HMSNEWS

Historical Metallurgy Society
63 **Summer 2006**

Grants

The society awards grants from the **Coghlan Bequest** and **R.F. Tylecote Memorial Fund** for research and travel. Members are encouraged to apply by completing forms available on the society's website (www.hist-met.org) and sending them to the Hon. Treasurer.

The Coghlan Bequest was set up to facilitate any research into historical metallurgy, including fieldwork, experiments, analysis and travel. Money from the fund is **awarded once a year in March**; applications must be received by the end of the preceding January to be considered. The award may be divided between a number of applicants.

The R.F. Tylecote Memorial Fund commemorates the renowned archaeometallurgist who was a founder member of the HMS and edited the Journal from its beginning until his death. It takes the form of Annual Travel Bursaries to help pay for travel, subsistence and conference fees, which will further the aims of the Society, including research, conferences, seminars, excavations, fieldwork and experimental workings. Money from the fund is **awarded in March and November**; applications must be received by the end of the preceding January and September. As a guide £100–£150 is usually awarded in each round. This may also be divided between a number of applicants.

Following an award, the results of the research undertaken or a report on the study visit must be sent to the HMS for possible inclusion in the Journal of the HMS or in the HMS newsletter. Any unused funds must be returned to the HMS.

Application forms may be obtained from Michael Cowell, Hon. Treasurer, "Little Gables", 17A Thorncote Road, Northill, Bedfordshire SG18 9AQ.

Devon and Cornwall's Mining Landscapes Granted World Heritage Status

Ten areas of Cornwall and West Devon with deep-mining remains dating from the period from 1700 to 1914 have been inscribed as a world heritage site. The decision was made at a meeting of UNESCO held in Vilnius, capital of Lithuania.

The decision to add the mining landscape to the list was in recognition of the contribution that Cornwall and West Devon made to industrialisation throughout the world and their influence on mining technology. Devon and Cornwall formed the world's greatest producer of such metals as copper and tin in the eighteenth and nineteenth centuries, providing the essential raw materials for the industrialisation of the world. Further global significance resulted from the migration of miners overseas to the Americas, Australia and southern Africa, for example. Stephen Gill, from West Devon Council, said: 'Our mining culture was transported around the world, which is why they have pasty shops in Mexico and play rugby in Australia and South Africa'.

Adam Paynter, the chairman of the Cornwall and West Devon Mining Landscape World Heritage Site Partnership, which includes all the local authorities behind the bid, said: 'This is fantastic news and I am over the moon that our bid has been successful. A lot of organisations and people have been involved in the bid and I am delighted that everyone's hard work has been rewarded in such a fabulous way. The Cornwall and West Devon Mining Landscape now officially belongs to the world and we are the custodians charged with ensuring that our heritage is preserved for the enjoyment of future worldwide generations.'

Figure. Derelict mines at Camborne, Cornwall

Rio Tinto

Lorna Anguilano

The famous mines at Rio Tinto, Huelva Spain have been investigated by many researchers (Rothenberg and Blanco-Freijeiro 1981). The enormous section through slag deposits revealed by modern mining at Corta Lago was studied in detail. Beno Rothenberg's team divided the section into 119 layers which could be dated by coins and pottery. It was originally assumed that the stratigraphic changes in slag reflected improvements in smelting technology. Slags from this section are currently being examined and analysed for a PhD thesis at the Institute of Archaeology, University College, London.

Figure. Map of Spain showing the location of Rio Tinto

The first phase, which can be dated to the pre-Roman period, is characterised by free-silica slags. The first Roman phase is Republican and it is characterised by tapped slags, thin, with tap hole size of 10mm, the second Roman phase (still Republican) is characterised by plano-convex, non tapped slags; the third Roman phase is characterised again by tapped slags, this time with a tap hole size of 20mm (this data possibly indicates a doubling of the furnace size as well), this last phase is dated as Late Republican and Imperial.

The differences between the pre-Roman and the Roman process is mainly due to the difference in the charge: the pre-Roman process is characterised by semi-solidus system, where quartz aggregates are in the system as solid particles, while in the three Roman phases the system is completely liquid. However in the four phases the smelting happens around 1200°C.

The liquidity of the system reached by the Romans helped the capture of silver by the lead, of course in a liquidus system the chemicals can diffuse more easily and in this case lead can diffuse and capture more silver, in fact the loss of silver goes from 300–1000ppm (Kassianidou 1993) of the free silica slags, to 100ppm of the Roman tapped slags.

If we focus on the analysis of the Roman period now we see the technological changes between the tapped slags and the plate slags, and then back to the tapped slags.

The plate slags are the result of a one-off smelting, and not of a continuous process as the tapped slags. The amount of time to recover the material from the furnace, repair the furnace and start another smelting was much bigger than in the tapped slags phases. However the optimisation of the process in the plate slag phase was much higher and in fact the loss in silver decreases to 40ppm. This result was achieved by the slight increase in sulphur in the system that could bond with the lead trapped in the slags that would not capture any silver in this way, so all the silver would go to the bullion and not be trapped with the lead in the slag.

The plate slag phase was then the best optimised but the slowest, so the technology went back to the tapping, even increasing the size of the tap hole, and the furnace, increasing in this way the efficiency and continuity of the process.

The isotopic signature of the slags indicates the same source of supply of lead for the pre-Roman and plate slag phase, while the tapped slags had a different source. Plotting a preliminary data set of local ores, this local signature corresponds to the tapped slag phases.

This data would suggest that the pre-Romans (Phoenicians) took their supply of lead from elsewhere, and the Romans in the slowest period of production went back to that source (possibly linkable with the two lead ingots stamped "Carthago", stored at the Museo Minero de Riotinto). On the other hand during the continuous process phases the Romans exploited local ores possibly recycling the lead after the cupellation, but not wasting capital importing lead from abroad but having a completely efficient and close system.

Socially and economically the period of the plate slags, the bases of which is radiocarbon dated to the 1st century BC, could coincide both with the civil wars happening prior the constitution of the Empire, but it could also coincide with the inability of the single owner of the mines to keep the production to the level requested by the silver production, so also the smelting had to slow down, this impasse was over gone by the changes in the ownership laws, and the smelting went back to a continuous process when the state took part in the ownership of the mine.

