, with some fist-sized lumps and smaller pieces, apparently fractured. Some tap slag was found. Some of the slag has a surface colour of brown to purple with a smooth shiny texture that may indicate a very long period of weathering on the surface. The area of surface scatter is about 25m long and a maximum of 10m across. No charcoal or ore fines were visible on a cursory inspection. The geology is Wadhurst Clay.

A surface concentration of bloomery slag including a piece of slagged furnace wall has been found in Rowland Wood, at TQ 8579 2123. The slag is a heap apparently piled up to about one metre high in a circular area about 20m across This is adjacent to (but not part of) a forest road at the point where a drainage ditch connecting a series of small shaft minepit depressions meets the forest road although the slag area is quite distinct from it. The geology is Wadhurst Clay.

A bloomery in Forest Row, East Sussex

Jonathan Prus

A surface scatter of bloomery slag (including tap slag) extending over about 100m, has been found south-west of Goat Farm, between TQ 3994 3231 and TQ 3998 3240. The former reference is on a field edge bounded by a wood bank that does not seem to contain slag. The latter reference is on a tiny stream. The area with slag on the surface is up to 30m wide. There is no distinct concentration, but a source at the upper end of the spread may be inferred on the general principle that it has worked its way downhill. The soil is typical Ashdown Forest podsol, but soaking wet from water that springs just inside the woodland. Black-coloured soil is more probably due to anoxic conditions in the soil or even a tannin-dissolved iron interaction, than charcoal staining.

A bloomery site in Heathfield, East Sussex

A substantial sub-surface area of slag with a length of about 15m and a width of 6m has been located at TQ 5533 2226, on a mound to the east of a small stream not marked on the 1:25000 OS map and in the property named Maigarth Farm.

A bloomery site in Warbleton, East Sussex

The probable site of a bloomery has been located at Little Iwood (TQ 6298 1761), about 50m west of the road between Rushlake Green and Bodle Street and on the north bank of the stream at that point. There are surface finds of tap slag and metal detector evidence of an extensive area of slag etc. beneath the surface. There is abundant slag in the stream bed for at least 500m downstream. There may possibly be a second source of slag by the gated entrance to the wood from the road about 50m east. This is suggested by metal detector response on the bank and slag in the stream near the culvert under the road. The slag covers an area of about $100m^2$ and is located on the Ashdown Beds.

A bloomery in Wadhurst, East Sussex

A concentration of bloomery iron smelting slag has been found by members of the Independent Historical Research Group at TQ 6505 2845, south of Maplesden Farm, in Wadhurst. Slag was found for a distance of about 11m along the east bank of a southward flowing stream. A very large slab of tap slag, measuring 1040mm x 510mm, has been found in the stream.

A bloomery site in Wadhurst, East Sussex

A concentration of bloomery slag, including tap slag, has been noted on the north bank of Sandyden Gill, at TQ 5898 3091. The deposit measures about 60m by 60m. Some erosion of the site, by stream action or deliberate removal of the slag, may have taken place. The nearest source of Wadhurst Clay ore lies to the north.

The two other sites that have already been noted along the same stream lie at TQ 5846 3092 and at TQ 5862 3092, the latter being dated to the Iron Age by a single radiocarbon date.[2] Both sites were re-examined, and the slag areas were measured at about 25m x 10m and 20m x 5m, respectively. Tap slag was evident at both sites. At TQ 5885 3085, in a south-

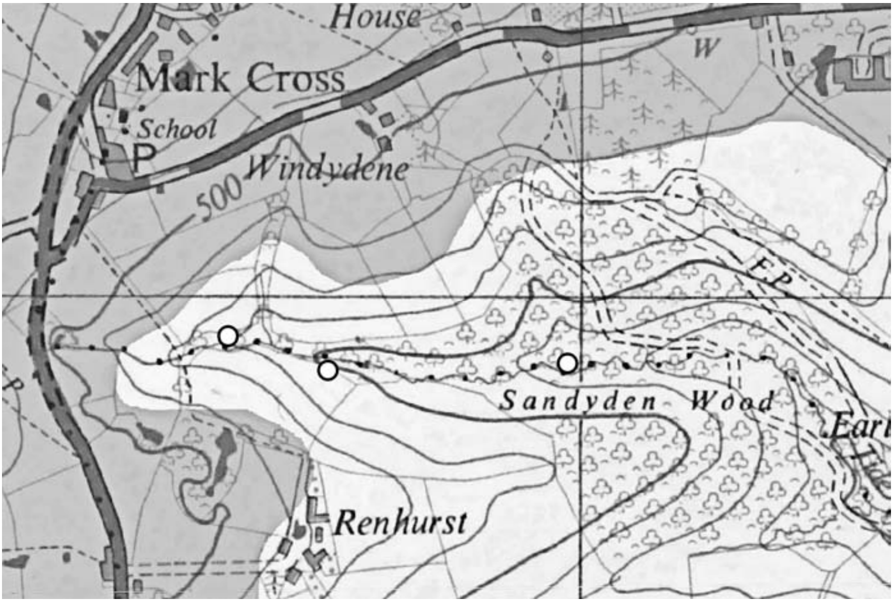

Fig. 1. Sandyden Gill, showing locations of bloomeries; dark shading indicates Wadhurst Clay, light shading indicates Ashdown Beds; based on Ordnance Survey 1:25,000 map 1959

ward-flowing bend in the stream, was a long mass of tap slag from a bloomery furnace. Approximately 700mm long by 300mm wide, it appeared to have been formed from two accumulations of slag, one having been allowed to flow onto the top of the other.

In woodland to the west of these bloomeries, the OS 1:25,000 map shows a long, water-filled mine/marl pit (TQ 5843 3075), although the pond now curves towards the west at its south end. Near the pond a dozen or so small, dry, mine pits were noted at TQ 5840 3075. The field, adjacent to the north side of the wood was marshy, suggesting that this was immediately above where Wadhurst Clay was overlying the Ashdown Sand.

A bloomery in Brightling, East Sussex

David Brown

A bloomery iron-smelting site has been discovered in Coblye Wood, Brightling. WIRG was invited by John Stafford (Forestry Commission) to examine a substantial pond bay and an area of iron slag, which he and Greg Chuter (archaeologist, East Sussex County Council) had noted.

The area lies entirely on the Ashdown Beds. The stream being investigated originates on a small outlier of Wadhurst Clay and drains into Darwell reservoir. A scattering of bloomery slag had been found in Holmans Wood, at TQ 6920 2070, and a bloomery site lies close to the source of the stream at Woods Corner (TQ 6717 1991).

The main stream was explored starting at TQ 6190 1940 and continued westwards. A side stream running north from the ford at Coblye Cottage was searched for a distance of about 150m. No slag was found there but some pieces of iron ore were found in the stream bed. Slag was found in the main stream at TQ 6878 1945 close to the ford, with more adjacent to a concentration of in a mound on the north bank at TQ 6851 1949. The area covered by the slag was 20m (E-W) by 8m (N-S). A piece of possible furnace lining was found and some tap slag.

It is possible that the pond bay was, in fact, a causeway across the stream, as the ground may have been too porous to support a pond bay effectively. What appeared to be a flat working area was noted on the bank of the stream at the breached (southern) end, with masonry and brick shoring up part of the bay. A ramp also led up to the top of the bay just north of the flattened working area. The area west of Coblye Cottage appeared to have been extensively quarried. The pond bay would seem to have post-dated the quarrying activities. There was a small amount of spoil (which probably led to the scattering of the bloomery slag) in comparison with the size of the quarry and, judging from hard sandstone blocks in the stream, it seems likely that building stone was being extracted.

A bloomery in Ticehurst, East Sussex

David Brown

A bloomery iron-smelting site has been discovered in Oldwoman's Wood, Ticehurst. A brief archaeological walkover survey of the wood, together with the adjoining Yellowcoat Wood, undertaken by Dr Nicola Bannister in 2003, had located slag in the stream. The wood on both sides of the stream mainly lies on Tunbridge Wells Mudstone and Sandstone. However, there is a substantial amount of Yellowcoat wood (east side of stream) lying on clay in the Tunbridge Wells Sand. The site of Pashley Furnace (TQ 7100 2950) lies 0.75km downstream

As the approximate position of the site was known, the stream or banks were not searched except in the immediate vicinity of the slag found in the stream, a concentration of which was found adjacent to a mound, centred on TQ 7122 3045, which lay between a drainage ditch and a small sunken trackway. The area of slag measured 30m (parallel with the stream N-S) by 15m (away from the stream E-W). No tap slag was noted, but pieces marked with the impressions of lengths of wood, suggesting that the furnace may have incorporated a wood-filled pit into which the slag flowed.

