HMS NEWS

Historical Metallurgy Society

61 Winter 2005/6

Investigation of a broken pile-shoe from a Roman bridge

Russell Wanhill (on behalf of the participants)

The site of a Roman bridge across the Maas river at Cuijk (see figure 1) was discovered in the early 1990s. Many stone blocks and more than 100 oak piles were recovered and stored. The piles were 2–3m long, 0.4m square above the pointed lower ends, and covered at these ends by iron pile-shoes (Figure 2). The piles and pile-shoes date from the 4th century AD.

Figure 1. Map of the Netherlands

Each pile-shoe was made from four rectangular bars, joined by heating and hammer-welding to form a point. One pile-shoe now has three broken bars, and at least one of the breaks is recent, probably owing to a fall during storage. This fracture showed large shiny facets, some up to 3mm in size. These were mainly grain boundary facets, with some cleavage facets especially in the centre of the bar. This unusual and very brittle fracture (Figure 3) prompted a detailed investigation which has yet to be completed. The participants in this investigation are Corus RD & T, IJmuiden; Philips Research − Materials Analysis, Eindhoven; National Aerospace Laboratory NLR, Emmeloord; and Museum "Het Valkhof", Nijmegen.

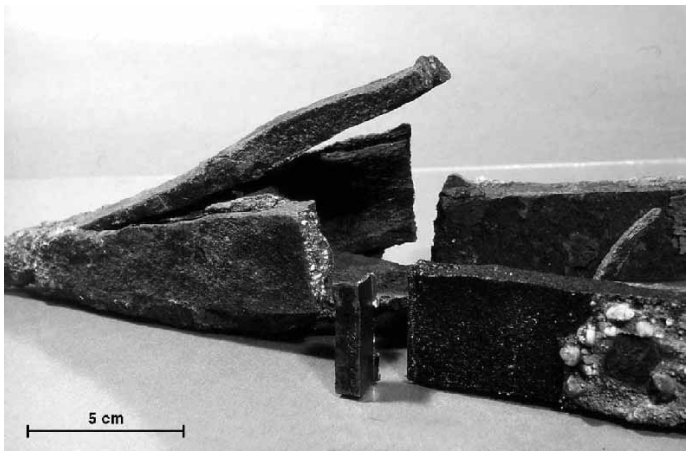

Figure 2. The broken pile-shoe with a sawn-off slice containing the upper fracture surface of the recent break

The broken pile-shoe is a phosphoric (0.5 wt.% P) wrought iron with very low sulphur, manganese and silicon contents, and extremely low carbon content (33ppm C). The extremely low carbon content accounts for the large grain size and also, most probably, for embrittlement by phosphorus. From modern metallurgy it is known that carbon can displace phosphorus from grain boundaries even if the bulk concentration of phosphorus is relatively high. This is why intergranular embrittlement by phosphorus is never observed for unalloyed carbon steels, except when the carbon concentration is unusually low (Erhart and Grabke, Metal Science, Vol. 15, September 1981, pp. 401–408). The extremely low carbon content of the bar from the pile-shoe is most probably due to decarburisation during the smithing process, i.e. heating and hammer-welding.

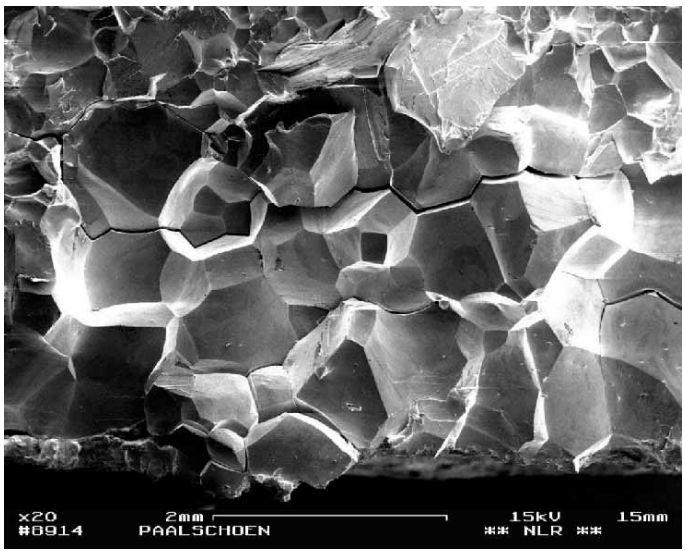

Figure 3. FEG-SEM fractograph at, and near, the external surface of a sample from the sawn-off slice. The fracture is almost entirely intergranular

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The Roman Denarius under the Julio-Claudian Emperors: a British angle?