Reference
Kassianidou, V 1993 'The production of silver in Monte Romero, a 7th century BC workshop in Huelva, Spain'. *Papers from the Institute of Archaeology* **4,** 37–47
Rothenberg, B and Blanco-Freijeiro, A 1981 *Studies in Ancient Mining and Metallurgy in South-West Spain*. London: Institute of Archaeo-Metallurgical Studies

Recent Work at AMTeC Co-op: X-rays, casting & education

Dana Goodburn-Brown

AMTeC Co-op Limited was formed in 1997, as a marketing cooperative for the investigation, conservation and public presentation of ancient technologies. It is located in the foundry, in the centre of Chatham Historic Dockyard, Kent.

In collaboration with a local non-destructive testing agency (CET Medway), applications of a portable XRF unit for assessment of archaeological finds and Renaissance – Modern bronze sculptures are being explored. One advantage of the Portable-measuring instrument is its ease of use and ability to survey many artefacts in one session. For example, more than 400 readings can be taken and stored in one session. As a surface technique, results should be read with caution, but initial comparisons between its output and that of other more powerful XRF instruments show that it is a valuable tool in the assessment of archaeological material. I am carrying out tests with this instrument and would be happy to share my experiences with using the portable XRF with others interested in developing this technique.

Examining Coin hoards

One use it has recently been put to is a survey of a hoard of potins (Iron Age coins) belonging to Maidstone Museum. The potins have characteristic high tin levels, but a selection of the potins were also found to have high levels of cobalt. Some others had relatively high levels of antimony. It is hoped to elaborate and quantify these findings through future work.

Another hoard (of late Roman coins, recently excavated in Chichester, by PreConstructArchaeology) has been examined by specialised imaging techniques at CET. It was not possible to get a sufficient image of the lump of coins using conventional X-radiography (300KV, 5 amps): as increasing the time to penetrate the mass meant a loss of definition at the edges. So gamma radiation was used: iridium 192, for 11mins X20ci at distance of 96cms. The increase in strength of kilovoltage with this technique was very useful in defining both the shape of the mass of coins in two directions, and in providing better definition of the stacking and quantity of coins present. The gamma radiograph shows that the hoard was deposited in a cloth bag.

Figure. Gamma radiograph of the coin hoard showing the shape of the bag

Experimental work

Another activity often carried out at AMTeC involving X-radiography is the examination of products of experimental casting and metalworking. AMTeC cast a series of bronze spearheads for a television production, and these were X-rayed to look for the presence of porosity. It is usually assumed that porosity within a casting indicate the direction of pouring the molten metal. An example of a spearhead with porosity is provided in English Heritage's recent guidelines on X-radiography (Fell *et al*. 2006, figure 14). Fell *et al*. suggest that the presence of porosity at the tip of the spearhead shows that it was cast 'by filling the mould with hot metal from the blade tip'. Our spearheads were cast into a cold stone mould (the mould was provided by the TV Company, so the exact nature of the material wasn't recorded). The X-radiographs of these spearhead shows porosity concentrated at the tips, although we know that the metal was poured from the opposite end to the blade. Porosity may therefore indicate that the metal solidified so quickly that there was no time for air bubbles to rise to the top and so they got trapped within the extremity of the thin end of the blade.

A diverse range of activities are taking place at AMTeC, despite the company emerging from a period of 'slow down' due to staff moves and problems with meeting overheads/costs of running a business within a large old building. Last year the facility hosted an extensive series of after school 'Hands on the Past' educational workshops for Medway Council (funded by the Big Lottery). Metalworking and casting coupled with microscopic investigations of toolmarks and surface textures resulting from different mould materials were

amongst the activities carried out with the 8–16 year old children. AMTeC hopes to revive its series of courses for professionals in the near future as well. AMTeC's experimental work has traditionally been 'media-led' — this means that projects are usually initiated at short notice and funded for a limited time. Nevertheless, a range of experimental material and reference collections are being built up in the organisation – from pigments and mummy wrappings to torc reconstructions and Adam Hart-Davis's head 'lost wax cast' in plaster vs. a clay mould from India! Future developer funded archaeological conundrums include a Roman lead coffin missing its lid on a site with a huge quantity of litharge, late Roman coins and a unusual AngloSaxon brooch (to be reported on in the next issue), as well as further analysis of the Chichester coin hoard.

Reference

Fell, V, Mould, Q and White, R 2006 *Guidelines on the X-radiography of archaeological Metalwork*. Swindon: English Heritage

The cooperative would welcome collaboration with outside organisations or individuals who wish to get involved. Please contact Dana Goodburn-Brown on 07973856311 or email danagb@msn.com.

LORN PIG IRON
Used for malleable cast iron locks in Staffordshire in 1863

John D Harper

An article published in *The Ironmonger* in 1863[1] described the production processes in the manufacture of locks and keys at John Harper and Company in Willenhall, South Staffordshire.

In 1863 John Harper, Junior & Company, then a partnership between John Harper (my great grandfather) and Matthew Tildesley, was already established in the factory which the partners had built in 1855, although the firm itself had started in 1852 when they had put together some older businesses with a lock making company which they bought from James Tildesley, Matthew Tildesley's cousin and John Harper's uncle. This business was already being managed by John Harper and had its own foundry, or "casting shop."[2]

The article describes the manufacture of cast iron locks and bolts which were the company's speciality: in a publication by Price in 1856[3] it is stated that "We believe that the latter firm (John Harper Jnr & Co.) were the first to produce locks entirely of cast malleable iron." At that time this would have been what is now known as European or white-heart malleable iron, whose heat treatment, packed in iron ore, results in a decarburised outer layer.

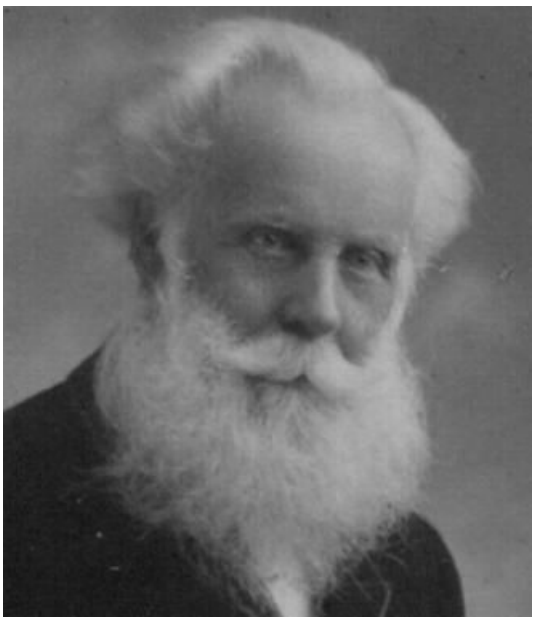

Figure 1. John Harper, junior

The article says:

" The iron used by Messrs.Harper and Co. for the best malleable castings consists entirely of a mixture of best Spanish pig iron and best lawn (*sic)* charcoal-iron from Cumberland. Beside these two sorts, Lancashire iron and Staffordshire iron are also used; the latter, however, more especially for wrought iron articles."