The two woods contain a number of archaeological features, including charcoal burners' platforms, sawpits, trackways, quarries, woodbanks, a pond bay and some platforms.

A possible Saxon bloomery site in Hartfield, East Sussex

In February 2009 members of the Field Group excavated a trial trench into a bloomery site that had been previously discovered in Whitepost Wood, near Cullinghurst Farm, Hartfield (TQ 4718 3922).[3] No pottery was recovered and, because possible evidence of burnt structures was becoming apparent, the trench was backfilled. A piece of charcoal was extracted from the context of the burnt remains and submitted for radiocarbon analysis to the Radiocarbon Laboratory of the Institute of Physics, Silesian University of Technology, Gliwice, Poland.[4] They reported a ^{14}C age of 1180 ± 100 BP, which gives a calibrated date range of 660AD to 1020AD at 95% confidence.

Subsequent excavation at the site in December 2009 produced sherds of pottery which were examined by Luke Barber, of the Sussex Archaeological Society. He reported that they were East Sussex Ware, of late Iron Age or Roman date. The disparity between the radiocarbon and pottery dates will be explored through further excavation of the site.

Notes and References

1. Botting, W. J., 1973, 'Romano-British Ironworking Site at Ludley Farm, Beckley,' *Sussex Archaeological Collections*, **111**, 111.

2. Cattell, C. S., 1972, 'Bloomeries in the upper (east) Rother basin,' *Wealden Iron*, **3**, 13.

3. *Wealden Iron*, 2nd ser., **28** (2008), 6.

4. Whitpost Wood/75 cm; Gd-19298.

Documentary and literary evidence relating to Burwash Forge and Wynhamford Mill, East Sussex

Kate Mees

INTRODUCTION AND ACKNOWLEDGEMENTS

This article has been adapted from a desk-based assessment, conducted as part of the MA in Landscape Archaeology at the University of Bristol in February 2009. The area of study consisted of a 1km^2 plot, approximately 1.5km southwest of the village of Burwash. It incorporates the sites of Burwash Forge (TQ 6631 2313), which lies within the parish of Burwash, and Wynhamford Mill (TQ 6560 2235), across the parish border in Brightling. Documentary research has revealed much about the nature of the industrial activities that took place at these sites in the medieval and post-medieval periods, and about the families and individuals who were involved in these enterprises.

Research was carried out at the East Sussex County Record Office (ESRO), Lewes, at Hastings Library and online via the National Archives (www.nationalarchives.gov.uk/a2a).

The author is grateful to the following for their assistance in the production of this article: Jeremy Hodgkinson, for reading numerous versions of the text and making valuable suggestions; Lesley Mees for help and support; Christopher Whittick, senior archivist at East Sussex Record Office, for locating relevant sources in the Ashburnham Family Archive (ESRO ASH/200a).

DOCUMENTARY EVIDENCE: BURWASH FORGE

There are no surviving medieval sources that refer unequivocally to Burwash Forge. As Cleere and Crossley (1985: 87) have testified, many aspects of the medieval Wealden iron industry remain "tantalizingly obscure", as documentary sources "throw no more than occasional light on the actions or products of the medieval smelter or smith."

Documents in the Ashburnham Family Archive relating to the "Manor of Burghurst, in Burwash" cite the payment of rental for a forge at Durefoldgate in 1432-3 (ESRO ASH/200a/11-12H6) and a new forge by Burwash Church in 1476-7 (ESRO ASH/200a/16-17E4). However, with their low rental cost, these premises are unlikely to have housed anything more than blacksmiths' establishments (J. Hodgkinson *pers. comm.*). The first documentary sources to relate unambiguously to Burwash Forge date from the 16th century.

John Collins and Burwash Forge

John Collins, who in the 1520s held part of the Manor of Socknersh (Salzman 1937: 229), took over the tenancy of Burwash Forge at the beginning of the 1520s. A document from 1523-4 lists the payment of £16 from the farm of the iron mill (*molendini ferrarii)*, leased by a John Colyn (ESRO ASH/200a/15-16H8). Although a tenant named as David Harvy was said to be operating a "late bloomery" at Burwash in 1524-5 (Cleere & Crossley 1985: 107; ESRO ASH/200a/16-17H8), no further information on him has been traced, and it seems his tenure of the forge was short-lived. By 1525, John Collins was operating a blast furnace at Socknersh, near Brightling (3.8km east of Burwash Forge, at TQ 7050 2330). This suggests that Burwash was being used as a finery forge, supplied with pig iron from his Socknersh furnace. Collins was also employing French workers, almost certainly to assist in the operation of his blast furnace. The Lay Subsidy 1524-5 has an entry under Hundred of Hawkesburgh stating, "Also the said John Collen [Collins] hath in his service VIII Frenchmen" (Awty 1981: 28). Further evidence of the existence of a furnace or forge connected to Colyn comes from an Ashburnham document with an entry dated 16 Henry VIII (1525-6) "*molendium ferreum ibidem die Johe Colyn*". Crucially, the words "iron mill" and Colyn are in association (Pettitt 1978: 11). Workers and members of the Collins family were also brought in to offer their expertise and empirical knowledge at the Sidney ironworks at Robertsbridge Abbey in the late 1530s (Hodgkinson 2008: 67). As Crossley (1975: 5-6) has noted, "it was significantly the Collins – Alexander and John, iron masters at Socknersh, who supervised construction at Robertsbridge and Panningridge." Alexander and John Collins junior, were in charge of building at both sites. Their involvement with the day-to-day running of the forge at Robertsbridge is evident. In 1542-3, the hammerman is identified as Bartholomew Collins, younger son of John Collins senior. For most of the same period, Alexander was founder (Crossley 1975: 51).

Clearly, the Collins family (John senior and his sons) were key figures in the Wealden Iron industry. From the mid-1520s onwards, they divided their time between four main iron producing sites: Socknersh, Robertsbridge, Panningridge and Burwash. This is perhaps a reflection of the accelerated growth that took place in the early- to mid-16th century; as Hodgkinson (2008: 7) reminds us, "the Weald was the principal iron producing region in Britain" at that time.

A series of documents from 1531 places John Collins senior in Burwash and details his involvement in a dispute over land in the village. In October 1531, John Colyn, his son Alexander (described as a husbandman, not a forge or furnace owner), together with others, including Thomas Assheburnham, entered property "held" by Thomas Waynmer. He was expulsed and his beasts driven away. Wayner claimed that he was falsely imprisoned and taken by force to the house of John Collins in Burwash. In fear of his life, he was forced to pay the sum of 40 shillings, the rent of the said manor (Mundy 1913: 73).

John Collins' will

Evidence provided by the will of John Colyn (Collins) senior, dated 18th November 1541, shows that both Burwash Forge and Socknersh Furnace were in his ownership. He stated,

> "I will that my said sons John, Alexander and Bartholemew and their assigns shall lovingly and brotherly occupy together my iron forge with all manner of tools and instruments and necessaries thereto belonging in the said Parish of Burwash. Forthwith my furnace with all manner of tools, instruments and necessaries thereto being in the Parish of Brightling." (ESRO AMS/5789/21)

A memorial or grave slab in Burwash Church is believed to be the earliest known cast iron example. The largely plain plate bears a small floriated cross, beneath which are the words, "*Orate Pannema Jhone Coline*" (Pray for the Soul of John Collins). Early writers on the iron industry assumed that the Lombardic style of lettering used, popular in the 13th and 14th centuries, indicated that the slab dated from that period. However, the use of cast iron means that it could not have been made earlier than the late 15th century. It is almost certainly a memorial to the John Collins of Burwash Forge who died in March 1536 (Hodgkinson 2008: 113).