Matt Ponting

There have, of course, been numerous analyses of Roman silver coins published over the years, most notably by D. R. Walker (1976), but as pointed out by Butcher and Ponting (1995, 1997a, 1997b, 1998) many of these are unreliable due to inappropriate sampling techniques and a failure to fully understand the processes employed by Roman mints to make silver coins. A recently completed project (funded by the Leverhulme Trust) set out to check the validity of the published figures for the silver content of Julio-Claudian silver and by extension the accepted view of Nero being the instigator of the progressive debasement that appears to typify the history of Roman Imperial fiscal policy. Additionally, use was made of modern instrumentation permitting more detailed trace element analysis (ICP-AES) and complemented by a limited number of high precision (LA-MC-ICP-MS) lead isotope analyses.

Figure 1. Roman denarius of AD61 (RIC28)

Figure 2. Roman denarius of AD64/65 (RIC53)

Earlier analyses have shown that the Julio-Claudian denarius was made of pure silver until the reign of Nero whilst the weight of the denarius appears to have remained unchanged up to the beginning of Nero's reign, when it was reduced slightly. The beginning of the debasement is traditionally placed in AD 64,

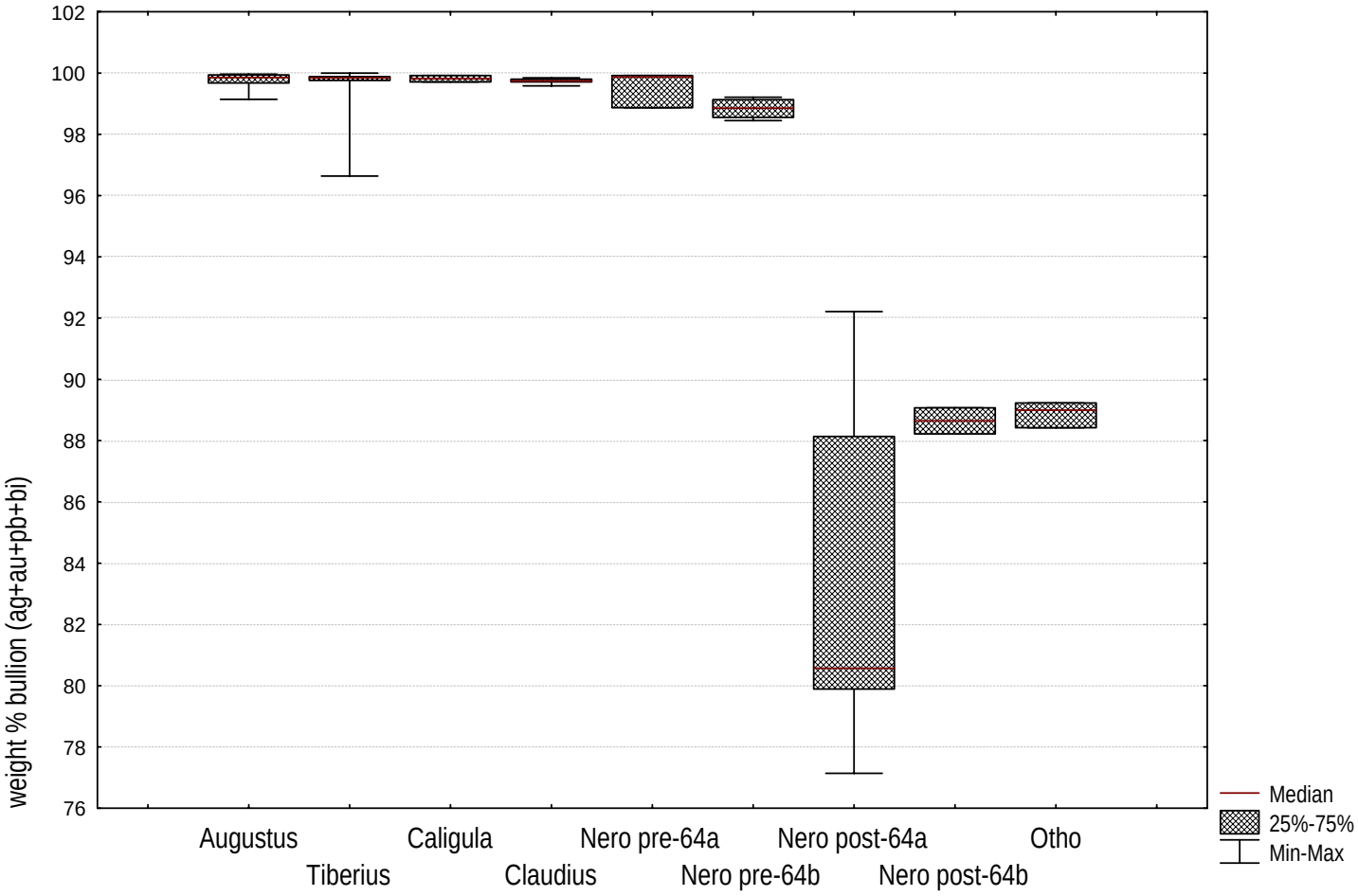

Figure 3. Bullion content of some first century denarii

accompanied by a further drop in weight, and is attributed to financial pressures, particularly after the disastrous fire at Rome in AD 64. There is no doubt that the 'post-reform' issues of Nero mark a watershed in the history of the denarius; hoards of the second and early third century rarely contain any Julio-Claudian denarii issued prior to AD 64, suggesting that these were removed from circulation entirely, probably in the later first century.