" The coke comes partly from Derbyshire and is partly made on the premises; Messrs Harper and Co. making their own gas, and using the light coke obtained in the process for *fine* or *pot castings*, which reduces the cost of the gas to almost *nil*."

" The pig-iron is broken with a sledge hammer into pieces about three or four inches long which are then mixed as required for melting in the cupola furnace, or for fine castings in the pot." The pots are later described as "the common Stourbridge clay melting pots. "

[1] Strauss, G M et al, reprinted also in *England's Workshops*, [Groombridge, London, 1864], as 'Lockmaking by Machinery'. *British Mercantile Gazette*, February 28 1879, and in *The Foundry Trade Journal* v.115, July 4 1963

[2] Tildesley, N, The Early History of the Albion Works, Willenhall, 1790–-1880, *West Midlands Studies* 1970–71, vl4, pp 32–45

[3] Price, G *Treatise on Fire and Thief-Proof \Depositories and Locks*, London, 1856

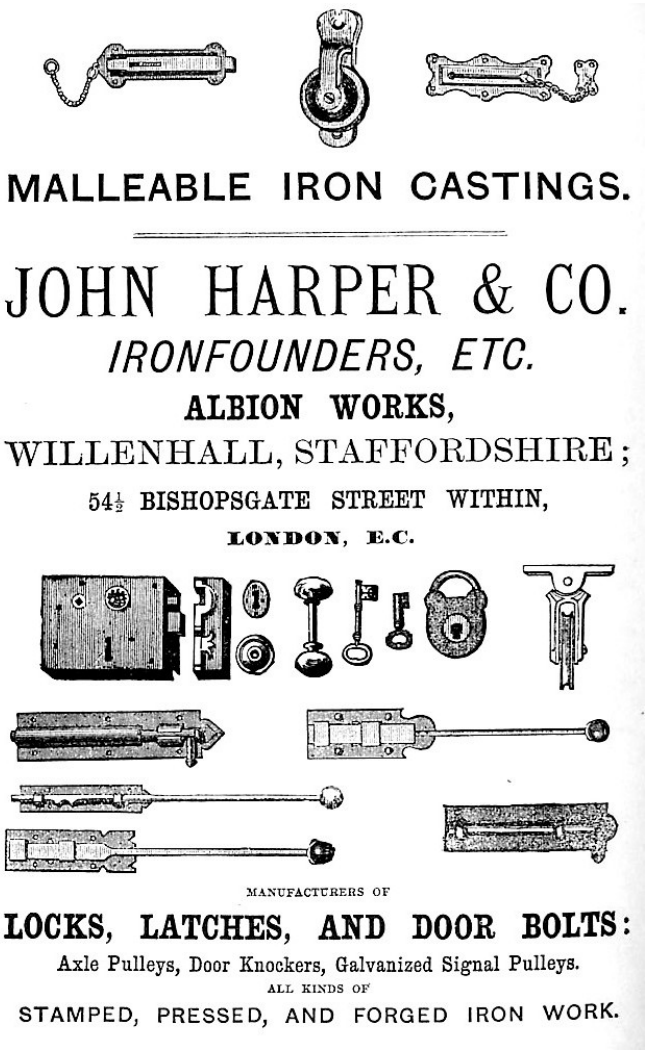

Figure 2. Advertisement from Griffiths Guide, *published in 1873 showing malleable cast iron locks*[4]

The article continues to describe the moulding and core-making operations, and the annealing of both the malleable and the "common" iron, the former "packed in rich red ore by the aid of which the carbon is extracted , and thus the iron becomes soft and may be hand-filed or drilled."

Despite this article, so far as is known John Harper's used, but never made, wrought iron. At the time the nomenclature was generally confused, the term "malleable iron" being used to describe both malleable cast iron and wrought iron, and even sometimes mild steel. Perhaps for this reason the authors of the article seem to have misunderstood what they saw or were told. As Staffordshire iron has a high phosphorus content this was presumably used only for making "common" (i.e. grey iron) castings, and not wrought iron. At that time Lancashire included the Furness area, now in Cumbria, and so the Lancashire pig-iron referred to in the article was probably made from the low phosphorus haematite ore of that region.

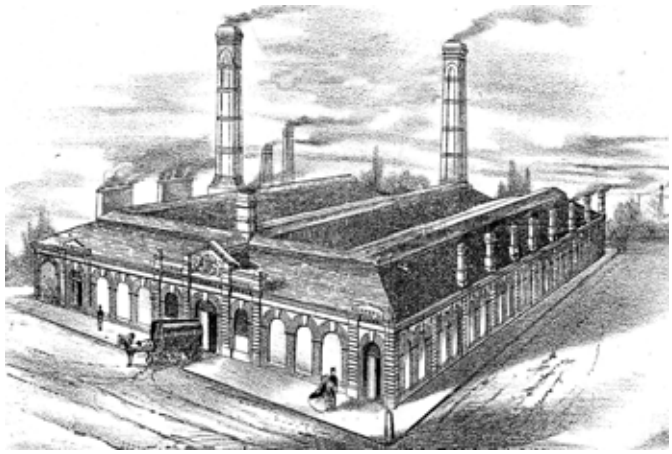

Figure 3. A drawing of John Harper & Co.'s factory from an 1879 advertisement but, from the costumes and what can be seen of the factory, seems to date from the 1860s.

The iron called "lawn" in the article can only be a mis-print, or a mis-understanding, for Lorn. Lorn pig iron was the brand name for the iron smelted in the Bonawe Furnace near Taynuilt on the shores of Loch Etive in Argyll.[5] This furnace was operated by Harrison Ainslie & Co., from Ulverston, now in Cumbria but then in Lancashire. Harrison Ainslie found it economical to ship haematite ore from Furness to the Scottish highlands where they had long term contracts for the purchase of adequate and relatively cheap local charcoal supplies.[6] Lorn pig iron was therefore not smelted with coke, and so not only had the low phosphorus content conferred by the haematite ore, but would also have had an unusually low sulphur content.