Colyn's will appointed two members of the Crotynden family, a Thomas Wenell and Richard a Wyke of Burwash as feofees. Richard a Wyke died in 1554 and his will includes the following: "I bequeth to John a Weke my brother my shoppe with all Implements therto belongyng all yron and cole only excepted both wrought and unwrought" (Garraway Rice & Godfrey 1935: 243). By 1500, the a Wyke family lived at Crowhurst Bridge Farm, Burwash (Barkshire 2000: 12). This may have been the Richard Weekes who was operating Mountfield Forge in 1548 (Cleere & Crossley 1985: 346). However, there is also a mention of the purchase of new hursts for the hammer at Robertsbridge Forge in 1554, including three from Mr. Weekes of Battle at Darvel furnace (Crossley 1975: 114). Although clearly a close associate of John Colyn and also a man with some involvement in the iron industry, it is not possible to identify Richard a Wyke precisely, or to say where the "shoppe" was located.

The 1574 Lists

A set of documents, known as the '1574 Lists', constitute the most extensive and important record of the extent of the Wealden iron industry for any one period in its history (Cattell 1979: 161). The Admiralty was concerned in bringing attention to the growing extent of the industry, which allegedly threatened supplies of timber for naval shipbuilding and other purposes. It was also claimed that the country's merchant shipping was put at risk by vessels armed with guns produced and sold by Wealden ironworks. The Privy Council ordered, therefore, that a list be drawn up of all the ironworks in the Weald. Burwash was visited three times on 28th February 1574 (Straker 1931: 56), and the owner, John Collins, summoned to appear before the Privy Council. However, although his forge is listed as among "divers forges and furnaces in Burwash", it seems likely that he was excused, being "an old man of LXXX yeres and not able to travel" (Teesdale 1986: 17). Unfortunately, the Lists contain no details of the works visited; however, there is no evidence of gun casting at Burwash in any other documentary evidence.

Goring's table, derived from the 1574 Lists and the works of Schubert, Straker and Cattell, details the relations of John Collins who were associated with the iron trade. No partnerships are indicated, but it cites Stephen Collins of Lamberhurst, forge owner and yeoman, and Thomas Collins of Brightling, yeoman and furnace owner (Socknersh), both of whom were his nephews (Goring 1978: 224-225).

The Lists of 1574 reveal a significant growth in the number of ironworks in the Weald. From a modest start at the beginning of the 16th century and the impressive growth to 1548 when there were 50 ironworks (Cleere & Crossley 1985: 123). By 1574, no less than 50 forges and 50 furnaces were recorded (Hodgkinson 2008: 69).

The 1592 sale

Burwash Forge passed briefly into the hands of Robert Cruttenden (Barkshire 2000: 9) and was then purchased by Thomas Hepden in 1592. The acquisition by Hepden resulted in a chancery suit being filed at some point between 1558 and 1603; performance asked for "an iron forge called Burwash Forge, the inheritance of Henry Colley, and a certain stack of coal lying at the same forge containing the number of 300 loads, being very necessary and beneficial for such person as should occupy the said forge" (C2/Eliz/C4/47). It seems very likely the Henry Colley was in fact Henry Collyn, son of John Collins junior, and hence the contentious Court of Chancery case. Four years later, in 1596, Henry's daughter, Constance, was to marry Richard Stollion, son of Thomas Stollyon of Warbleton. Thomas had worked Glaziers Forge and Waldron furnace for Sir John Pelham at the time of the 1574 lists. At that time he also held Warbleton Priory furnace (Cleere & Crossley: 319; 363-4). The marriage settlement (ESRO SRL/7/5) of November 1596 mentions lands in Burwash, "conveyed to Henry Collins by his father John, deceased".

There is no indication of the value of Burwash Forge in 1592, nor any detail of buildings; only coal is mentioned. However, some indication may be given by an inventory of the goods and property belonging to Richard Maynard, an iron master and yeoman farmer of Birchden Forge in the Parish of Rotherfield (TQ 533 353). He died in 1610 and out of his total moveable wealth of £1457, £546-13-00 was tied up in stock and equipment at the forge. Burchall (1983: 24) cites the items, which included:

135 Loafe of coals	£121-00-00
18 ton and a halfe of sowes	£74-00-00
7 yron plates	£2-00-00
gynne and cable to loade timber	£6-00-00

Is it possible that the 300 loads of coal could have been worth in the region of £300?

Both the will of John Collins senior and the sale of 1592 reveal information about some of the more prominent families in Burwash and their involvement in the local iron industry. As the Rev. John Coker Egerton observed, from the year 1558 when the Parish Registers begin, "we have a tolerably regular account of the Cruttendens, Collinses, Hepdens and Westons amongst us" (Egerton 1924: 142). John Collins senior left his furnace and forge to his sons John, Alexander and Bartholemew. His daughter Odyerne was married to John Crotynden (Cruttenden). The Cruttendens were yeomen farmers at Tottgreene, at the eastern end of Burwash village. A Robert Cruttenden ran the forge in the period up to the sale of 1592. The Hepdens were also wealthy landowners, who bought Mount House on Burwash High Street in 1584. Thomas Hepden's brother Goddard built the imposing Holmshurst Manor House in 1610.

While John Collins junior operated Burwash Forge, Alexander was recorded in 1548 as starting an ironworking site at Lamberhurst, on the Sussex-Kent border. Thomas Darell complained that "Alexander Collyn hath begun to make a hammer for iron making … and hath cut down the most part of oaks standing and beginnith to cut down the beeches, by mean thereof in short time the same woods if that hammer do there continue will be utterly wasted and destroyed". Further, he complains that Collyn "hath caused a great ditch to be made to turn the water of a common stream or river there which doth divide the King Majesty's shires of Kent and Sussex" (Straker 1931: 269).

From the mid-1540s onwards, there is evidence that a wide cross-section of Sussex landowners were taking advantage of their resources (and those of others), namely ore, timber and water. As Cornwall (1976: 20) has pointed out, most of the families prominent in the Wealden iron trade came from the yeomanry and minor gentry. In this respect, Burwash families followed this pattern, albeit on a fairly small scale.

The state of the industry in the 17th century

The Wealden iron industry remained pre-eminent in the production of bar iron during the 16th century, reaching a peak in the 1590s, when its output was in excess of 9000 tons annually (Hodgkinson 2008: 73). However, furnaces and forges were steadily being established in other parts of England and Wales. By 1610, output from other areas actually exceeded that of the Weald, with a consequent loss of ironworking sites. By 1653, there were 35 furnaces in the Weald, a figure which had fallen to 14 in 1664, although another 12 were still in good repair and capable of operation. Of the forges, 19 went permanently out of use, with 5 idle but in good working order (Hodgkinson 2008: 73). Socknersh Furnace is described as "continued in repair and partly stored at ye beginning of 1664", while Burwash Forge is listed as amongst those which "yet continue in hope of encouragement" (cited in Delany 1921: 30).

It is against this background of relative decline and stagnation in the Wealden industry, that a far more detailed description of Burwash Forge can be seen. On 1st November 1661, a deed of feoffment (sale) was made between John Hepden, born in 1636, the only son and heir of Thomas Hepden, who had taken over the forge in 1592, and Jeffrey Glyde of Dallington (ESRO SAS-RF1/1).

The Glyde family (variously spelt Glydd, Gleyd or Glyd) had been involved in the iron industry since the mid-16th century. They formed part of the "yeomanly gentry", to borrow a later term from Celia Fiennes (Tyacke 2001: 97). Like John Collins and his sons, Thomas Glyde, active from at least the 1560s, was almost a "professional iron master" (Hodgkinson 2008: 70). In 1568, he leased from Sir Robert Tyrwhitt, Etchingham Park, Darvel Furnace and Etchingham Forge. (Vivian 1953: 191). The lease, for ten years, allowed Glydd to use "all the woods and underwoods in Sussex to make coal necessary for the iron to be made at the furnace and forge" (DUN14/1 1 Feb 1568). Thomas Glydd and Simon Coleman built and operated Batsford furnace on land leased from Lord Dacre in 1571. Baker's Declaration and the Lists of 1573-4 confirm Glydd's involvement with Darvel and Etchingham. Glydd was also the tenant at Panningridge between 1584 and 1586. By that time, he had considerable interests in the (iron) industry, being involved with Etchingham and Kitchenham forges, and Darvel, Panningridge and Batsford furnaces. These formed a compact group, well supplied with wood from the district at Brightling and Dallington (Cleere and Crossley: 155).

In 1620, a Thomas Glyd was granted land in Brightling, "in consideration of the long service thereto done to him", by Robert, Earl of Leicester. This was to ensure that, "the said Thomas Glyd should not be in danger of any forfeiture for digging up or cutting down any of the said trees" (SAS-RF/1/295). This implies a continuing need for a source of timber with which to fuel a furnace or forge. Jeffrey Glyde was, therefore, a part of a family with long and varied experience in the Wealden iron industry.

