NEWSLETTER No.38 Autumn 2003

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LETTER FROM THE CHAIRMAN

Dear Fellow Members,

I am writing this letter at an exciting time, with the imminent excavation of a bloomery furnace – the first such excavation by WIRG for many years. It has been a disappointment that we have not had at our disposal sufficiently expert personnel to enable us to mount more lengthy and probing excavations. Indeed, much of what has been discovered about the technology of early Wealden ironmaking was the result of work in the 1960s and 70s. Since then, while we have been able to increase our knowledge about the extent of the industry, through fieldwork, the investigation of structures and working areas has been neglected. I am hopeful that the forthcoming (or, by the time you read this, recent) dig will presage a resurgence of a more investigative role for the group.

Another disappointment has been my personal decision to disengage myself from the project to establish a Historic Ironworking Centre at Horam. I still believe that there is a demonstrable opportunity for such an attraction in the Weald, but I reached the conclusion that the conditions at Horam were never going to allow the fulfillment of the scheme I drew up in 1996. To succeed, it needed to be completely focused on iron, and not merely be one of a disparate group of 'attractions'. If another site were proposed, where the required conditions could be met, I would be among the first to want to seize the opportunity.

It was good to see so many members at the AGM. As usual the Committee is always pleased to hear news of discoveries and developments, or to offer help in pursuing lines of research.

My best wishes for 2004

Jeremy Hodgkinson.

ANNUAL GENERAL MEETING

The **Annual Report and accounts** will in future be sent out with the Autumn Newsletter.

Our meeting this year was held in Mark Beech Village Hall and as usual it was well attended. The venue this year was chosen so that we could visit nearby Cowden Furnace in the afternoon. After the business of the meeting was concluded, our Chairman gave a talk on the sometimes confusing ownership of Cowden Furnace, the gist of which is given below:

In the Cowden valley there were two furnaces that we know to-day as Scarletts and Cowden but these were in the past variously referred to as "Cowden", "Skarlets", "the upper furnace at Cowden", and "Cowden the lower", not to mention "a furnace for iron works commonly called Swaynslands".

The earliest reference to Cowden appears in a Will of April 1559 which refers to 'Lawrence the founder of Cowden'. Michael Weston appears in the 1574 list as occupying a furnace at Cowden. However, the enduring owners of Cowden Furnace appear to have been the Swaysland family, who began by operating the furnace themselves, or with partners, but who later let out the furnace to other ironmasters. When the demand for guns was high, such as during the Dutch Wars, the Browne family, then gunfounders of Brenchley habitually leased other furnaces. They were at Cowden in 1638 and there are further references to them at Barden, Scarletts and Cowden in the 1650s.

After the Brownes, came another notable ironmaster, William Benge who, in 1692 was reported to have supplied grenado shells from the foundry at Cowden. However, again there is some doubt about this because in 1664 Scarlets is referred to as "stocked" whereas "Barden and Cowden the lower were ruined before 1664 and so remain." It may well be that the granadoes shells were made at the newly stocked Scarlets.

In 1732, Henry Swaysland sold Lower Cowden Farm to George Lewis and it later came into the possession of William Bowen. In 1729 William Bowen first appears involved in iron in Southwark when he purchased sows from John Fuller. He was also associated with an iron depôt near Marigold Stairs, Southwark, close to where Blackfriars Bridge is. (Many ironfounders had yards on the Thames and could deal with each other). William Bowen was also connected with Barden. Guns and other iron products would be sent along the Medway from Branbridge (East Peckham) and thence to Newhithe and the Thames. Bowen is known to have subscribed to the Medway navigation. Bowen sold guns to the Board of Ordnance and may have sold to the merchant service and others. His guns, an example of which has been recorded on St Kitts, West Indies, can be identified by his initials WB on their trunnions.

John Fuller described Bowen as "the best moulder among us". He produced cannon and mortars with beautiful mouldings at his brass foundry in Southwark and perhaps at one of his Wealden furnaces. He died in 1771 leaving his estate to his wife's niece, who was by then married to the Rev. John Warren. His executor was Stephen Remnant, son of Sam Remnant, who was agent at Woolwich for several Wealden ironmasters. There were close relationships between the Bowen and Remnant families.

Jeremy's talk and the excellent map that he provided (courtesy of William Bowen) gave us useful evidence on which to base and enjoy our subsequent visit to the site of Cowden furnace. In fact, there was little there that could have told us exactly where the various features of the furnace site had been, although much evidence of slag and burning – just enough to whet the appetite for conjecture. Was that building contemporary with the furnace? Was that the actual site of the furnace? And so on........

Dot Meades

THE SMELTING EXPERIMENTS

Experiments continue at the bloomery furnace site by changing various parameters in a fairly logical fashion, although occasionally an experiment produces an unexpected result. For example, we do not have much control over the type of wood that is charked for us and is usually Hazel. However, our collier, Mr Mann of Edenbridge, produced some Beech charcoal at the Bentley Wood Fair, Uckfield, Sussex, in the autumn of 2002. This charcoal was tried using our normal 4 litres per second blowing rate, finding that the thermocouples measuring the temperature showed a 100°C average higher temperature, compared to Hazel. This resulted in a very good slag-run when it was tapped, because the slag was much less viscous, and our largest ever bloom of around 3.8kg was produced; this has been sectioned and polished and will be kept as an exhibit. A certain amount of hammer scale (Fe_3O_4) (magnetite) was added to each charge to try to minimize the free-flowing temperature of the tap slag (see Newsletter No.36); this might be considered cheating but the smiths of old would have produced hammer scale in great quantity and might well have used it in this way (although ours came from Coalbrookdale).

Basically, the harder the wood that charcoal is produced from, the greater the amount of heat it will produce (calorific value), unfortunately, we have been unable to find the calorific value of Beech charcoal; any ideas from anybody would be appreciated. (*but see p5.)* We now have some Oak charcoal, another hard wood, and hope to get some smelting data on this before the next Newsletter.

In theory, it should be possible to increase the furnace temperature by blowing harder than the usual 4 litres/second; this should enable Hazel charcoal to reach the temperature of Beech charcoal. However, this airflow could well oxidise the iron in the bloom. When the experiment was tried, it was found very difficult to reach the Beech charcoal temperature, even with an airflow rate of 6 litres/second. Nevertheless, a bloom of iron was produced, although it was smaller and the tap slag did not flow so well.

In the past we have used a 7/8" tuyere made from mild steel pipe that stopped at the inside surface of the furnace whilst allowing a flexible air pipe to be connected to the other end. Unfortunately, a short length of pipe always melted away, leaving an undefined tuyere hole-size inside the furnace at some point during the smelt. It was argued that we might as well start with "just a hole" inside the furnace but still place a tuyere pipe about half way through the furnace wall. This has been used with success, and without adverse effects.... providing the tuyere-pipe and furnace hole are both aligned to allow sighting and rodding-through when the hole becomes blocked with molten slag. Very little is known about Roman shaft furnace tuyeres; they are assumed to protect the nose of the bellows from the heat of the furnace and it is not known if they reached beyond the inside of the furnace; this could produce yet another series of experiments.