The silver contents of the denarii (Figure 3) prior to the reign of Nero are all very high (means for each reign of over 98%). This is in general agreement with Walker's analyses, where means of between 97.4% and 98.1% are given (Walker 1976, 18). However, it now appears that Nero started to add copper to the silver bullion of some of his coins from at least AD 61, because certain issues of his 'pre-reform' denarii contain only 96.5% silver and an addition of around 1.5% copper (the remainder being lead and gold usually associated with ancient silver).

It is with the undated issues struck after AD 64, the traditional date for Nero's reform that the amount of copper added increases dramatically, with a corresponding decrease in silver. The debasement is far greater than that given by Walker; the silver content of Nero's post-64 denarii is 80% across most of the issues, considerably lower than Walker's figure of 93%. This is the standard of 1 part copper to 4 parts silver; the same as was used under Vespasian and Trajan (Butcher and Ponting 1995, 1998), and suggests the Nero's reform was more far reaching than was previously thought.

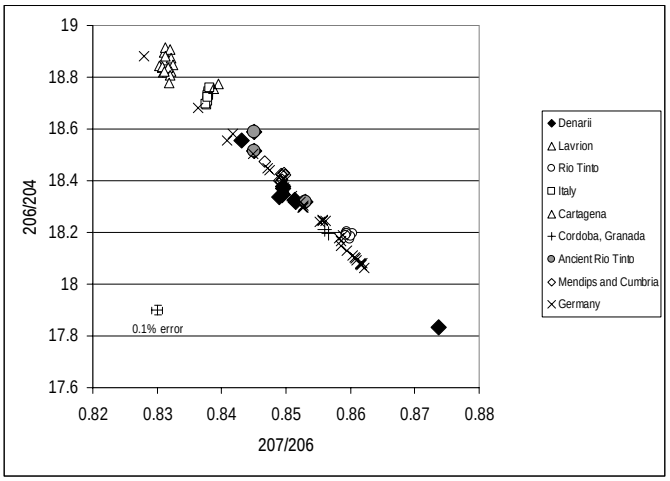

Figure 4. Lead isotope ratios

A small group of eight denarii had the different isotopes of lead in their metal quantified. These ratios were then compared with existing lead isotope data for various locations that may have been sources for lead ores that were either the source of silver, or the source of lead used in the refining of silver (data from Craddock *et al*. 1992, Stos-Gale et al. 1995, 1996, Rohl 1996, Boni et al. 2000 and Niederschlag *et al*. 2003). The results (Fig 4 and 5) show that at least one denarius is consistent with Spanish silver from Rio Tinto, however, the other denarii fall in a group for which the best matches are found in British and some German lead ores, as well as lead metal from Pompeii (Brill & Wampler 1967; Boni et al 2000).