In the 1661 sale, Jeffrey Glyde paid the sum of £400 for:

> "one forge or ironworks called Collins forge, and all the

> wheeles, beames, tooles and implements lying and being within the said forge and belonging to or used therewith and also the fludgates & penstocks belonging to or used with the said forge." (ESRO SAS-RF1/1)

Details are also given of the buildings on the site, including 2 cottages or workmen's houses and one iron house. The site was said to occupy about one and a half acres. Land around the forge was used "to lay sowes, coales, sinders, iron and other materials and necessaryes and for the use of the said forge" (ESRO SAS-RF1/1).

There is evidence too that the forge area had recently been fenced to divide it from other land still owned by John Hepden. Mention is made of "dowles and stumps newly set up in several places". It is stated that the newly erected boundaries were made in order to separate the forge site "from the close or forestall of the said John Hepden belonging to the messuage wherein he was living". In addition, the sale included 2 acres "lying between the hedge of the coppice called the Forge Wood and another lode or stream running into the saide pond towards the saide forge" (ESRO SAS-RF1/1).

Jeffrey Glyde was also allowed to dig clay from "Calbrooke field (where clay used to be digged)" and to "take earth and loame to make new the walls of the said forge or ironwork and workmen's houses." Glyde and his workmen living in the cottages were also permitted to keep "2 hogges and 2 young sheates [sheep?] to grase and depasture in the said close or forestall." However, the animals were to be "well ringed at all times for the preservation of the corn and grass yearly growing upon the aforesaid lands of John Hepden."(ESRO SAS-RF1/1)

In 1662, a dispute occurred concerning the parcels of land and wood in Burwash called the Pond. Again, the Cruttendens were present – Goddard was described as the "bedell" (beadle) at a "court" held on 24th April 1662 and presided over by Joseph Bennett, rector of Brightling Church. A right of way and the "liberty of overflowing pond of Collins forge" was granted to Thomas Cruttenden and Thomas Watkins, "2 customary tenants of the Manor" (ESRO SAS-RF/13/26).

In November 1664, the forge was leased to Richard Glyde senior of Bletchingley, Surrey, by Jeffrey Glyd and Richard, his son (ESRO SAS-

RF1/3).

In June 1669, the forge changed hands again, and the names of the protagonists have a familiar ring. Mr. Thankfull Hepden entered into a tenancy agreement with Jeffrey Glyd for a period of 2 years at an annual rent of £25. Thankfull Hepden was born in Burwash in 1594, son of Goddard Hepden. At the time he leased Burwash Forge, he would have been 75 years old. In 1652, he is recorded as supplying wood for charcoal to Glaziers Forge in Brightling (Goodwin 1959: 100).

Under the terms of the lease of 26th June 1669, Thankfull Hepden was granted rights to

> "have, occupy and enjoy ALL that forge or ironworks together with the hammes [*sic*], bellowes, tongues and all other instruments and utensils of worke and the iron house, cottages, coal places and lands, copyhold and freehold, therefore bought of John Hepden and Thomas Weston senior or one of them in Burwash" (ESRO SAS-RF/1/7).

The detailed inventory of equipment and fittings present at the forge is as follows:

> "Two Turn Sowes, Five ringers, 2 pair of Great tonges and two pair of small tonges, one Quas, 3 old Bellow pipes, 2 old iron pins, 2 hammers, one paire of old Chaffry Charnells, 3 Hursts, one Beame and Scales, 2 whole hundredweights, 3 half-hundred weight 6 smale weights containing 45 pounds, 2 cheezells, one carne iron, one hammer, anvil and hurst, 10 plates in the forge belonging to the hammer and Finery which are visible, one Smith's anvil, 2 old coale waines, one pair of Chaffry bellowes, one paire of Fynery bellowes, one willborrow" (ESRO SAS-RF/1/7).

Some five years earlier, Richard Glyd senior had leased 276 acres of land in Brightling to a Richard Chandler, citizen and haberdasher of London, and William Wright, cloth worker of London (ESRO SAS-RF/13/27). It seems that Richard Glyd junior had died, leaving a widow and four young daughters. On 31st August 1664, a settlement was made for them by their grandfather, Richard Glyd senior, and for the seven daughters of William Wright and Anne his wife, daughter of Richard Glyd senior (ESRO SAS-RF/13/28).

In February 1671, when Thankfull Hepden's lease expired, and both Jeffrey and Richard Glyde deceased, the forge passed to Richard Chandler and William Wright (ESRO SAS-RF/1/8). In June 1672, they leased Burwash Forge to Samuel Western for one year (ESRO SAS-RF/1/9).

In October 1672, another "controversy" over the Burwash Forge site was settled, involving Thankfull Hepden and Thomas Western. It referred to the river, stream and watercourses running from the forge pond to Hepden's land. Western was granted rights to the said water supply and was "at liberty to dig up weeds", presumably to allow water to flow freely, keeping the pond and streams clear. Hepden, in turn, who was clearly still actively involved in the iron trade, was "at liberty to bring sowes to the forge and have free use of utensils" (ESRO SAS-RF/1/12).

From the mid-16th century, the Wealden iron masters had been essentially local in origin. By the mid-17th century, the concentration on the merchant trade in guns brought the merchants themselves into the business. One of the first of these was Thomas Western. Born in 1624, he was well established as an ironmonger by 1650. Western became one of several Wealden iron founders who prospered as government contractors for ordnance. One of Britain's first armament tycoons, he remains the 189th richest person in Britain since 1066; in today's money he would be worth around £3.6 billion. Although his family was not actually resident in the area, much of its industrial activity was centred there, particularly in the vicinity of Brede and Burwash (Beresford & Rubenstein 2007).

When Samuel Western died on 22nd August 1699, his father Thomas decided to relinquish Burwash Forge. On 22nd November 1700, a deed of covenant was made between Maximilian Western and John Fuller of Waldron (ESRO SAS-RF/1/14).

The Fuller Family

The Fullers had been major landowners in Sussex since the mid-16th century and had amassed a considerable fortune from their involvement in Jamaican sugar plantations, as well as in the iron industry. In 1693, Captain John Fuller built a blast furnace in Heathfield, approximately 8km west of the site. The furnace (TQ 599 187) concentrated on the production of castings for cannons. The purchase of Burwash Forge and its retention throughout the 18th century allowed the Fullers a ready source of bar and wrought iron to complement their business in Heathfield (Crossley & Saville 1991: xvi-xvii).

The deed of covenant of 22nd November 1700 explains that Thomas Western had purchased Collins forge and kept it in trust for his son Samuel (by now deceased). The site had retained its "forge, two cottages and the pieces of land and other premises in Burwash" (ESRO SAS-RF/1/14).

John Fuller paid £200 for the purchase of the premises. It was further covenanted that Maximilian Western would, within 17 years, "procure good title to be conveyed to John Fuller". In the meantime, Fuller could "hold and enjoy the premises with their rights and privileges without any rent" (ESRO SAS-RF/1/14).

It may be indicative of the decline of the industry that less than 40 years previously, Glyde had paid twice the sum for the forge. On 2nd May 1716, a deed of release is recorded between John Fuller and William Western.

Details of the workings of the forge are mentioned in correspondence between Fuller and his customers. In March 1731, he wrote to Samuel Remnant, regarding an order. "I have ordered the iron to be made for you at the Forge, which you bespoke, which shall be sent by a Maidstone Hoy when the wayes are a little better" (cited in Crossley & Saville 1991: 45). Fuller was here dealing with one of the largest suppliers of ordnance and a key figure in the industry. Master Smith to the Board of Ordnance, Remnant had his own works at Woolwich, near to the Royal Arsenal (Hodgkinson 2008: 84). Again in June 1732, Fuller informed Samuel Remnant,

> "I sell my Barr iron att the Forge for 18 pounds a Ton, ready money as it runs, and this being picked iron and costing me 25 shillings a Ton sending to you, cannot afford it under 19 pounds a

> ton, which I doubt not will be fit for your service" (Crossley & Saville 1991: 48).