We also have our fair share of disasters, as previous reports have noted. The most recent was the destruction of the cast iron tuyere on a portable farrier's forge that was on loan to us. In retrospect, perhaps we were expecting too much from this little forge as it was only meant to heat horseshoes for shaping at, say, 1000°C, whereas we were using it to heat a 1kg piece of iron to fire welding temperature, say 1200°C. Needless to say, the cast iron tuyere melted, leaving just a molten lump of misshapen iron in the hearth.

We have <u>now</u> decided to build our own forging hearth; at least when we build something, we should be able to mend it! It is made-up of angle iron (Dexion) bolted together to give a hearth area of 18in x 18in, and with the capability of using tuyeres of differing diameters. The hearth has a mild steel base and is covered with a 1in thick layer of Ashdown Sand (having a certain amount of clay) rather than using the usual firebricks, which will make it easily repairable. A 2in tuyere pipe terminates before the hearth and a nozzle made of Ashdown Sand formed at the end; once again, it is easy to repair and change the hole size. The furnace bellows can produce the necessary air to the tuyere because we never smelt and forge at the same time.

We noticed with the farrier's forge, and also our original smithing hearths made as a bowl-shape in the ground, that the charcoal fuel was blown away when using a standard 7/8in tuyere, but worked well when modern smithing coke "beans" were used. We think this is probably due to the charcoal having a low density and poor aerodynamic properties compared to smithing coke. Our very first experiment with the new hearth, using a 1½in tuyere, charcoal fuel, and blowing at about 10 litres/second was a great success, even in front of the Carlton TV cameras, when everything would be expected to go wrong. What tuyere size was used in the days of charcoal smithing would be of interest; any ideas?

Ever since starting our recent smelting experiments, we have taken care not to expose the pumpers to the toxic carbon monoxide (CO) gas coming out of the furnace. This has been accomplished in two ways: -

(1) Keep the gas ignited at the top of the furnace at all times.

(2) Have a long air pipe between the bellows and tuyere. However, we have never bothered to make the pumpers' life comfortable; either siting the bellows on the ground or tying them onto wooden blocks (tree trunks). This problem has now been addressed, and a low, three legged wooden trestle made to take both bellows, and even with a form to sit on. Note: two legs will be at the extreme ends of the form, so that one pumper standing up will not deposit the other one on the ground, as per the good old days at school.

Brian Herbert

BOOK REVIEWS

Fernhurst Furnace and Other Industrial Sites in the Western Weald.

Chichester District Archaeology 2, John Magilton et al, Chichester District Council, 2003, 108 pp index, bibliography.

This excellent in-depth study of Fernhurst's North Park blast furnace and environs contains much more than a detailed excavation report on the site, having several articles on the western Wealden iron industry. The first two chapters 'Settlement in the Western Weald' (Thomas) and 'Iron-making in the Weald' (Hodgkinson) provide a wider historical context.

North Park was one of the earliest western furnaces and the last of these to close down. The excavation uncovered some puzzles, which remain unresolved. Intriguingly, some (limited) evidence suggests there may have been three near-parallel wheelpits at one time, although it seems unlikely three waterwheels were necessary for the bellows. It is suggested one wheel possibly powered the elusive boring mill, the exact location of which remains obscure. North Park was a relatively small furnace structure (5.4 x 5.4m) but its gun-casting pits are the largest so far excavated (diameter 2.5m). Unusually, elegant stone revetments of greensand and ashlar blocks reinforced the pond bay; these repairs occurred late in the furnace's working life, or perhaps after work ceased. The unique structural features of this complex site are well illustrated by plans, and photographs of the hearths, sluices and other building foundations.

Barnes's chapter on Pophole and other Wey-powered sites combines a clarification of the oft-confused northwest Wealden ironworks and other mills, with an examination of parish records of some of the people who worked there. Evidence is also presented attesting to the role of vagrant, as well as migrant, workers in the region (Barnes and Magilton). A chapter on the Yaldwyns of Blackdown, a local iron family variously connected with Frith, Imbhams, Lurgashall furnaces and Witley forges yields insights from their accounts, including provision for workers and tenants (Thomas). Magilton ends with a discussion of the impact of ironworking on the Wealden environment.

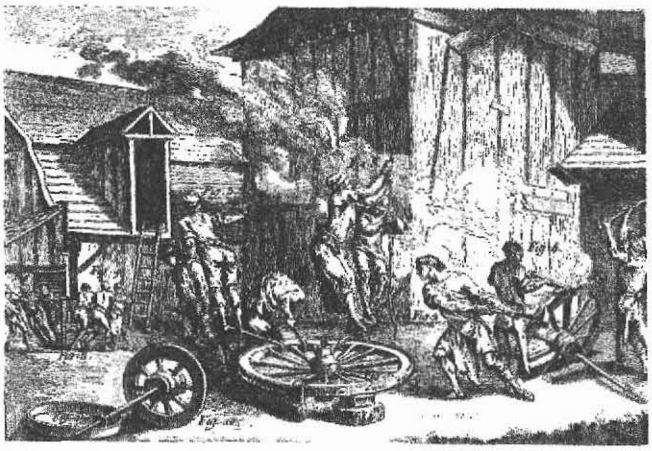
The book has enough technical detail for those familiar with industrial archaeology and/or Wealden iron without alienating novices and should stimulate further interest among the latter. Maps, diagrams and other illustrations are used well throughout the text. Magilton and Chichester Archaeological Service deserve congratulations for producing a technical historical report in a reasonably popular, attractive format. It's a pity more ironworks haven't enjoyed the same individual attention but perhaps this example will inspire similar publications about other sites. It is also to be hoped this book will act as a spur to obtaining sufficient funding to repair and conserve this site.

Helen Pearce

Gillespie on Diderot

One often sees references to Denis Diderot's Encyclopedias, a set of some 2,000 copperplate etchings published about 1871, in France. His reasoning for making these engravings is quite interesting:

"Let us at last give the artisans their due. The liberal arts have adequately sung their own praises; they must now use their remaining voice to celebrate the mechanical arts. It is for the liberal arts to lift the mechanical arts from the contempt in which prejudice has for so long held them, and for the patronage of the kings to draw them from the poverty in which they still languish. Artisans have believed themselves contemptible because people have looked down on them; let us teach them to have a better opinion of themselves; that is the only way to obtain more nearly perfect results from them. We need a man to rise up in the academies and go down to workshops and gather material about the arts to be set out in a book which will persuade artisans to read, philosophers to think on useful lines, and the great to make at least some worthwhile use of their authority and their wealth".