The low phosphorus was essential for ductility and impact resistance: modern malleable iron specifications set a maximum of 0.1wt% P, while iron smelted from Cumberland and Furness ore is sold with a maximum of 0.05wt% P. This would be essential in cast malleable lock components which could be subject to rough treatment. But the advantage, if any, from the low sulphur content of the Lorn iron is not so clear — although high sulphur was known to cause "hot shortness" in wrought iron, in malleable its effect is more complicated, depending on the manganese content. If the sulphur content is very high, it may favour the formation of spheroidal graphite particles on annealing, which in thin, decarburised sections where pearlite

[4] Griffiths, S 1967 *Griffith's Guide to the Iron Trade of Great Britain* [1873]. Gale W K V (ed), David & Charles

[5] Stell, G P and Hay, G D 1995 *Bonawe Iron Furnace*, Historic Scotland

[6] Lindsay, J M, 1977 'The Iron Industry in the Highlands; charcoal blast furnaces'. *Scottish Historical Review* **56**

cannot form, could provide good ductility.[7] But most malleable iron is now made with sufficient manganese to offset the sulphur by forming manganese sulphide, and, despite its more ragged graphite particle shapes, is fully ductile with sulphur contents of up to 0.15wt% and manganese of 0.4–0.5wt% — a composition typical of the coke-smelted pig iron sold to foundries from the Furness area.

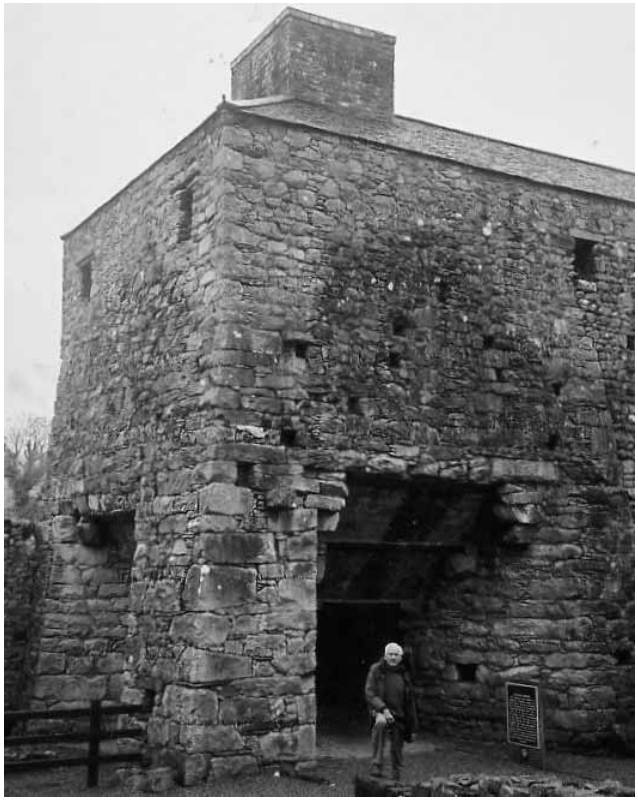

Figure 4. Bonawe furnace

How much of this metallurgy could have been known to Black Country lock makers and foundrymen, a year before Percy's and Sorby's works were published and when the first metallurgy courses in Birmingham were still over twenty years away?[8] John Harper's, which later claimed to be the first iron foundry in the Midlands to do so, did not employ a metallurgist until 1913.[9] Even then this metallurgist was for some years frustrated by obstruction from furnace foremen, who regarded pig iron selection as their private skill.[10]

On the other hand, Matthew Tildesley, one of the founding partners, had previously been in business as an iron merchant, and although he appears to have sold this business to raise money towards the new factory in 1855, would still no doubt have been in contact with, and aware of developments in, the trade, including the then relatively recent strong demand for low phosphorus pig-iron for steel making[11], following Henry Bessemer's discovery of the need for low phosphorus content to avoid brittleness. (It was not until 1879 that Gilchrist Thomas established the basic converter process which removes the phosphorus.) Matthew Tildesley must had some kind of technical ability of his own, as ten years later John Harper and Co. was advertising "Tildesley's Patent Compound," an oxide (probably made from mill scale) for annealing malleable iron, as an improvement on and cheaper than, haematite ore.[12] And both partners, as well as James Tildesley from whom they had bought the original business, were related to Richard Tildesley, who in the previous generation had first developed the production of malleable iron in Willenhall.[13] By experiment, trial and error, judging pig-iron and castings by fracture and performance rather than by laboratory tests, and probably by gossip and conversation in the trade, they must have found that Lorn charcoal pig iron served their purpose.

The *Ironmonger* article refers to this iron as "lawn charcoal-iron from Cumberland." It is possible that Harrison Ainslie used the Lorn trade mark not only for iron melted at Bonawe, but also from their other charcoal blast furnaces at Duddon which was in Cumberland or at Newland near Ulverston, then in Lancashire.[14] A pig of iron in the museum at the well preserved and maintained Bonawe furnace site, is lettered LORN in cast relief from the sand pig bed, but, since all these charcoal irons were marketed by Harrison Ainsley, the name Lorn and the Cumberland origin may have been indiscriminately used for all. A note in a published record of blast furnaces[15] indicates that the Bonawe output was sometimes listed as "Lancashire Charcoal iron."

From the late 1850s the Bonawe furnace was often out of blast, for repair or during renegotiation of the charcoal supply arrangements. 1863 was the only year in which it is recorded as being in blast between 1859 and 1867,[16] so it could have made the iron reported in the article that year. Bonawe continued in production until 1876, one of the last three charcoal fired furnaces operating in Britain.