John Fuller died in 1745 and his estate passed to his eldest son, also John. He died in 1755 and left £200 a year in his will to his brother, Rose Fuller, "until he should take possession of the real estate, for his trouble in managing the furnace, foundry and iron works". Among the bequests, dated 17th January 1755, was this: "To and amongst the workmen employed at the testator's furnace, foundry and ironworks £50 to be distributed as his executor should think fit" (ESRO SAS-RF/11/26).

Jack Fuller (Rose's nephew) made the decision to shut down Heathfield Furnace in 1787. It cast its last guns in 1799 and continued to produce iron sows for Burwash Forge and other local forges. But, faced with competition from coal-burning furnaces in the Midlands and North, by the late 18th century, it was no longer economically viable.

Most sources state that Burwash Forge closed in 1803. However, using Land Tax assessment records, P.W. King has put the date of closure somewhat later. From 1789 to 1803, it was operated by John Fuller and Samuel Standen in partnership. In 1804, only "widow" Standen is mentioned. Between 1806 and 1810, Thomas Standen was the occupant and only then did it close (King 2002: 28).

DOCUMENTARY EVIDENCE: WYNHAMFORD MILL

As stated in the ESHER (East Sussex Historic Environment Record) entry, the first documentary evidence for a mill at Wynhamford is a 1315 charter, in which it is granted to Robertsbridge Abbey, a Cistercian abbey founded in 1176. It is possible that during the 14th and 15th century, the mill featured as part of a monastic semi-industrial landscape. The presence of a fulling mill is not mentioned until 1471, and as it is known from the Inquisitiones Nonarum that the abbey did not possess any large flocks of sheep in the 14th century, the use of the original mill for corn grinding seems more likely (Pelham 1934).

The Glidd/Glyde Family

In 1610, Richard Glidd (almost certainly a member of the same family that purchased Burwash Forge in the 17th century) revoked the lease of the Manor of Werth in Brightling, granted to him in around 1605 by Robert, Lord Sidney of Penshurst, Viscount Lisle. The Sidney family had substantial iron and steel workings, including those mentioned at Robertsbridge and Panningridge. In June 1617, Glidd purchased the Manor of Werth, which included a dwelling house, barn, stables and 2 watermills called Wynhamford Mills. Richard Glidd paid £1600 for the manor, which comprised some 500 acres (ESRO SAS-RF/13/19). Richard is described as "citizen and tallow chandler of London" (ESRO SAS-RF/13/18); the sale provides more evidence of lands around the area of the forge being taken up by wealthy landowners and members of the merchant classes.

In November 1649, Glidd leased parts of the farm called Weard (Werth), including

> "one messuage, two barns, one outhouse called Shephouse or Waynehouse, together with all that messuage, outhouses, buildings and those mills called Wynhamford Mills and all watercourses, bays, lands and meadows containing 10 acres in Brightling and Burwash" (ESRO SAS-RF/13/23).

In 1664, Richard Glyd senior leased some 276 acres in Brightling to Richard Chandler and William Wright, for one year. It is not known whether the leased land included Wynhamford or its two watermills. However, Richard Chandler was described as "citizen and haberdasher of London", while William Wright was referred to as "a cloth worker of London" (ESRO SAS-RF/13/27). This may be an indication that the fulling mills were still in operation in the 17th century.

In a deed of May 1690, there is a brief description of "the messuage called Winhamford, with barns, land and 10 acres in the occupation of Thankful Ticehurst" (ESRO SAS-RF/13/36), but no mention of any mills.

LITERARY REFERENCES

The Dudwell Valley is portrayed by Rudyard Kipling as a landscape populated by mythical creatures and legendary characters. Kipling, who in the early 20th century lived at Batemans, a few hundred metres northeast of the study area, wrote the description:

> "Just beyond the west fringe of our land, in a little valley running from Nowhere to Nothing-at-all, stood the long overgrown slag-heap of a most ancient forge, supposed to have been worked by the Phoenicians, Romans, and since then, uninterruptedly till the middle of the eighteenth century. The bracken and rust-patches still hid stray pigs of iron, and if one scratched a few inches through the rabbit-shaven turf, one came on the narrow mule-tracks of peacock-hued furnace-slag laid down in Elizabeth's day. The ghost of a road climbed out of this dead arena, and crossed our fields, where it was known as 'The Gunway', and popularly connected with Armada times. Every foot of that little corner was alive with ghosts and shadows." (Kipling 1937: 200-1)

The protagonists of *Puck of Pook's Hill* are clearly based on the former inhabitants of the area. The Hepdens, who owned the forge in the 17th century, are alluded to with "old Hobden, who lived at the Forge cottage" and "burned charcoal hereabouts, just beyond Bog Wood yonder" (Kipling 1908: 19).

Kipling evokes the auditory experience of the local landscape at the time when the industry was at its peak, also showing how interconnected the ironworks were:

> "Many a night has Master John Collins's big trip-hammer shook me in my bed here. *Boom-bitty! Boom-bitty!* If the wind was east, I could hear Master Tom Collins's forge at Stockens [Socknersh] answering his brother, *Boom-oop! Boom-oop!* And midway between, Sir John Pelham's sledge-

> hammers at Brightling would strike in… The valley was as full o' forges and fineries as a May shaw o' cuckoos. All gone to grass now." (Kipling 1908: 237)

James Hurdis, described as "a learned scholar, divine and poet" (Egerton 1924: 160), was born near Seaford in Sussex, and became Rector of Burwash in 1786. In 1788, he published a lengthy, somewhat romantic lyric poem, *The Village Curate* (cited in Straker 1931: 303). It contains a passage that describes in detail the workings at the low-roofed Burwash Forge in the final phase of its existence, and is the only first-hand description of its interior. The "pale and hollow-ey'd smith" is a figure for whom Hurdis has admiration, and the wrought iron bar he fashions is a metaphor for virtue. Defining the smith's skills from furnace to anvil, the piece extols the dignity of labour, in a scene from the life of the community. The poem paints a vivid, infernal picture of the noise, heat and intense atmosphere of a working forge in the post-medieval period.

CONCLUSION

From the documentary evidence examined, it is clear that Burwash Forge was a relatively long-lived ironworks. It was certainly in operation by the early 16th century, and continued working at least until 1803, if not later. One or more working mills at the Wynhamford Mill site were also in operation for a long period of time, spanning at least 4 centuries.

It is clear that Burwash Forge was important for the local community, as well as on a regional and national scale, given its connections with the country's wealthiest entrepreneurs of the 17th century. The forge could be viewed as a microcosm of the post-medieval industrial landscape of the Sussex Weald.

Bibliography

Awty, B. G., 1981, 'The Continental Origins of Wealden Ironworkers, 1451-1544,' *Economic History Review* 2nd ser., **34**, 524-39.

Barkshire, J., 2000, *Burwash: Domesday to Millennium* (Burwash, The author).

Bedwin, O. 1976, 'The Excavation of Ardingly Fulling Mill and Forge, 1975-6,' *Post-Medieval Archaeology,* **10**, 34-64.

Beresford, P. & Rubenstein, W. D., 2007, *The Richest of the Rich: The Wealthiest 250 People in Britain since 1066* (Petersfield, Harriman House).

Burchall, M. J., 1983, 'Richard Maynard – yeoman and ironmaster,' *Wealden Iron,* 2nd Series, **3**, 24.

Cattell, C. S., 1979, 'The 1574 lists of Wealden ironworks,' *Sussex Archaeological Collections [SAC],* **117**, 161-72.

Cleere, H. & Crossley, D. W., 1985, *The Iron Industry of the Weald* (Leicester, Leicester University Press).

Cornwall, J., 1976, 'Sussex Wealth and Society in the Reign of Henry VIII,' *SAC,* **114**, 1-27.

Crossley, D. W., 1975, *Sidney Ironworks Accounts, 1541-1573* (London, Royal Historical Society.

Crossley, D. & Saville, R., 1991, *The Fuller Letters 1728-1755: Guns, Slaves and Finance* (Lewes, Sussex Record Society).

Delany, M. C., 1921, *The Historical Geography of the Wealden Iron Industry*.(London, Benn).

Egerton, J. C., 1924, 'Lecture on the history of the parish of Burwash,' in *Sussex Folk and Sussex Ways* (London, Methuen) 131-162.

Garraway Rice, R. & Godfrey, W. H. (eds.), 1935, *Transcripts of Sussex Wills as far as they relate to ecclesiological and parochial subjects, up to the year 1560, vol. 1* (Lewes, Sussex Record Society).