A wheel being tyred - Plate 175 from Diderot

Some of Diderot's etchings are reprinted in:- **Pictorial Encyclopedia of Trades and Industry; with notes by C. C. Gillispie**; *Dover Publications, Inc, New York; 1987; approximately A4 paperback; Vol. 1 ISBN 0-486-27428-4 & Vol.2 ISBN 0-486-27429-2*. The etchings are free from copyright and may be copied at will, but I guess not for profit.

These are available from the web: -
Vol.1 is available from www.Amazon.co.uk for about £20.
Vols. 1 & 2 are available from www.store.Doverpublications.com for about $30 each.

The two books cover countless trades and industries, for example, agriculture, beekeeping, dowsing, glass, marbling of paper, metallurgy, paper, silk, sugar & tanning. Each picture/etching is accompanied by a very short description by the editor, seemingly not a translation but from other sources. As with woodcuts, copperplate engravings tend to be, not surprisingly, clinical and static, rather than the inferno of reality, however Plate 175 is outstanding, and shows a dynamic scene of a wheel being tyred.

All the pictures are from a French point of view, but the modern descriptions compare them to American & English practices of the period. Nevertheless, these descriptions are very basic, and hours of fun and argument are to be had by filling in the details; especially the iron related etchings.

BH

Handbook of Charcoal Making by Walter Emrich
Published by D Reidel Publishing Co., PO Box 17, 3300 A A Dordrecht, Holland, 1985, £148.00 for the Commission for European Comunities but fortunately available from the British Library.

In the smelting team's quest for information concerning the calorific value of different woods used for charcoal, it was hoped that this Handbook would give, or at least point the way, to this information. Unfortunately this was not so. The book has been written for governments interested in setting-up large scale charcoal-producing plants, although small-scale charcoal production is also considered. It is not helpful on the day-to-day requirements of the collier using his secrets to do a very unhealthy job for a valuable product.

However, a few interesting points are noted below:.

Between 100° and 170°C, water is evaporated, between 170°C and 127°C, CO, CO_2 and pyrolysis oil can be produced, and between 270°C and 280°C, CO and CO_2 production ceases and an exothermic reaction starts with the spontaneous heat raising the temperature to 400°C to 450°C and condensable vapours increasing.

Charcoal has now been redefined as: "The residue of solid non-agglomerated organic animal or vegetable matter that results from carbonization by heat in the absence of air, at a temperature greater than 300°C. This distinguishes it from coke that becomes plastic before it carbonizes."

The charcoal kiln may be heated in three basic ways, (see Figs 1,2,3, on p 12)although two of these are only applicable to an industrial environment using a metal kiln.

"Pyrolysis oil" is the condensed vapours that can be collected from industrial charcoal kilns and were once used by the chemical industry.

After production, charcoal vigorously absorbs up to 6% of its weight from water in the air.

Half-burnt charcoal is known as brands and contains an excessive amount (>30%) of volatiles.

A minimal sulphur (<0.05%) and phosphorus (<0.03%) content is important for metallurgical applications.

Calorific values between 6,500 and 7,200-kcal/kg (30,100-KJ.kg) are attainable (no tree type considered), similar to bituminous coal. The main ingredients of wood are: - cellulose, hemicellulose and lignin, and it is the latter (being greater) which determines the calorific value of the resulting charcoal, with a hardwood figure of 29% against softwood of 23%.

Fresh wood may have a moisture content of 67%, the limit of combustibility and this factor will depend on the wood species and its age, but after drying, hardwood may be as low as 30% and softwood 46%.

Mention is made of both the "pit" and "earthmound" method of making charcoal, the two methods requiring the least capital outlay; they do, however, require skill and patience which often contain the secrets of successful charcoal making and these are handed down from father to son. Not the least important is the insulation over the earthmound, which, if it develops holes will cause it to flare-up. In the past, bracken, turfs and earth have been used to seal the heap with the result that the charcoal is contaminated when the heap is opened-up; this is not too important when the charcoal is just used for cooking but may not be suitable for smelting due to chemical contamination.

It is assumed that the fire is started at one end before the pit is covered and smaller pits tend to be more efficient because the airflow is more evenly distributed. If a metal cover is available, eg corrugated iron, the resulting charcoal will not be contaminated by soil

Earthmound charcoal is produced in much the same way, except that the one air inlet is replaced by several holes around the base of the heap, whilst smoke pipes are not required because it permeates from the top of the mound. The logs are placed vertically for circular earthmounds and horizontally for rectangular ones, although this is just for convenience, I suspect. It is not practical to cover the heap with metal sheeting unless several pieces can be cut and curved to overlap all around. Once the fire has been started, the operator will see the evaporated water emerging as a dense white smoke, for a day or two, depending on the size of the charcoal kiln; the smoke will next turn blue and then eventually become clear. Having decided that charcoaling is complete (with the earthmound type the kiln will have shrunk in size), the next stage is crucial. All air supplies are cut off and after a great deal of patience the charcoal burner will be rewarded because the charcoal will not catch fire when the kiln is opened. **(Please see diagrams on page 12)**

BH

Also see Straker, Wealden Iron p132-135 quoting John Evelyn (1679 edition) *p212 for picture and description of contemporary charcoal burning, still in use in Straker's time.*

For Calorific Values of woods see Wood as Fuel - **A Guide to Burning Wood Efficiently by Geoff Keighley**. Copies from local offices of the Forestry Commission or by post (50p plus sae) from Geoff Keighley, B.Sc, 26 Halls Farm Close, Winchester, Hants SO22 6RE, Tel 018962 880553

DMM

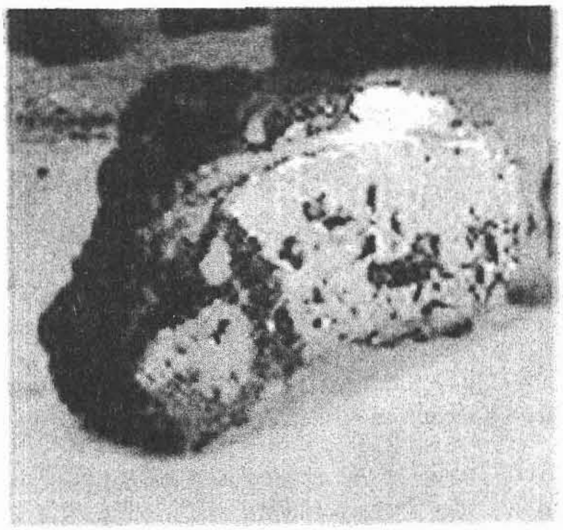
WIRG SMELTERS' VISIT TO ERIC LAMPRELL'S FORGE, MARCH 20TH 2003.