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7 Boultbee E & Schofield G (eds) 1981 *Typical Microstructures of Cast Metals*. IBF Publications

8 Gale, W K V 1967 *The British Iron and Steel Industry*. David & Charles

9 Field, H 1950 *The Story of the Old Works*. Willenhall

10 Harper, J D, 2001 '130 Years of Changing Cast Iron Technology'. *Historical Metallurgy* **35.1**

11 Lancaster, J Y & Wattleworth, D R 1977 *The Iron & Steel Industry of West Cumberland*. Workington

12 Griffiths, S 1967 *Griffith's Guide to the Iron Trade of Great Britain* [1873]. Gale W K V (ed), David & Charles

13 Tildesley, N *The Early History of the Albion Works.*

14 Riden, P 1993 *A Gazetteer of Charcoal-Fired Blast Furnaces in Britain in Use Since 1600*. Cardiff: Merton Press

15 Riden, P and Owen, J G 1995 *British Blast Furnace Statistics 1798–1980*. Cardiff: Merton Press

16 *ibid*

Metalworking at Mont Beuvray (Bibracte), France

David Dungworth

Between 1999 and 2004 I was lucky enough to participate in excavations on the French Iron Age hillfort of Mont Beuvray. My contribution was an exploration of the ways in which workshops could be investigated through the recovery of hammerscale from workshop floor deposits.

The hilltop site of Mont Beuvray in Burgundy, France is the most famous late prehistoric site in France (see Guichard *et al*. 2003 for further details). At the end of the Iron Age it was known as Bibracte and was the capital of the Aedui. The Aedui were allied with the Romans during the early stages of the Roman conquest of Gaul but in 52BC they joined the general rebellion against Caesar. Bibracte was the site where Vercingetorix was elected as leader of the Gauls. The site was intensively investigated in the 19th century by J-G Bulliot and his nephew Déchelette. Bibracte was used by Déchelette as the type site for the definition of *oppida*, the urban or proto-urban sites of temperate Europe, in his *Manuel d'Archeologie*.

In 1984 archaeological research at Mont Beuvray was re-started with the establishment of a museum and a research centre. Fieldwork has been conducted by teams from France, Germany, Britain, Italy, Spain, Switzerland, Hungary and Slovenia. From 1999 to 2004 We took archaeological teams from Britain (including students from Sheffield and Southampton Universities) to Mont Beuvray to investigate evidence of metalworking. Part of the fieldwork involved the excavation of a blacksmith's workshop which was in use for a decade or two following the Gallic Wars (i.e. *c*.50BC to *c*.30BC).

The preservation of the archaeological remains was highly variable: in some areas later activities had removed portions of the archaeology, but in some areas the original floor surface and some fixtures remained *in situ*. The front walls of the workshop and some of the occupation deposits had been disturbed by natural erosion processes in antiquity. In other areas, 19th century exploratory trenches had destroyed archaeological remains. Nevertheless over 5m^2 of the collapsed back wall of the workshop was preserved as charcoal showing the remains of both the upright posts and the planks nailed to these. Under the destruction/abandonment deposits, the occupation horizon survived over an area of 27m^2. Within the workshop it was possible to recognise three separate rooms (A, B and C, see figure 2) separated by beam slots.

The workshop appears to have been abandoned before it was destroyed and most fitting and tools were removed. Nevertheless, we recovered two large fine-grained sandstone blocks set into the floor which were probably used to grind and polish finished objects. In one room a hearth was set into the ground with a block tuyère *in situ* to one side. Also beside this hearth were two 'hoards' of scrap iron. These consisted of small off-cuts of wire and strip which had been saved but then left when the workshop was abandoned.

The hearth in room C was very simple and consisted of a shallow circular depression (~0.15m deep and ~0.8m wide at the top). There was no superstructure but a block tuyère was *in situ* on one side. The hearth had not been deliberately lined with any specific material and was only slightly baked with no sign of any vitrification.

We were particularly interested to recover hammerscale from the occupation deposits which were black and contained varying levels of charcoal and hammerscale but were not particularly thick (in most cases <5mm). We used the sieving/magnet/weighing method developed by Mills and McDonnell (1992) to process over 1000 soil samples. In the first season the soil samples were collected on a grid at 0.25m intervals but subsequent seasons experimented with a 0.125m interval. The 0.125m grid did provide more detail (compare the top and bottom halves of figure 3) but increased the number of samples and so the amount of time to process them fourfold! The soil samples contained between 0.1wt% and over 50wt% hammerscale (figure 1).

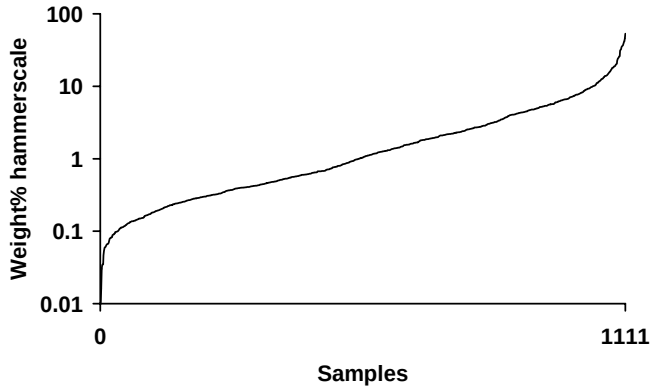

Figure 1. Proportion of hammerscale (weight%) in soil samples (in rank order)

The spatial analysis of the hammerscale data was frustrated by the incomplete survival of the workshop (see figures 2 and 3). On the whole, the proportion of hammerscale in the soil samples increased towards the front of the building (making the lack of survival at the front especially regrettable). The two large stones set into the floor were initially interpreted as anvil stones