Goodwin, J., 1959, *Burwash and the Sussex Weald: An English History in Miniature*, (Burwash, The author).

Goring, J. J., 1978, 'Wealden Ironmasters in the Age of Elizabeth,' in Ives, E. W., Knecht, R. J. & Scarisbrick J. J. (eds.), *Wealth and Power in Tudor England: Essays Presented to S.T. Bindoff* (London: Athlone Press) 204-227.

Hodgkinson, J., 2008, *The Wealden Iron Industry* (Stroud, Tempus).

Hopkins, R. T., 1921, *Kipling's Sussex*, (New York: Appleton).

King, P. W., 2002, 'Bar Iron Production in the Weald in the Early Eighteenth Century,' *Wealden Iron,* 2nd Series, **22**, 25-28.

Kipling, R., 1908, *Puck of Pook's Hill* (London, Macmillan).

Kipling, R., 1937, *Something of Myself: For My Friends Known and Unknown*, (London, Macmillan).

Mundy, P. D. (ed.), 1913, *Abstracts of Star Chamber Proceedings Relating to the County of Sussex, Henry VII to Philip and Mary* (London: Mitchell, Hughes & Clarke).

Pelham, R. A., 1934, 'The Distribution of Sheep in Sussex in the Early Fourteenth Century,' *SAC,* **75**, 130-137.

Pettitt, J., 1978, 'John Collen: his hammer-forge in Burwash 1524-6,' *Wealden Iron,* 1st Series, **14**, 10-11.

Salzman, L. F. (ed.), 1937, *The Victoria History of the County of Sussex, Vol. 9: The Rape of Hastings* (London: Oxford University Press).

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

Teesdale, E. B., 1986., 'The 1574 lists of ironworks in the Weald: a re-examination,' *Wealden Iron,* 2nd Series, **6**, 10-17.

Tyacke, N., 2001, *Aspects of English Protestantism* (Manchester, Manchester University Press).

Vivian, S. P. (ed.), 1953, *The Manor of Etchingham cum Salehurst* Lewes, Sussex Record Society).

Sources Consulted at the East Sussex Record Office

Additional Manuscripts, Catalogue L

AMS/5789/21 Probate of John Colyn the elder of Burwash, mentioning forge in Burwash and furnace in Brightling, and lease of marsh in Herstmonceux and Hailsham, 1541

Archive of the Maryon-Wilson Family of Searles in Fletching

Title deeds - other parishes:

SRL/7/5 Messuage, barn, stable and land (7a), lands (60a) called Calldebrough, lands (20a) called Highe Lands, messuage and land (50a) called Climshurst in Burwash; 1596: Settlement (covenant to levy fine) for £400 (18 Nov 1596)

Archive of the Roberts Family of Boarzell in Ticehurst and Stonehouse in Warbleton and the Dunn Family of Stonehouse

Deeds of various properties in Etchingham, Essex, Battle, Hailsham and Kent 1529-1740:

DUN 14/1 Draft or copy lease for 10 years from 24 Aug 1568 (1 Feb 1568)

Ashburnham Family Archive - Manoral Documents

Manor of Burghurst, in Burwash (Accounts):

ASH/200a/11-12H6 Rental of 2d for a forge newly build at Durefoldgate (1432-3)
ASH/200a/16-17E4 Rental of 2d for a new forge by Burwash Church (1476-7)
ASH/200a/15-16H8 £16 received from the farm of the iron mill leased to John Colyn (1523-4)
ASH/200a/16-17H8 £20 received from the farm of the iron mill leased to David Harvy of Burwash (1524-5)

Deeds and Documents relating to lands formerly belonging to the family of Fuller of Brightling

Collins Forge in Burwash:

SAS-RF/1/7 Articles of Agreement (26 Jun 1669)
SAS-RF/1/8 Release and quitclaim (26 Feb 1672)
SAS-RF/1/9 Lease for a year (28 Jun 1672)
SAS-RF/1/12 Agreement (25 Oct 1672)
SAS-RF/1/14 Deed of Covenant (22 Nov 1700)

Probates and Wills:

SAS-RF/11/26 Probate of the Will of this date of John Fuller of Rose Hill, esquire (17 Jan 1755)

Miscellaneous:

SAS-RF/13/18 Memo. of Agreement (3 Jun 1617)
SAS-RF/13/23 Lease for a year (1 Nov 1649)

SAS-RF/13/26 Copy of Court Roll of the Manor of the Prebend of Brightling of a Court of Joseph Bennett, clerk, rector of Brightling church (24 Apr 1662)
SAS-RF/13/27 Lease for a year (30 Aug 1664)
SAS-RF/13/28 Release (31 Aug 1664)

Sources Held at the National Archives (Consulted Online)

Records created, acquired, and inherited by Chancery, and also of the Wardrobe, Royal Household, Exchequer and various commissions

Court of Chancery: Six Clerks Office: Pleadings, Series I, Elizabeth I to Charles I:

C2/Eliz/C4/47 Crottenden etc. v Hepden (between 1588 and 1603)

Pot founders at Wealden ironworks

J. S. Hodgkinson

In the journal kept by Giles Moore, Rector of Horsted Keynes in the mid-seventeenth century, he noted, in the section he reserved for purchases of iron articles, that he had been promised an iron fireback "in Mr Michelbornes mould … the next Time that the Potters cast." In the next entry in the same month, November 1657, he recorded the purchase of a pot from Stephen Marden, potter.[1] This was, almost certainly, the Stephen Marden, pot founder, to whom a marriage licence had been granted in 1634 when he was living (and presumably working) in Lurgashall.[2]

Pot founding was a skilled branch of the founder's craft which involved the production of castings in iron using box moulds. Hollow wares, such as pots could only be cast in this way and the skill in their manufacture necessitated expertise in making moulds that would allow iron to fill a shaped void within a sand- or loam-filled container. The fact that they were sometimes referred to as potters, as in the case of Stephen Marden, may have led to the Oxford Dictionary definition of pot founding formerly being incorrectly associated with the making of ceramics. This has now been corrected.[3] The source for the definition is the marriage licence of a John Tiler, pot founder of Hawkhurst, in 1631.

Information about the activities of pot founders in the Weald is fragmentary, and the number of individuals who can be so identified is unlikely to represent the degree to which the production of such wares was carried out in the region. Schubert identified the Buxted founder, Charles [Pulleyn], as supplying a pot to Robertsbridge in 1548,[4] and it is likely that many founders produced such objects without being specifically described as pot founders. At Horsted Keynes furnace, Giles Moore paid the founder, John Tully, for an iron pot the year before his purchase from Stephen Marden.[5] That a pot founder had to be called upon for the casting of a fireback, which might be regarded as a fairly simple object to make, calls into question the level of skill of the labour force at Horsted Keynes furnace, and the need for Giles Moore to wait until such an artisan was available suggests that pot founders operated at several furnaces, perhaps visiting them in rotation. Such skill levels may have been experienced at other furnaces.

The first person it has been possible to identify as a pot founder is a French immigrant ironworker named Renney Durante, who died at Horsmonden in 1592.[6] He is probably the same individual who was noted as working in Rotherfield Hundred twenty years earlier.[7] From him sprang two more generations of pot founders. His executor was his son, Anthony Durrant (the change in spelling is recorded in Renney's will), who clearly continued in his father's trade, being named as such in his own will which he made in 1613 just before his death in East Grinstead.[8] Among Anthony's many children was another pot founder, Humfrey, who was married at West Hoathly the same year but who was to die at Rudgwick only four years later.[9] We do not know at precisely which ironworks the Durrants worked, but Mill Place furnace, which lies between East Grinstead and West Hoathly, is a likely candidate, and Dedisham furnace was almost certainly where Humfrey would have been active before his death.