Eric Lamprell, who is a well-known local blacksmith with a forge at Ashurst Wood, very kindly agreed to demonstrate for the benefit of our WIRG smelters. Those present were John Baillie, Dennis Beeny, Brian Herbert, Peter Goodall, Tony Meades and Tim Smith

As part of the complete process of converting ore to iron, we have been trying to learn how best to forge any blooms we make, into useful shaped iron, i.e. bar iron. A 'rough' bloom has 'spikes' of iron around the surface, which when reheated for the first time in the hearth will probably burn/drop off before hammering can be started; hammering within the furnace might well remove some of the adhering slag. In additiion, there are often large fissures and internal voids. Recent experiments, which involved hammering the bloom, against the bottom of the bloomery before removal, have produced the most consolidated blooms. The dissection of these showed a markedly improved structure, i.e. much more iron consolidation with fewer fissures and voids. Logically this should provide a good starting point from which to forge good iron.

We have read various accounts of others working at the forging process, including a group in America (Lee Sauder's), who have been very successful. I have had the opportunity to try forging but with limited success. We hoped that this visit would help us to understand and begin to learn how to deal with the difficulties encountered.

Eric Lamprell has his forge at Ashurst Wood, near East Grinstead, Sussex. He is a very experienced blacksmith and although he had not tried this before, he kindly agreed to help us to learn how to forge bloomery iron. I have seen Eric perform many forge fire welds at public shows and this skill is directly related to our need. Brian arranged the day and time with Eric. Brian brought half of bloom no. 17 for Eric to try to forge. The starting weight was approx 0.7 to 0.75 kg and the piece is shown below:



Half-bloom for forging by Eric Lamprell
Picture by John Baillie

Eric's hearth is much larger than ours, being about 3ft x 3ft, and uses small coke, sometimes known as coke beans; it was already fired up when we arrived. An electric fan provides the air blast and the tuyere is about three to four inches diameter. He placed the bloom in the fire, slightly in front of and about three inches above the tuyere. This placement is very important. The air blast arrived at the bloom piece after having passed through burning coke. This route ensured that the bloom piece was sitting in a reducing (low oxygen +CO) atmosphere. This prevented oxides from forming on the bloom piece surface, which would interfere with the fire welding process.

He limited the air blast so that he could heat the bloom piece up slowly, again most important, to make sure the whole piece was all raised to the right temperature, not just the outside surface. During this heat soak he turned the bloom piece over several times, this helped to even out the heat distribution.

When he judged it was ready, a very bright yellow colour, (he said it must not be sparking, as at that heat it may get 'burned' beyond recovery), he quickly removed it with tongs to the anvil and hammered it very hard. During this time he kept turning it alternately forwards and backwards 90° on the anvil, for about 8-10 blows. This method of hammering is aimed at drawing the iron out into a square section bar and not a cube shape that I had tried to forge. He then returned it to the fire before repeating the hammering.

The next time he swapped ends, i.e. he held the forged end in the tongs and repeated the process on the unforged end, thus extending the square bar shape. During this hammering, he and we had noticed a crack opened across the bar. He put the bloom back in the fire and at the next heat he hammered it on its end to try to close and weld the crack. This did not work and part of the bar broke off.

Summarising, I suggest the essentials to follow, for success:

1. Heat the bloom forward and well above the tuyere.
2. Take time to ensure the heat has soaked right through the bloom.
3. Judge the correct temperature for welding.
4. Apply appropriate hammering techniques.
5. Be prepared to fold and fire weld iron on iron to recover fractures.

Allow enough time to complete the process.

I have included the American's approach below (including US spellings) to provide some reference of success. Explanations of unfamiliar expressions are in brackets.

Lee Sauder's description:

"We forged two currency bars of similar dimensions from portions of this billet (*bloom*). The first trial was a continuation of the morning's billet smithing, using the same forge set up and personnel. A roughly cubical section was isolated from the billet by fullering, and then hammered to a flat of approximately 7.5 cm wide by 2 cm thick. A major transverse crack appeared where the billet had been most drastically deformed during the fullering. We welded this crack as best we could, and then folded the flat section in two, and faggot-welded *(laid one piece on top of the other and welded just like Eric had)* the entire length. We than cut this flat section from the billet and continued to draw out the bar, welding up any cracks as they appeared. We made the mistake, when faggot-welding, of forging the bar to a fairly thin flat cross-section, which slowed the drawing out process considerably. A more efficient forging technique would have been to forge it to a square cross-section that would then be forged to the correct flat stock in the final heats. The latter portion of the work was carried out with a single striker. The final result, after 2 hr 30 m (representing 6.5 man/hours of work) was a socketed currency bar 2.5 x .6 x 50 cm, weighing 623 g. Forging from bloom to billet to this final bar required 73 kg of charcoal.

The following afternoon, Sauder forged another currency bar, utilizing the lessons of the previous day's work. The forge was reconfigured as a shallow side blast forge (they used typical American bottom blast forge before) by filling the firepot (hearth\) with refractory insulation. A more traditional approach to this would have been to create an insulating base of packed cinders (Fitzgibbon 1990). We set our tuyere from the bloomery on the forge table, ad stacked up firebricks around it to create a hearth. This hearth set-up functioned much more satisfactorily than either of the previous day's attempts. The side tuyere was not troubled by slag blocking and choking by charcoal dust as the bottom blast had been. Also, by having a shallow, well insulated base, the bottom of the hearth reflected heat to the fire. Somewhat counter to expectation, the hottest zone of the fire was not in front of the tuyere but below it, halfway between the tuyere ad this reflective base.

A 3 cm chunk of the 5 cm x 5 cm billet, weighing 538 g, was hot cut completely from the bar. All forging was done with a single 2 kg hand hammer. This smaller chunk was easy to bring to a welding heat. Four heats were used to weld from all three directions, bringing the billet chunk to a cube. After a total of 17 heats in 1h 35m, we had a short bar 1.6 cm square and 21 cm long. A further hour of forging and 16 heats produced a socketed currency bar 4.5 mm thick, 2.25 cm wide, and 37.5 cm long, weighing 312 g. This represents 58% of the starting billet weight, and a yield at this stage of 21% of the iron available from the ore. Forging this bar from the billet consumed 20.5 kg of charcoal.

Total labor required for this bar was 2h 35m. This bar was smaller than we intended. If we had started with a 5 cm length of billet, it is reasonable to assume that a 500 g bar could have been forged in 3 hrs.".

Forging our half-bloom
Picture: John Baillie

NEWS FROM ELSEWHERE

Iron Production on Roman Exmoor

A number of WIRG members attended The Historical Metallurgy Society's Annual Conference in September last. There were, of course, some very interesting papers to be heard on various aspects of metallurgy. However, the reason that we particularly wanted to attend this year was the prospect of a visit to the excavation of a Roman ironworks whose size suggested some comparison with Wealden discoveries. We were not disappointed.

Fieldwork and excavations have been undertaken by the Exmoor Iron project, which is run by Exeter University and the Exmoor National Park Authority, with funding from English Heritage.