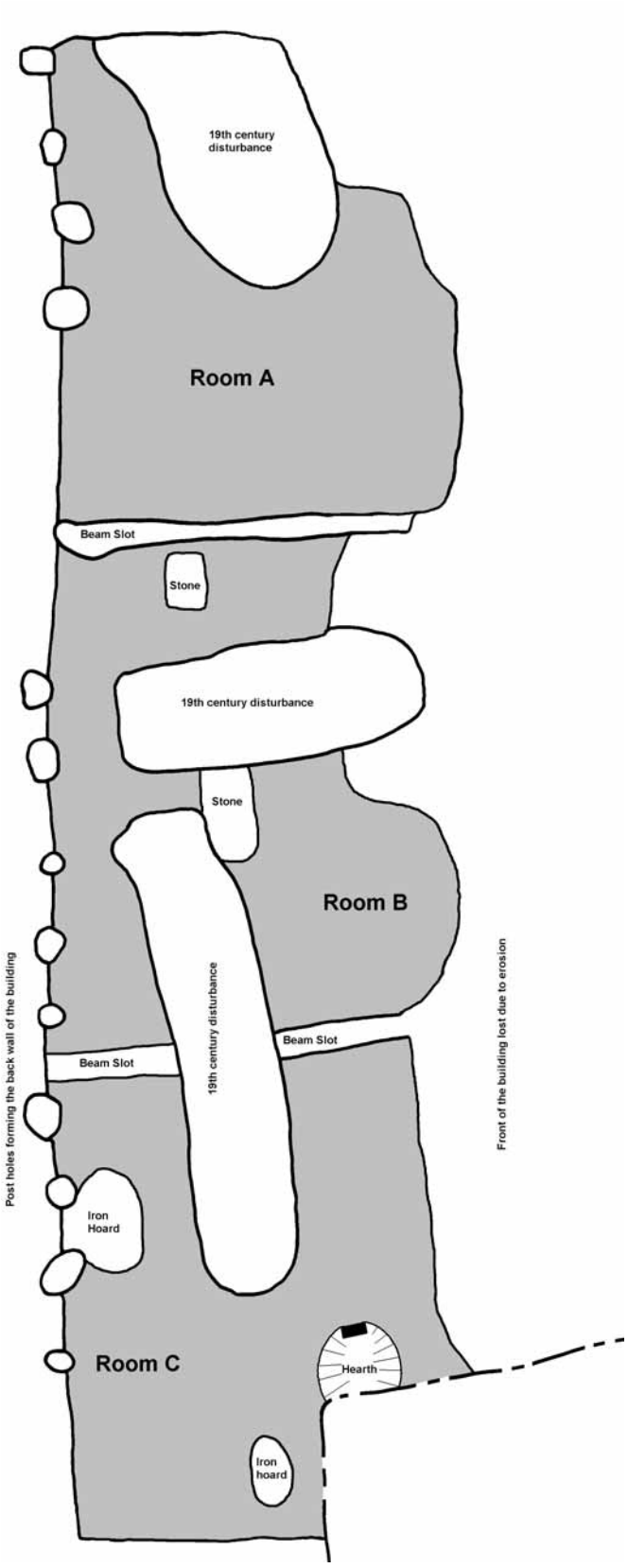

Figure 2. Plan showing the archaeological features excavated at CP11bis, Mont Beuvray. The areas highlighted in grey are the workshop floor surfaces which contained hammerscale

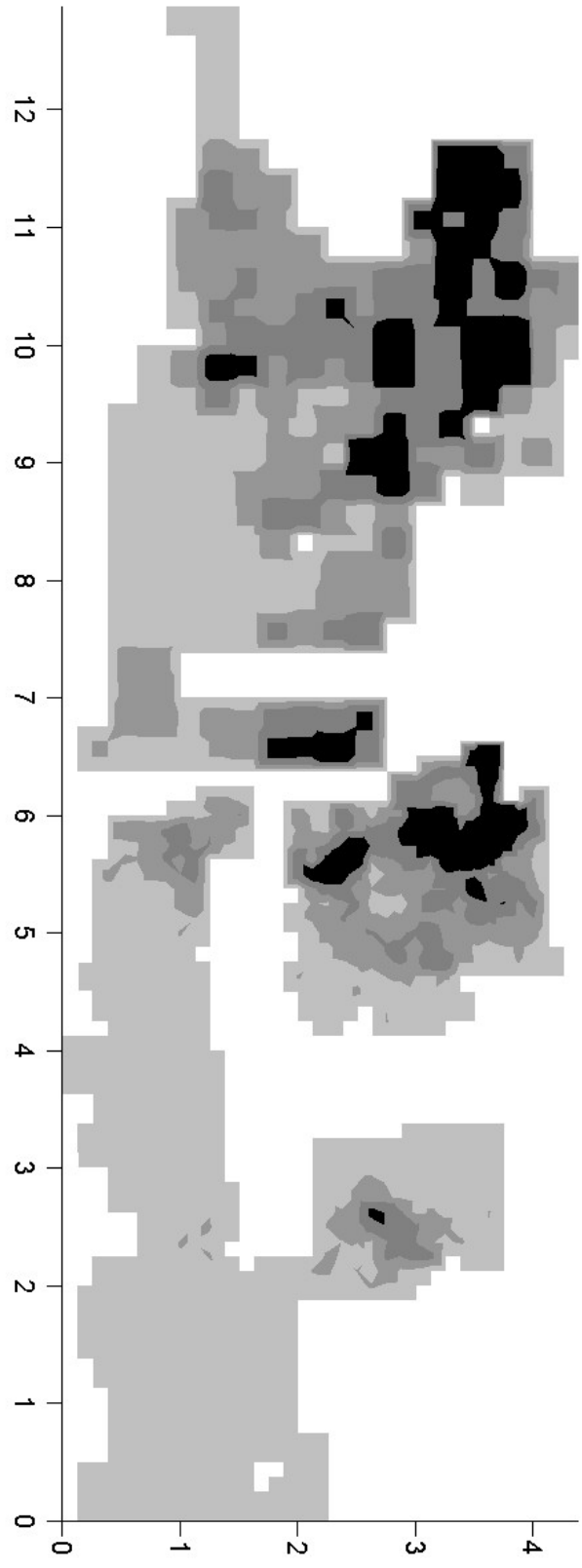

Figure 3. Plot of the hammerscale concentration.
Light grey up to 2wt% hammerscale
Medium grey 2 to 5wt% hammerscale
Dark grey 5 to 10wt% hammerscale
Black more than 10wt% hammerscale
NB the top half of the plot was done on a 0.25m grid while the bottom half was done on a 0.125m grid

but the proportions of hammerscale around them were very low, suggesting they were not anvils. When the stones were examined more closely we noticed that they were fine-grained sandstones with slightly concave surfaces, and they are now interpreted as grinding stones.

References

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Mills, A. & McDonnell, J.G. 1992. The identification and analysis of the hammerscale from Burton Dassett, Warwickshire. Ancient Monuments Laboratory Report 47/92. London: English Heritage

Valley of the First Iron Masters

The team that has been surveying archaeological remains in the Foulness Valley in east Yorkshire and has found important early evidence for Iron smelting has now placed a database and interactive map on a website.

www.ironmasters.hull.ac.uk

CONFERENCE REPORT

Archaeometry 2006

The 36th International Symposium on Archaeometry took place in Quebec City, Canada from the 2nd to the 6th May. The symposium included sessions of interest to archaeometallurgists; there were 13 oral papers and no less than 43 posters on the technology and provenance of metals.