The pot founder who figures most prominently in the records is Symon Colman. He was described as of Brede when he acted as surety for licences for two marriages, in 1634 and 1635, at Brede and Westfield respectively.[10] However, he was living at Sevenoaks when he wrote his will in 1650,[11] and it provides us with a wealth of detail about his own career as well as mentioning a number of other pot founders with whom he was associated. The beneficiaries of his will included five people for whom Colman worked, leaving each of them a modest bequest because, as he testified, they "were loveinge unto me", and "I did earne much money of them." Their identities give us clues as to where Colman had worked: John Browne, of Horsmonden furnace, whose monopoly, obtained in 1635, of casting pots, among other iron products, "in the French manner", did not seem to prevent others carrying on the trade;[12] Sir Thomas Sackville, of Sedlescombe, who owned Brede furnace; Peter Farnden, also of Sedlescombe, who had Beckley furnace; William Wood, of Crowhurst, whose involvement in the iron industry has not been recognised until now, but who owned the Oldlands estate in Buxted and Maresfield between 1609 and 1614;[13] and Walter Lucas, of Wivelsfield, who was associated with Maresfield furnace where he had worked for Sir Sackville Crowe in 1619.[14] In addition, Colman names two other pot founders: Thomas Walker, of Tonbridge, whose son, Symon, was also a beneficiary, and William Turner of Bidborough, who is likely to have worked at Barden furnace, and who was appointed one of the overseers of Symon Colman's will.

Of other pot founders who may have lived and worked in the Weald, only the name of Laurence Kempe has been noted. He was living in Wadhurst in 1640.[15]

Notes and References

1. Bird, R., 1971, *The Journal of Giles Moore* (Lewes, Sussex Record Society), 24-5.

2. Dunkin, E. H. W., 1911, *Calendar of Sussex marriage licences recorded in the Peculiar Courts of the Dean of Chichester and of the Archbishop of Canterbury. Deanery of Chichester, January, 1582-3, to December, 1730. Deaneries of Pagham and Tarring, January 1579-80 to November 1730* (Lewes, Sussex Record Society vol. 12), 57.

3. Oxford English Dictionary online; http://dictionary.oed.com/cgi/entry/50185292/50185292se71single=1&query_type=word&queryword=potfounder&first=1&max_to_show=10&hilite=50185292se71; accessed 11 May 2010, 15:30.

4. Schubert, H. R., 1957, *History of the British Iron and Steel Industry* (London, Routledge & Kegan Paul), 268.

5. Bird, op. cit., 24.

6. The National Archives (hereafter TNA), PROB/11/79.

7. Awty, B. G., 1984, 'Aliens in the ironworking areas of the Weald: The Subsidy Rolls 1524-1603,' *Wealden Iron*, 2nd ser., **4**, 47.

8. TNA, PROB/11/121. I am grateful to Michael Leppard for drawing my attention to this document and for, thus, motivating this brief article.

9. West Sussex Record Office, Chichester, Par/379/2/4, Transcript of marriage registers, with index, 1606-1900; compiled by D.J.H. Clifford and West Hoathly Local History

Society, 1995; 13 Jan 1613. TNA, PROB/11/130.

10. Dunkin, E. H. W., 1901, *Calendar of Sussex marriage licences recorded in the Consistory Court of the Bishop of Chichester for the Archdeaconry of Lewes, August 1586 to March 1642-3* (Lewes, Sussex Record Society vol. 1), 211, 219.

11. TNA, PROB/11/212.

12. TNA, SP/16/264, f.154.

13. East Sussex Record Office, Lewes, SAS-F/214 & 216.

14. Cleere, H. F. & Crossley, D. W., 1995, *The Iron Industry of the Weald* (Cardiff, Merton Priory Press), 175.

15. Dunkin, E. H. W., 1907, *Calendar of Sussex marriage licences recorded in the Consistory Court of the Bishop of Chichester for the Archdeaconry of Lewes, August 1670 to March 1728-9, and in the Peculiar Court of the Archbishop of Canterbury for the Deanery of South Malling, May 1620 to December 1732* (Lewes, Sussex Record Society vol. 6), 285.

Addition to the catalogue of early iron graveslabs[1]

J. S. Hodgkinson

CHAILEY, EAST SUSSEX TQ/3919

1762 RICHARD PORTER, under tower; 90.5 x 182cm.

> Here lieth the Body / of Richard Porter AM / Who was eight Years / Rector of this Parish / He Died the third day / of February Anno Domini / 1762 / Aged 46 Years

Plain, borderless slab; very even Roman letters in centred lines 26cm from top edge and 94cm from bottom edge; caps 4.5 - 4.9cm; lower case 3 - 3.5cm.

Richard Porter was educated at Jesus College, Cambridge, and was Rector of East Hoathly from 1741, resigning the living in 1752 in favour of his brother, Thomas, to become Vicar of Mayfield. In addition he became Rector of Chailey the following year, there succeeding his uncle, also Richard.[2] The graveslab of another member of the Porter family - Frances, *née* Colpepyr, the wife of Thomas Porter - is in Wadhurst church.[3] Despite the Wadhurst slab being older by 45 years, the similarity of the size and style of the lettering with the example in Chailey suggests that both graveslabs may have come from the same source.

Notes and References

1. *See also Wealden Iron*, 2nd ser., **8** (1988), 12-47; 2nd ser., **9** (1989), 9; 2nd ser., **14** (1994), 28-9; 2nd ser., **22** (2002), 22-3; 2nd ser., **28** (2008), 21-2. I am grateful to Mr

F. Millwood for the location of this memorial.

2. Vaisey, D. (ed.), 1984, *The Diary of Thomas Turner* (London, Oxford UP), 336. Dunkin, E. H. W., 1875, 'Contributions towards the Ecclesiastical History of the Deanery of South Malling,' *Sussex Archaeological Collections* **26,** 71.

3. *Wealden Iron*, 2nd ser., **8** (1988), 41.

Some operating characteristics of Wealden iron industry waterwheels, bellows and tuyeres

Jonathan Prus

The power delivered by Wealden iron industry waterwheels may not have exceeded 300 Watts, very little by modern standards. The data that lead to this assessment are archaeological and historical but they are limited in scope and number. However, the maximum and minimum power ratings are tightly constrained by other data that are more easily checked, notably by the chemistry of blast furnace operation (which provides minima) and by human physiology (which provides power maxima).

1. Statement of maximum input power

The energy that might be delivered by an overshot waterwheel is given by the expression:

$$E = mgh$$

where m is the mass of water moving the vertical distance h under gravity g. This states the theoretical maximum available and ignores the factors that reduce efficiency. In addition the designs of the (archaeologically) available examples (Cleere and Crossley, 1995) are sub-optimal: the buckets on the wheels are configured to drop their water before they approach the lowest point of their cycle, thus sacrificing some potential energy. The near-contemporary designs of John Smeaton went a long way towards eliminating this fault, but these ideas do not appear to have been embraced by the Wealden iron industry. In the calculations associated with this paper it is assumed that the loss of energy at the low points of the revolution is offset by the gain in kinetic energy from the water flow input at the top. Whilst this assumption is approximately true for surviving waterwheels from other contexts, it may not be correct for the Wealden iron industry: power inputs may have been lower than suggested here.

Crossley *et al.* (2006, p.196) present an *Appendix* in which the calculation of the power developed by an overshot wheel is made, applying the expression $E = mgh$. They are concerned with wheels used to grind steel working with efficiencies that could only be achieved with improved waterwheels. Tylecote and Cherry (1970) approached a similar problem (the power developed at a water-powered bloomery and trip-hammer) working from assumptions about the velocity of water in a channel serving a wheel thought to be of the undershot type. Their conclusion that the air-pumping component of this system required 2.5 horsepower (about 1900 Watts) to pump about 35 litres of air per second is challenged by the numbers presented below.

			metres	inferred	metres sq	vol. per
	metres	metres	Bucket	no. of	bucket	bucket
	Diam.	Width	spacing	Buckets	x-sect	litres
Chingley	3.34	0.32	0.37	28	0.04	14
Batsford	3.9	0.45	0.33	38	0.04	16
Chingley Forge	2.44	0.66	0.33	24	0.03	19

Table 1. Wheel data used in the following calculations.
Source: Cleere and Crossley 1995

Cleere and Crossley (1995) give explicit details of the remains of three water wheels used in Wealden iron industry contexts. Given a rate of two revolutions per minute (Hodgkinson, 1995) these archaeological details suggest that they used about 18 litres of water per second and had a diameter of about 3 metres.

Assuming that the vertical distance through which the water passes is the diameter of the wheel, this suggests a typical upper limit to input power of about 530 Watts. However, machines are inherently inefficient and a probable efficiency for a pre-industrial revolution water wheel is around 55%. This gives us a likely power rating of about 290 Watts, a mildly surprising result.

Inefficiencies arose from water turbulence, splashing and axle friction. Relevant to the argument here, further inefficiencies arose from the work done flexing the bellows, cam friction and turbulent airflow. All of these must, to some extent, have reduced the total system efficiency. At times obstruction of the tailrace may have reduced power input at the axle.