Dr Gill Juleff of the Department of Archaeology, University of Exeter, accompanied us to an excavation of a large iron-smelting site on the southern fringe of Exmoor. The site is made up of a series of large, man-made platforms, cut into the slopes of a steep-sided valley that lies between open moorland to the north, with its deposits of high-grade ore, and lowland routes to the south, giving access to the markets of the Empire. Extensive woodlands nearby probably supplied the large quantity of charcoal that would have been needed to fuel the iron-smelting furnaces. As we find in Eastern Sussex, there were massive deposits of dumped slag and smelting debris, filling parts of the valley bottom. Production would have been far beyond local requirements and one wonders who was running the site and to where the product was being exported.

In the summer of 2002 and again in 2003, staff and students from Exeter University's Archaeology Department carried out the excavations that we were taken to see. This year's fieldwork by staff and students from Exeter University's Archaeology Department, included excavating a trench across the largest platform and slag dump complex. The trench was almost 3m deep and cut through layers of slag and furnace waste. It revealed remains of smelting furnaces as well as all the elements of a complex workshop where ore was smelted to metal and then forged into bars and billets before a final smithing into whatever iron products were needed. An intact and very solid smithing floor had been formed by the gradual build up of hammerscale from smithing, indicating generations of work on the site.

Radiocarbon dates and pottery finds suggest that the site was in use from the late Iron Age to the 2nd century AD. The site is not unique but one of several along the southern edge of Exmoor, which suggests an organized industry. Lack of arable cultivation has left the site exceptionally well preserved, as are many of the other iron production sites now coming to light through the work of Exmoor Iron. It seems that in Roman times, Exmoor was not the remote wilderness we know now but a thriving industrial landscape.

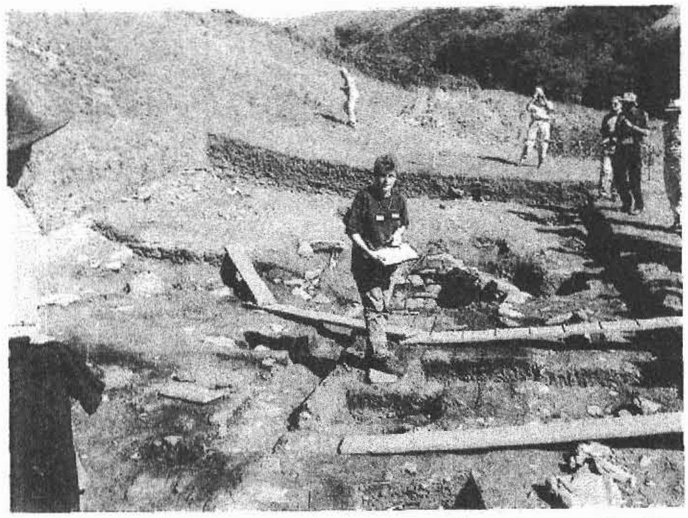
DMM

Captain Cook's Cannon

It seems that no matter where our Chairman goes on holiday, Wealden Iron catches up with him. He writes:

"I came across a nice Wealden cannon in the Australian Maritime Museum. It had been left behind by Captain Cook, from the Endeavour, and is the only example I know of from Darwell furnace. The marks were IC on the left trunnion (for John Churchill) and D on the right (for Darwell). There is an example of a IC – R from Robertsbridge at Fort Nelson (he had both furnaces).

JSH



Excavation at Sherracombe, Exmoor: furnace remains far left and behind figure; smithing area in foreground.
Picture: J S Hodgkinson

FAMILY CONNECTIONS

The International Relf Society

On 13th September I 'stood in' for our Chairman, Jeremy, to give a short talk to the members of this genealogical society at their 13th annual gathering and AGM in the Rose & Crown pub in Mayfield, on "Wealden iron and the Relfs". Knowing nothing about the Relf ironmasters beyond what is in Cleere & Crossley, I did my best to explain (in the 20 minutes or so allotted to me) first, the geology of the Weald, handing out photocopies of Bernard Worssam's diagram of the ancient layers, how the iron got where it was and how these strata could have been found and can still be found. Then I talked about bloomery furnaces, Romans, bloomery slag, blast furnaces and forges, WIRG's experimental furnace, the Field Group and the dinosaur's footprint. Finally I dared to suggest that their ancestor, "William Relfe, ironmaster, of Mayfield," might have learned his skills and made his early money, while working at Mayfield Furnace in the early C16th before he left for Panningridge and Cowford, etc.

Anne Dalton

Edward Daniell, Founder, and Scarlets Furnace

East Grinstead parish register records the publication of the banns of marriage of 'Edward Daniell, founder of [this] parish, & Mercie Desper of Cowden in Kent' on 14 June etc. 1657 and their marriage at an unspecified date in July that year.

There are no references to Edward Daniell in the published literature on the Wealden Iron industry or in any other East Grinstead sources. The surname Daniell is not found in the parish under thirty years either side of 1657.

A reference in Guy Ewing's *A history of Cowden* (Tunbridge Wells, 1926), however, enables us to locate the furnace at which he worked. On p 111 Ewing quotes from the schedule to the Private Act of Parliament concerning the estates of Leonard Gale passed in 1761, inter alia: 'a Messuage or Tenement called Scarlets and ground on which stood a Furnace called Scarlets Furnace, and the Founders House with the site of a forge and 1 other messuage and water corn mill, gardens, orchards, etc. 110 acres, formerly in the occupation of Thomas James and Edward Daniel, now of Wm. Berry, Richard Turner and William Harris'.

Since the boundary between East Grinstead and Cowden runs through the furnace pond there is no problem in Daniell's being of the former parish in 1657 while working in the latter. On p 85 Ewing comments that in Cowden 'the Iron-masters, and their workmen, do not seem at any time to have been natives of the Parish'.

The James family were gentry, with property in East Grinstead as well as Cowden, so Thomas James is unlikely to have been a founder. He was probably the occupant of the property after it went out of use.

In 1707 the Cowden churchwardens 'allowed Mr. Gell [Gale] for the tax of his furnace that was not paid on arrear, 6s.6d (*Sussex Archaeological Collections,* vol.20 (1868) p 118.

Ewing shows, on p 107, how the Gales were related by marriage to the Knights, previous occupants of the site, and the Johnsons, who had Wire Mill.

I know nothing about the family of Mercie Desper.

M J Leppard

FORAY NOTES

Wood below Netherfield Place Farm 15 March 2003

This wooded area – the lower part of High Wood and Duckreed Wood between Netherfield Place Farm and Foxhole Farm – contains several man-made features: four or five pond bays and a 'causeway' bank, as well as several ancient boundaries. The valley runs generally from north-west to south-east, with a side valley joining from the north.

A map in the East Sussex Record Office (ASH/4377) shows the area as surveyed in 1639. Details include one of the bays, the causeway, the boundary of one pen pond (although this had even by then become part of the wood) and a field called 'Sinder-hill'. This map, when compared with the modern 1:25000, is very accurate and field and woodland boundaries are remarkably similar after 350 years.