Papers touched on almost all metals and covered a time period from the early Bronze Age to the early twentieth century.

Sébastien Perret presented results from his analysis of slags and other materials from Fiko Mali (see HMSNEWS60). He showed that the tuyère were designed to melt during smelting and helped in the formation of slag (although the furnace walls were different and did not vitrify as easily).

Lorna Anguilano described the work she was carrying out on prehistoric and Roman slags from Rio Tinto (see above).

Papers by Claire Cohen and Alexander Veldhuijzen were well presented and contained a wealth detail (although much of this seemed to have been reported at a previous Archaeometry symposium).

Aude Mongiatti reported on her examination of the contents of the ceramic vessels from Oberstockstall, Austria. The ceramic vessels themselves had already been studied by Marcos Martinón-Torres. Some of the vessels seem to have been used to process argentiferous fahlerz (grey ores).

Justine Bayley gave us a frank account of her changing opinion of some Roman crucibles from Chichester. The crucibles had originally been interpreted as evidence for glass and enamel working. An earlier re-examination of the 'glassmaking' crucibles showed that they were used for parting (separating gold from silver-gold alloys). The recent re-examination of the 'enamelling crucibles' has shown that the red vitreous material coating the inner surfaces is not enamel. It is in fact a lead-rich slag formed during the refining of silver.

Aaron Shugar told us of his experiences using a portable X-ray fluorescence spectrometer to measure the alloy content of items from the Nahal Mishmar hoard.

Dirk Visser presented some spectacular images of renaissance statues generated using neutron radiography and neutron tomography. The 3-D computer images provide an exceptionally detailed view of the entire sculpture but the cost of such analysis preclude its routine use.

Daniel Jeffery talked about his research into the nature of the medieval ferrous objects made and used at Novgorod. He has been carrying out chemical analysis of the slag inclusions in ferrous tools and weapons and has shown that the later items have slag inclusions with much more variable chemical compositions compared to the early material.

The posters by Mike Baxter and Ron Hancock illustrated that multivariate statistical methods may not be any better at establishing patterns within compositional data compared to a series of simple bivariate plots.

The poster by Philippe Dillmann and colleagues on their multidisciplinary project on the use of iron in historic French buildings. Their analyses of slag inclusions in structural iron shows that it was usual for a single building to source iron from several producers. The slag inclusions also give some clues as to the technology of iron manufacture and the provenance of the iron.

FUTURE CONFERENCES

The Sixth Conference on the Beginnings of the Use of Metals and Alloys (BUMA VI)

15th–20th September 2006, Beijing and Anyang, P. R. CHINA (Second Circular)

One of our main Supporting Organizations, the Needham Research Institute (NRI) in Cambridge, has agreed to provide its web site for the use of BUMA VI. From now on, we shall post future updates to the conference programme, registration details and information on travel and hotels on the NRI web site as follows: http://www.nri.org.uk/BUMA.htm

We will not be sending further mailings so please refer to the web site. You can find the first circular on the web site too.

We are pleased to announce that the Institute for Archaeo-Metallurgical Studies (IAMS), London, has joined us to become one of the major organizers of BUMA VI and will financially support the conference. The University of Science and Technology Beijing and the China Numismatic Museum have also agreed to provide financial support to the BUMA VI conference.

Theme and Sessions
The general theme of BUMA VI is **Metallurgy and Civilisation**. Discussions will be focussed on the impact of the emergence and use of metals on the development of human civilisations. A number of topics have already been suggested, such as *Early Metallurgy in the Eurasian Steppe*, *Lost Wax Casting Technology: origins and diffusion*, *The Origins of Piece-mould Casting Technology*, and *Copper and Lead smelting in Continental China*.

Programme Schedule:
15 September: arrival, registration and reception
16–17 September: conference sessions
18 September: morning: conference sessions afternoon: travel by train to Anyang (Those who prefer to stay in Beijing can do so as they like).
19 September: visit to the Anyang Museum and archaeological sites night train back to Beijing
20 September: conference sessions, closing ceremony
21–27 September: A post-conference academic excursion to Kunming and Dali in Yunnan Province will be organised in cooperation with a travel agency. There will be another international conference on traditional crafts in the regions where ethnical minorities lived for those who may like to participate in. Further information will be provided later.

There will also be an International Symposium on Bronze Industry and Early Civilization held in Tongling City of Anhui Province during September 24–26, 2006, which is organised by the Centre for the Study of Ancient Civilizations at Peking University and other relevant institutions. Those who are interested in the symposium may arrange their travel plan accordingly.

Venue
Conference Centre, University of Science and Technology Beijing. Conference Language: English

Accommodation
Conference Centre, University of Science and Technology Beijing (US$30–40/night-person)

Registration fees
Registration and payment before 15 May 2006: US$250
Registration and payment after 15 May 2006: US$300
Accompanying Person
Registration and payment before 15 May 2006: US$130
Registration and payment after 15 May 2006: US$150

Payment
All payment from non-PRC participants should be in US dollars by Bank Transfer to:
Account number: 0200006219200080785
Account name: University of Science and Technology Beijing
Industrial and Commercial Bank of China
Beijing Municipal Branch, Beijing, PRC
Please state clearly that your payment is for BUMA VI registration fees.

Estimation of costs:
A number of scholars have asked about the overall costs for travelling and staying in China during the BUMA conference. We would like to offer a rough estimate based on the information currently available. Please be aware about possible changes in the coming months.

The overall costs for accommodation and train tickets in Beijing and Anyang during 15–20 September would be US$250–300 per person.

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Early Iron in Europe
Prehistoric and Roman Iron Production

1st CALL FOR PAPERS

International Conference in Hüttenberg, Carinthia, Austria

Over the last three years, archaeological excavations and archaeometric studies have shown that Hüttenberg in Carinthia, Austria was a major centre of production of Ferrum Noricum, the famous Noric steel - frequently mentioned in Latin texts from the 1st century AD onwards. Archaeological evidence shows that iron production in Hüttenberg began in the 1st century BC and lasted until the 4th century AD. We now want to present the results so far to a wider international audience, and therefore invite to a conference on Roman and prehistoric iron production in Europe. We hope this to be a timely and stimulating meeting.