So far we have been concerned with the conversion of potential energy in water into useful work: a second approach to the problem is suggested by the records of wheel-bellows systems being operated by man-power alone. In 1744 Fuller alluded to this:

> "…both Mr. Crowleys furnaces are blown out for want of water… they tread the wheel att Waldron, Robertsbridge and Beckley, which is an excessive charge…".(Crossley and Saville, 1991, 188)

The gross energy delivered to the wheel by treading men, equivalent to mgh, must have been limited by what real humans can deliver over an extended period. Athletes can deliver several horsepower, thousands of Watts, but only for fractions of a second. Fit young males can deliver power in the range 400 to 900 Watts for a few seconds, but these are not very useful numbers. It is more useful to consider food inputs in kilojoules: if we take a daily diet of one quartern loaf (four pounds) and use a value of 10,280 $kJkg^{-1}$ (modern wholemeal bread) the mean energy input would be 216 Joules per second (i.e 216 Watts). Assuming 30% efficiency for the human machine, we cannot imagine any normal man sustaining an output of much more than 200 Watts over a period of hours. (200W output is approximately equivalent to running upstairs at two steps a second. This calculation is another application of the expression $E = mgh$.) The widths of the wheels listed by Cleere and Crossley preclude the possibility that more than two men at a time worked such wheels as treadmills. Thus about 400 Watts delivered to the axle of the system would appear to be an upper limit in treadmill mode, but this was sufficient to maintain the blast.

2. Air pumping requirement and system pressure

A third approach to understanding the power requirements of the wheels-bellows systems of the Weald is to look at the mass of oxygen needed to complete the oxidation of the fuel in the furnace. There is a minimum volume of air that must pass through a tuyere of some sort. This tuyere must have a maximum and a minimum plausible diameter. These issues are considered in this section and the two following.

The air throughput of a blast furnace can be calculated from:

Daily output of iron during campaign
Charcoal consumed per ton output
An assumption about the mineral content of charcoal used.

To burn a simple carbon fuel such as charcoal requires a fixed amount of oxygen. Oxygen constitutes just under 21% of air, and all gasses occupy about 22.4 litres per mole at ordinary temperatures. The Rev. A. Young (1812) tells us that the Ashburnham furnace required 3.85 loads (approximately a ton per load) of charcoal to produce one ton of pig iron, a value similar to those quoted elsewhere (e.g Hodgkinson, 1995, p.11, Cleere and Crossley, 1995, p. 287). If the furnace produced one ton of pig iron per day of the campaign (compare Cleere and Crossley, *ibid*.), and assuming that the charcoal had a fairly typical 20% non-combustibles content, the air requirement was about 166 litres per second of operation.

If the power used to drive this air through the system was about 290 W, then the maximum average pressure that could have been sustained in the system was about 1760 Pascals, or slightly less than 0.3 pounds per square inch, during alternate and effectively continuous down strokes. It should be noted that this must refer to the pressure within the bellows and that the pressure within the furnace itself had to be lower.

3. The dimensions of the bellows

The wheel-bellows systems of which we know had two sets of three nubs or cams on an axle driving two pair of bellows and we know of wheels timed at two revolutions per minute (Hodgkinson, 1995), but this may only be an approximate time. Two revolutions per minute from a three-nub axle driving two pair of bellows implies twelve strokes per minute. If the air requirement was 166 litres per second, the volume driven out on each down stroke must have been about 1660 litres, a huge volume. Rounding the calculation, and assuming each pair was four metres long and one metre wide and had an effective stroke of 600 millimetres, the required air could be pumped out by a wheel turning at 2.1 revolutions per minute. (These dimensions are approximately the same as those reported by Sir James Hope for bellows he saw in Kent in 1646 (Marshall, 1958)).

Assuming that the down strokes were effectively continuous and that the travel on the upper bellows board was 600 millimetres, 290 W could exert a force on the end of the bellows of about 2300 Newtons, equivalent to a weight of 235 kilograms pressing down. This is equivalent to 1760 Pa acting on the ‘centre’ of the bellows board in the opposite direction.

4. The Tuyere

If 290W was *all* used to drive air along the tuyere we must infer that it had a minimum internal diameter of 64 mm. This requires that furnace pressure was at or below atmospheric pressure, with the consequent inference that a chimney-effect significantly reduced furnace pressure and/or that Venturi effect at the inlet prevented the egress of gas. (Pumping air into a furnace with internal pressure above atmospheric would have required more power than could have been available.) The absence of a seal between tuyere and furnace is consistent with Sir James Hope’s slightly cryptic description (Marshall, 1958, 149-150)

290 W is the power required to accelerate the air to a sufficient velocity to allow the requisite volume to pass through a pipe with internal

diameter 64 mm.. Unfortunately this understates the total power requirement because it ignores the effects of turbulent airflow in the tuyere: there exists no possibility that this flow was laminar. There are too many unknowns (the nature of the surface of the tuyere, its cross-sectional and longitudinal shape, and its length) accurately to calculate the whole power requirement. However, if we simplify this calculation by treating the tuyere as a simple orifice causing turbulence, the power available suggests that the tuyere orifice should have a minimum diameter of about 75 mm.* It may be objected that a chimney or 'stack' effect within the furnace would reduce the power requirement. Stack effect can be calculated using a simple formula that has been available to industrial archaeologists for a long time (*see*, e.g. Warburton 1987):

$$\Delta P = Cah\left(\frac{1}{T_o} - \frac{1}{T_i}\right)$$

where C is a dimensionless coefficient, h is the height of the stack (or furnace in this case), T_o and T_i the outside and inside temperatures respectively and a is atmospheric pressure. Making the most generous assumptions, for a blast furnace this pressure difference is 60 Pa or less, or about 3.5% of the pressure generated by the bellows. The flow along a pipe (or through an orifice) varies with the square root of pressure difference, so this value probably had little effect of the size of tuyere required. However a pressure difference of 60 Pa may well be enough to obviate the need for any seal between the tuyere and the furnace.

An internal diameter of about 64 to 75 mm. is similar to the ceramic blast furnace tuyere on display at the museum of Le Fourneau de St. Michel near St. Hubert in the Ardennes (internal diameter about 71 mm.). The calculation of tuyere minimum diameter suggests a researchable question: can one locate any ceramic, brass or cast iron pipes or fragments that may come from blast furnace contexts that could match

*This calculation was performed using the on-line calculator to be found at www.flowmeterdirectory.com this description?

5. Conclusion

The physics and chemistry of water power and blast furnace operation give us the same answers about the power requirements of Wealden wheel-bellows systems as the archaeology and the historical records. We may confidently believe in wheels with a three metre diameter rotating at 2 rpm, or thereabouts, and delivering less than 300 watts. In particular the tiny streams filling many pond bays were adequate to produce the tiny amounts of power that appear to have been used. We may, perhaps, add the limitations of these power sources to the other factors that prevented the Wealden iron industry from participating in the industrial revolution of the nineteenth century.

The present writer will provide a copy of a spreadsheet allowing interested persons to explore and modify these calculations: requests to jonathan@avens.co.uk

Bibliography

Crossley, D., *et al.* (eds.), 2006, *Water Power on the Sheffield Rivers* (South Yorkshire Industrial History Society).

Cleere, H. and Crossley, D., 1995, *The Iron Industry of the Weald* (Cardiff, Merton Priory Press).

Hodgkinson, J. S., 1995, 'Notes on early 18th-century Memoranda on the making of iron,' *Wealden Iron*, 2nd. Series, **15**, 9-18.

Marshall, P., 1958, 'The Diary of Sir James Hope, 1646,' *Miscellany of the Scottish History Society,* **9**, 129-197.

Muller, G. & Kauppert, K., 2003, 'Old watermills – Britain's new source of energy?' *Civil Engineering*, V, **150**, 178-186.

Tylecote, R. F. and Cherry, J., 1970, 'The 17th-century bloomery at Muncaster Head' (Appendix A), *Transactions of the Cumberland and Westmorland Antiquarian & Archaeological Society*, New series, **70**.

Warburton, R., 1987 'The Factory Chimney: Some Technical Aspects,' *Industrial Archaeology Review*, **9**, *2*, 195-8.

Young, A., 1813, *General View of the Agriculture of the County of Sussex* (Newton Abbot, David & Charles Reprints 1970).

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