The following features were investigated:

Pond Bay at 72171705 – length 75m, height 3m.
This bay appears to be the site of an early blast furnace. There is a huge quantity of 'puddingy' slag (BH description) both on the bay and on the surface for some 50m downstream, and for 100m in the stream, including some fairly large lumps. The bay is breached by the stream at its NE end, with the stream making a dogleg across the valley above the bay. A further breach - now used by a path - has occurred towards the SW end of the bay. At this point a long bank of slag up to 1m high runs parallel with the stream, apparently to contain an overflow channel. Near this bank a piece of furnace lining was found. In the root of a hazel nearby was a piece of material which appeared to be metal but was a mixture of iron and slag, irregular in shape but roughly 16"x8" max, 0.5"-2" thick.

In the stream near the breach are several large pieces of slag, also a piece of limestone, possibly from the Purbeck beds. Above the breach, on the fairly steep far bank, are several pits and flattened areas. The bay and the slag bank below the channel are home to some huge ancient coppice stools, mainly ash and hornbeam.

?Bay at 72101716 (where we lunched) – length c100m, height up to 1m.
This is a long low bay just below the confluence of the streams from the NW and N. At the SW end it is breached by the stream; some ?10m from the SW end is a distinct depression and a change in level. A boggy channel runs parallel with the bay on its downstream side. The ground above the bay is silty and rushy.

Causeway at 72151716
This is a curved, low feature, which appears to run from the corner of the field (Twelve Acre) towards an ancient trackway up through the wood. In the stream were bricks, possibly from a collapsed bridge or culvert. The banks of the causeway contain blast furnace slag and charcoal.

Bay at 71911723 – length approx 75m, height 7.5m/6m
This huge bay is breached by the stream towards its N end; the stream does a dogleg below the bay. At this end the bay supports old boundary coppiced hornbeams. Towards its S end a deep (?3m) spillway runs parallel to the stream for some 50m; it then turns through 90 degrees to rejoin the stream. A shallow channel runs from the bay near the spillway, diagonally towards the stream.

?Bay at 72101727 – length ?50m, height ?2m
Pond in water. This bay takes the old trackway from Netherfield Place Farm towards Beech Mill. The bay contains small pieces of slag, and in the stream banks some 50m below the bay are deposits of glassy and 'puddingy' slag about 1m down below the silt.

Bay at 72101740 – length 70m, height 5-6m
This big bay has been breached at its W end (the stream does a dogleg above the bay). At the E end, and high above the present stream level, are two curving channels which appear to take water away from the bay to the pond (?) below.

Ann Callow

Towards the end of the 2002-2003 foray season another foray was made to **the North Heathfield area** to try to sort out where Bungehurst Blast Furnace is supposed to be, (see Newsletter No.37), and once again we failed to come to a decision. The pond @ TQ600239, the C&C site, has been changed greatly since Fred & Margaret Tebbutt visited it. The bay has probably been heightened and the working area covered with several feet of sub soil, so making it impossible to see any slag; in fact, not one piece of slag was found here or down stream. Another visit, yet further down stream, is to be arranged

A very small bloomery furnace site was found about 20 feet up the right bank and 100 feet from the stream at TQ60102410

Further down stream and also on the right hand bank, at TQ60032428, a possible slagged track or causeway was found across the valley bottom. The type of slag could not be determined without destroying the evidence.

The next objective was to find Old Mill Blast Furnace, reputedly over the hill at **Old Mill Cottage** at TQ600244. This turned out to be on a very small stream, quite unsuitable for a blast furnace, as its source was only about 400yards away, and not even marked on 2¼-in/mile maps. However the metal detector suggested that there could be bloomeries nearby, even without any visible slag. This effect has been noticed before when large metal smelting sites are to be found upstream, this is also true on farmland, where the slag seems to have become distributed around, but is invisible.

As expected, the bloomery site was found after some 300-yards, almost at the top of the stream. The valley here is unusual in that it widens-out into a saucer-shaped valley-end, instead of getting narrower. Although there was much large-slag in the stream, the working area seems to be high up on the left bank; whilst there is negligible slag on the opposite bank, a usual feature, for some reason. So we ended up finding a new bloomery site when looking for a blast furnace site; this we had to explain to the owners of Old Mill Cottage. The consensus was for a Roman site, mainly due to the typical tap slag runs and the size of the site.

With the owners consent, the first foray of the 2003-2004 season saw us return and try to date the site by trenching through the slag heap for pottery. After 1.5 hours the first pottery appeared, it seemed to be typical East Sussex Ware, having that "soapy" feel when cleaned and dried. Another two pieces of pottery were found during the afternoon, looking much the same. This pottery-type was in use for many years before and during the Roman occupation; due to its long use it is unlikely to give a close dating for the site. A pottery expert will be checking this in the near future. The latest news is that we will be excavating the site with the services of a professional archaeologist. (see report below).This season's forays seem to have-got off the good start; let's hope they carry on this way!

BH

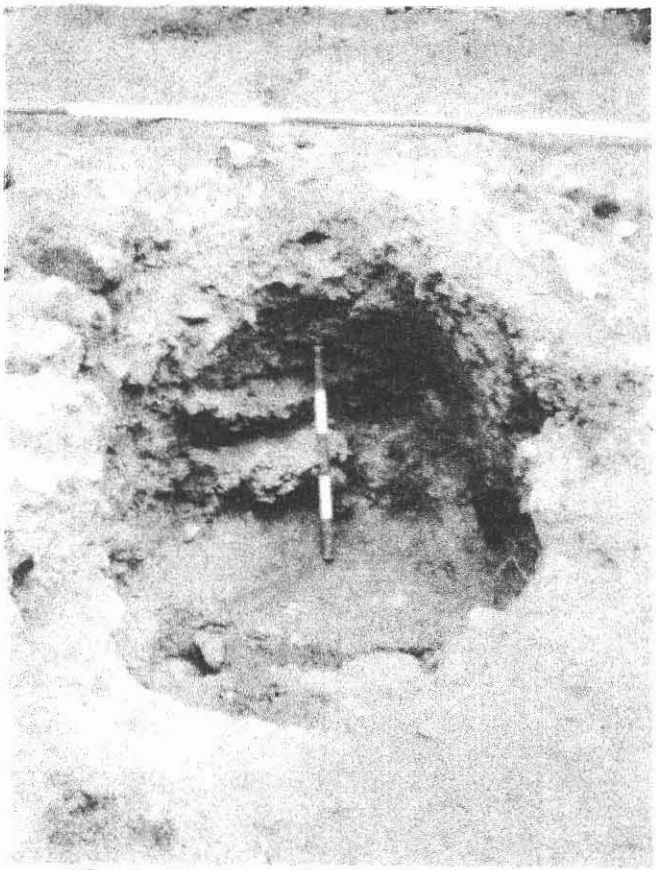
Following on from the above report:
In the course of the above-mentioned trenching exercise, members of the Field Group found what appeared to be part of a bloomery smelting furnace. On the basis of the small part of the furnace that had been revealed, it was decided that further investigation was warranted. Accordingly an excavation has been mounted, and the Mid-Sussex Field Archaeology Team responded to our appeal for assistance. Chris Butler is directing the dig, assisted by members of MSFAT and WIRG, in what is already proving to be a very successful collaboration.