Hüttenberg is a village about 60km from Klagenfurt (nearest airport) and 15km from Treibach/Althofen train station. Accommodation and conference seating are limited, and we have to limit the number of participants to about 100, with a maximum of approximately 35 oral presentations and 40 posters. We hope that this will stimulate good discussions, and the setting in a preferred holiday region should further contribute to a successful conference. We are now inviting expressions of interest to facilitate planning.

Date of the conference

8th Registration and Welcome Reception
9th and 10th Presentation of papers and posters
11th Excursion

Registration Fee

Euro 120. Accommodation in Hüttenberg is available from about Euro 25–30. The registration fee and the costs for the accommodation may be subject to minor changes.

Topics of the conference

The conference aims to cover all main aspects of prehistoric and Roman iron production in Europe, focusing on results of archaeological excavations of smelting and smithing sites and archaeometallurgical studies of furnaces, slags, blooms and iron objects. The conference is meant to offer a forum for established scholars, graduate students and younger colleagues to present and discuss the results of their research and the problems they encountered. The conference language is English.

Proceedings

Papers accepted for presentation (oral or poster) will be invited for submission to a fully refereed volume of Conference Proceedings.

Call for paper

Offers to present a paper or poster are now invited, including a tentative title and an abstract of about 400 words. The abstract should provide sufficient information for a fair assessment of originality, novelty and significance of the content of the presentation. To enable up-to-date publication, final abstracts to be included in the conference booklet will be requested closer to the conference date (see below).

Deadlines

Submission of titles and abstracts October 31st, 2007
Notification of acceptance January 31st, 2008
Firm registration for attendance April 30th, 2008
Final abstracts for inclusion in booklet June 30th, 2008

Contact address

postal address
Brigitte Cech, Quaringasse 22/3/7, A-1100 Wien, Austria
Phone: ++43/1/607 13 60
e-mail: cech.conference@gmx.at
Conference website: www.huettenberg.at

HMS in Dublin

Justine Bayley

In 2007 the HMS conference will be in Dublin, over the weekend 15–16th September. The format will be slightly unusual as most of Saturday and Sunday will be spent hearing about aspects of Irish metalworking, and visiting the National Museum's spectacular collections of metalwork. The archaeological treasures range from large amounts of Bronze Age gold, through Early Christian metalwork such as the Tara brooch, to Viking silver hoards and metalworking finds. For those interested in more recent periods, there are major collections of Irish pewter and silver.

It is planned to arrange accommodation in Trinity College, which is very close to the Museum in Kildare Street. Most of the lectures will be in the other branch of the Museum, at Collins Barracks, which is just a bus ride away.

It may be possible to arrange a visit to the abandoned 19th-century lead mines in the Wicklow Mountains to the south of Dublin on the Friday afternoon. There are lots of other things to see and do in and around Dublin so I hope you will all put this date in your diaries, maybe make a long weekend of it, and let me know if there is anything in particular you would like to see included in the conference programme.

Pots and Pans: domestic artefacts of base metal

23rd–24th September 2006

The Finds Research Group AD700–1700 will be holding its autumn meeting in Taunton. The meeting will be held in the gallery and Wyndham Hall at the Somerset County Museum. Further details are available on the website of the Finds Research Group AD700–1700 (www.frg700-1700.org.uk).

Papers will include:

'Six hundred years of bronze cooking pots' Christopher Green

'Can you learn new tricks from an old pot? experimental archaeology at Hampton Court kitchens' Marc Meltonville

'Evidence for cauldrons, posnets and skillets reported to the Portable Antiquities Scheme' Danielle Wootton

'The Wenlock Jug' Marian Campbell

'Highly decorated early pewter ware and other domestic items' Geoff Egan

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VIKING TO VICTORIAN

Exploring the Use of Iron in Shipbuilding

Olaf T Engvig, tells us that he has a new book out, 'to my knowledge the first book devoted to this particular subject'. The book has lots of connections to Great Britain, York Archaeological Trust and iron ship building on the British Isles. It is hard cover, letter format, four colours, index and references, 176 pages. Price $45, plus shipping. For further details contact the author, Olaf T. Engvig, 1451 Lomita Blvd # 4, Harbor City, CA 90710, USA. olafengvig@earthlink.net

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MacFarlane's Architectural Ironwork

The Scottish Ironwork Foundation have produced a limited edition reprint of a sample book of photographic plates illustrating the work of one of the world's leading architectural ironfounders; Walter MacFarlane and Co, Saracen Foundry, Glasgow. This catalogue was issued as a demonstration of the range and prowess of the firm in the early Twentieth Century. Whilst past their 1890s peak, this book provides a wonderful record of some of the projects undertaken by the firm around the world, and includes a comprehensive company history by David S Mitchell. The book is A4, hardbound in canvas with gold foil as per the original. All profits generated go to support the work of the Foundation and producing further publications. The book costs £23 plus £4 postage and packing in the UK. If you wish us to post anywhere else, please contact us directly, The Scottish Ironwork, Foundation, 22 Alexandra Place, Stirling, Scotland, FK8 1UN,
david@scottishironwork.org, www.scottishironwork.org

Due to increased postage costs and the necessity of reprinting some of the older issues there has to be an increase in the cost for multiple copies of back issues of *Historical Metallurgy*. Prices will in future be as follows:- Any one issue £10; Two to five issues £8.50 each; six or more issues £7.50 each. These prices include second class postage within the UK and the cheapest available rate overseas. Urgent orders can be sent by alternative means at cost. Payment is not due until the goods have been received. If insurance is deemed necessary to protect HMS from risk of excessive loss then this will be added to the cost. All back issues are available although issues before Volume 20 may be reprints in a different cover.

In addition there are the following HMS special publications (£10 PLUS POSTAGE) *Boles & Smeltmills*, (lead mining and smelting), *Metals and the Sea*, *Mining before Powder*, *Mining and Metallurgy in South-West Britain* (mainly Copper, Tin & Arsenic), *Iron & steel on the European market in the 17th Century* (published by the Swedish Ironmasters Association) £10 plus postage. Also available are a few copies of a two part facsimile edition of Percy's *Metallurgy*, Volume III - Lead costing £34 inc postage

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While submissions to the Newsletter are welcome at any time, if you want to have something in a specific issue of the newsletter then it needs to be with me by the following deadlines.

1st March, 1st July 1st November

Contributions can be sent in any format (hand-written, typed, email, floppy disk, CD-ROM, etc).

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