Our initial excavation
Picture: J S Hodgkinson

What has been found is a domed furnace, of late-Iron Age or Romano-British date, set in an elongated pit cut into the top of a valley slope, down which lies a spread of tap slag. The surviving structure of the furnace is impressive; the hearth has an approximate internal diameter of 1 metre, and a height of just over 1 metre, which makes it somewhat larger than other furnaces of the same period found in the Weald, and comparable to contemporary furnaces found in Northamptonshire and of slightly earlier date in France, south east of Paris. Sufficient lining remains to offer the hope that archaeo-magnetic dating may be possible.

Three days' work have been carried out, with most of the furnace structure being revealed, together with an area in front of the furnace and two other test pits being examined. Work is expected to resume in the spring when the clocks go forward again.

JSH



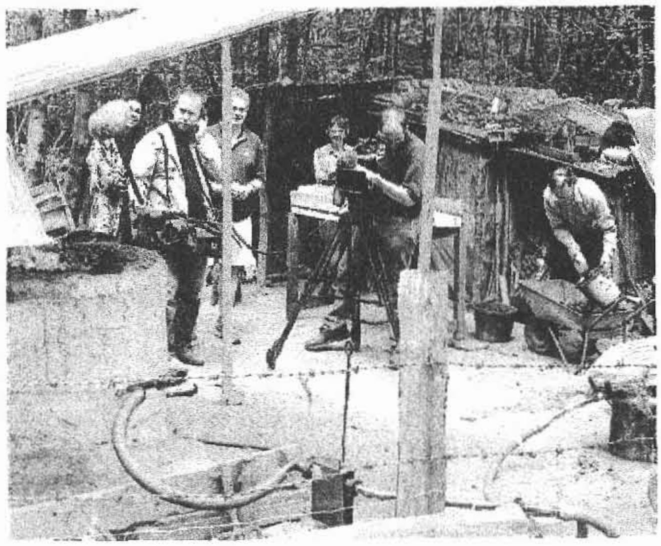
After further excavation - note signs of successive rebuilding, top right
Picture: J S Hodgkinson

CARLTON FILMING

On 20th August last, we were telephoned by Tony Francis, who said that he runs a small film production company which was making a programme on Ashdown Forest for ITV's Carlton Country series. He asked if he could film a smelt in a week's time. The smelting team decided that they could fit this into their research series and that there was just time to make the necessary preparations.

So at 6.30 am on the 27th, the furnace was fired. Somewhat later, Tony Francis arrived with his lady presenter, a camera man, and a sound man with a large fluffy microphone on a stick. They came and went at various times during the day, alternating filming the more interesting parts of the smelt with filming deer, etc. on Ashdown Forest.

The date for broadcasting was given as 'sometime in February' so we look forward to seeing the results of our combined efforts to spread the word about the Wealden iron industry.



The 'Carlton Country' smelt
Picture J S Hodgkinson

FORAY PROGRAMME

A brief note of the proposed forthcoming forays: We try to keep to the visits decided in September but if something really special is found, as has recently happened, subsequent forays may be altered. Non-members of the field group who wish to attend one of these forays may obtain fuller details from Hugh Sawyer, Spindles, Hackwood Road, Basingstoke, RG21 3AF. Email: sawyerhja@aol.com

Sat. 15 Nov. 2003: Bungehurst furnace, Heathfield - survey and fieldwalking.
Sat. 13 Dec. 2003: Blackham, Hartfield, fieldwalking.
Sat. 24 Jan 2004: Netherfield, recording blast furnace site and fieldwalking adjacent valleys.
Sat. 21 Feb 2004: Heathfield, fieldwalking study area.
Sat. 20 Mar 2004: Coopers Farm, Ticehurst and Snape, Wadhurst, fieldwalking.
Sat. 17 April 2004: Chillies Farm, High Hurstwood and Clappers Wood, Vines Cross, sampling for analysis.
Sat 15 May 2004: Indoor 'foray' at Fairwarp to discuss preceding season plus members' contributions.

Now for a little light relief, appropriate for November:

IRONWORKERS' RECREATIONS

The feast day of St Clement, the patron saint of metalworkers and blacksmiths, falls on 23rd November. Traditionally an annual holiday for smiths and their apprentices, 'Old Clem's Night' sparked off with the ritual 'firing of the anvil'.

Gunpowder was packed into a small hole in an anvil and then struck with a hammer, creating entertaining showers of sparks. A local blacksmith or apprentice, disguised as 'Old Clem' in wig, mask and cloak, led the others from tavern to tavern.

Rowdy songs and toasts to Old Clem were followed by demands for free beer or donations for the 'Clem feast' supper.

This wasn't just a rural custom - iron foundry apprentices at Woolwich Dockyard also paraded, holding Old Clem aloft brandishing a hammer and tongs. Such processions expanded into the custom of 'clementing' or 'clemening', where children called door-to-door singing 'clemeny carols' in exchange for apples, pears and other treats. These festivities may be survivals of earlier pagan rituals connected with the Saxon myth of Wayland the Smith, metalworker, who shares this feast day with the saint.

Clemening gradually died out by the twentieth century. However, St Clement's Day is still celebrated in a few parishes across the UK, including Burwash and Mayfield, and there's a national ironworkers' assembly at Finch *Foundry in Devon.*

Helen Pearce

DATES FOR YOUR DIARY

31st December 2003 WIRG Winter Meeting (details to follow)
From January for three months WIRG will exhibit at East Grinstead Museum.
7th February 2004 Copy date for WIRG Spring Newsletter.
5th June 2004 WIRG will exhibit at the Kent Archaeological Society's meeting.

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FROM THE EDITOR

My thanks, as always, to our contributors. I should be grateful if copy for the 2004 Spring WIRG Newsletter could reach me by 7th February 2004.

Happy New Year! ***Dot Meades***

ANALYSIS OF RECENT EXPERIMENTAL AND ANCIENT SLAGS

The chemical analysis and structures of the experimental slags made with additions of hammerscale to the charge are coming close to samples of ancient slags found in the field.

Comparing the main constituents of the slag, FeO (this represents both free wustite and the FeO combined with silica as fayalite $2FeO.SiO_2$, Alumina (Al_2O_3) and lime (CaO) the table provides the average compositiions taken from 5 points on the polished surface of the slag.

The table shows that the compositions of the ancient slags are themselves variable with a tendency for the Roman slags to have a higher FeO content than the Medieval (ie Roman has less efficient smelting), and, with the exceptiion of Roffey, the Medieval slags have a higher CaO content, the Ca displacing Fe from the slag thereby improving the effiency of the smelt - but raising the melting point of the slag.

Of our experimental slags, smelt 21 has the closest analysis to Roman slag compositiions, but as this smelt was conducted at a low blowing rate and an average mid-shaft temperature of only 900°C (compared with our usual 1050 to 1075°) no bloom was formed. For practical smelting, a 100% beech charcoal which resulted in a higher smelting temperature and a slag containing a smaller amount of wustite than in slag 23, or the Roman samples. The similarity in the FeO contentin the Table is because much of the FeO is combined with silica to form fayalite.

The chemical analysis alone cannot distinuish between FeO as wustite and that combined with silica as fayalite ($2FeO.SiO_2$). Thus, samples are polished and examined under the microscope. The wustite shows up as a white phase with an aligned globular structure (dendrites). For companison, the two micrographs show the structure of the tap slag from smelt 23 compared with Roman slags from Oldlands, both at an original magnification of x480. (See Table on page 12)

.For comparison, the two micrographs show the structure of the tap slag from smelt 23 compared with Roman slags from Oldlands, both at an original magnification of x480.

Tim Smith

Re The Excavation of a Blast Furners Green by Wilfrid Beswick (WIRG Bull. 2003) our analysis by X-ray diffraction of roasted siderite ore (FeCO3) for the Experimental bloomery showed that the magnetic phase was Maghemite, ie Gamma Fe203 with no sign of any magnetite (Fe304) which Wilfrid concludes must be present to give the magnetic properties.

TS

Analysis of slags (wt %)

Slag Sample	FeO	SiO_2	Al_2O_3	CaO	Charge Ore : C	Comment
Exp 21 Furnace	51.9	21.2	6.0	12.2	1 : 0.75	Low blowing rate
Exp 21 Tap	64.5	13.0	5.5	8.4	No mill scale	No bloom
Exp 22 Furnace	37.7	34.4	8.1	11.1	1 : 1	100% beech C
Exp 22 Tap	40.6	30.7	7.8	11.1	150g scale/chg	Hot run Av 1150°C
Exp 23 Furnace	51.0	22.6	7.2	9.8	1 : 1	Mixed charcoal
Exp 23 Tap	44.2	28.7	7.8	10.5	150g scale/chg	Av 1075°C
Oldlands Roman	47.8	27.3	8.5	8.5		
Blacklands Roman	67.9	14.1	3.3	6.6		
Holyte Roman	47.0	28.9	9.0	7.2		Roman Road
Sharpthorne Med?	33.6	30.1	9.4	15.7		Dated from mine pits
Roffey Medieval	33.5	34.5	18.0	6.2		
Tudeley	36.8	29.4	7.4	15.6		Probably medieval

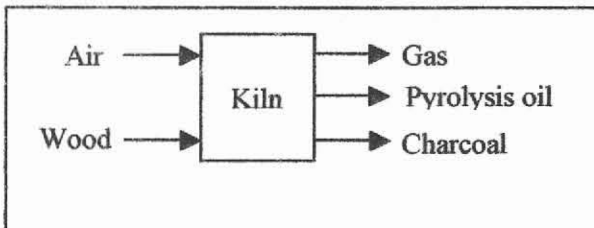


Fig 1 Internal self-heating uncontrolled

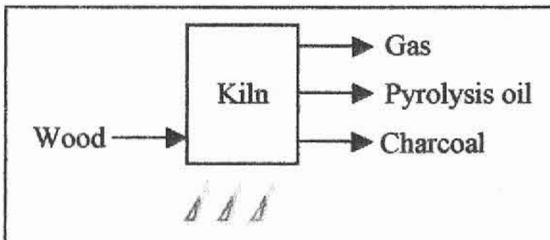


Fig.2 External heat source

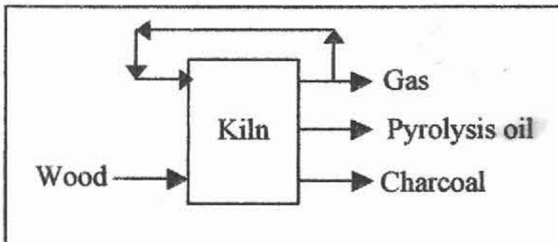
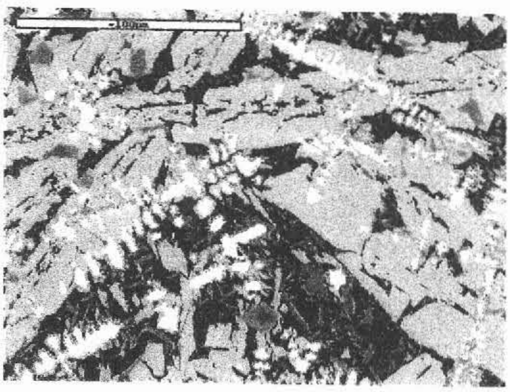


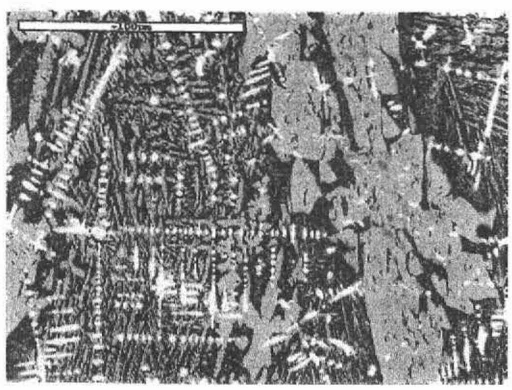
Fig.3 Controlled self-heating

BH

Oldlands micrograph:



Experimental furnace micrograph:



T Smith

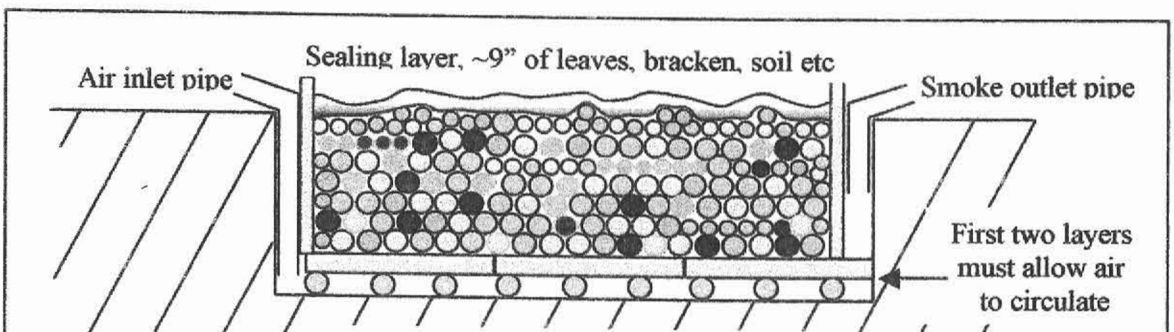


Fig 4 Section through charcoal pit

B Herbert