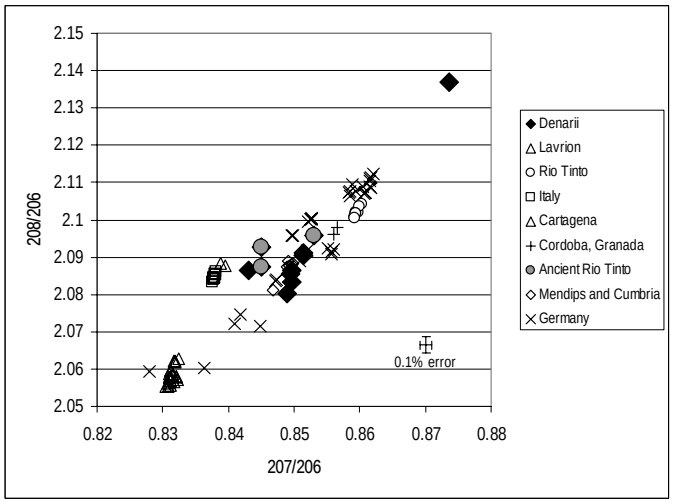

Figure 5. Lead isotope ratios

This suggests that British or potentially German lead was being used to refine the silver, or even that British or German silver was being used to strike denarii. However, the use of German lead or silver is unlikely, given that these regions were well beyond the imperial frontier and Tacitus explicitly states that Germany was poor in silver (Germ. v). Of course, Britain was also beyond the imperial frontiers prior to the Claudian invasion of AD 43. However, the earliest dated lead ingots from the Mendips were produced a mere six years after the conquest suggesting that an already existent lead production system was taken over by Rome; indeed, lead artefacts have been recovered from the pre-Roman settlements at Meare and Glastonbury, and there is even some suggestion of pre-conquest exportation (Todd 1996, 11–12).

The big question is, of course, whether British lead was exploited for silver by the Roman State: analysis of lead ingots (Smythe 1939/40) shows that silver was not extracted from Derbyshire lead, but Mendip lead is generally richer in silver and it is possible that this could have been exploited. The silver content of galena can vary considerably within an ore body (Tylecote 1986, 69) and silver was regarded as one of the fruits of victory listed by Tacitus (Agr. xii); silver may have been extracted when suitable ores were available. It may be suggested that while it was uneconomic to extract silver directly from British lead, the latter could have been shipped to Spain for use in silver refining, where any silver originating in the lead would be extracted during the process of extracting silver from jarosite ores. Rio Tinto is relatively poor in lead ores, and the LI analyses of Craddock *et al*. (1992, 209) indicate the use of

imported lead, some from within Spain itself; but the use of British lead is a possibility. Curiously, the trace element signatures of the silver are consistent with a likely Spanish origin, and this is supported by a coin that has both trace element and LI signatures consistent with Spanish silver. Therefore, on the basis of the present data it would be reasonable to suggest that the coins sharing an isotope signature that indicates a British origin were made of Spanish silver that had been refined with British lead.

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Viking metalworking in Dublin

Justine Bayley

I spent much of this summer in Dublin, going through the National Museum's collection of finds from excavations at High Street, Christchurch Place, Fishamble Street and Winetavern Street, identifying those relating to metalworking. I recorded over 1700 complete or fragmentary objects – and also re-discovered about half a ton of iron-smithing slag hidden in the stores! This work was part of a project which will eventually publish all the Viking-period metalworking finds from the National Museum's excavations in Dublin in the 1960s and 1970s.

About half the finds were crucibles that had been used to melt copper alloys, gold or silver. Further analyses are needed, and it will be interesting to see if there is any correlation between metal composition and crucible size, form or fabric. There are smaller numbers of ceramic vessels that appear to be 'heating trays' or cupels for refining silver and gold, and also some fragments of parting vessels – similar to those I identified from the Coppergate site in York. The clay moulds for casting objects are small and scrappy but there are numerous open moulds for casting bar ingots, made from a variety of local and imported stone. Nearly a third of the finds were metal: complete and fragmentary bar ingots, spillages and wrought bars, rods and lengths of wire. Most of them were copper alloys – with brass predominating – but there were also considerable amounts of lead and some gold, silver and pewter.

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HMS Council

At the July HMS Council meeting two members were elected: Peter King (re-elected) and Ian Freestone (new).

HMS meetings in 2006

Bob Smith

The next AGM will be held in London on the 10 June 2006. The afternoon visit will be to the Whitechapel Bell Foundry and the AGM will be held nearby but we are still finalising details as to the exact venue.

The Conference for 2006 will be in the Forest of Dean on the 15–17 September. Arrangements are still being finalised but we will have the usual lectures and visits as in the past.

Wealden Iron Research Group News 2004

Jeremy Hodgkinson

The 2004 WIRG Bulletin contains two articles relating to iron production in the late16th-early 17th century. The first is a transcript of the information on the owners, occupiers and output of furnaces and forges in Kent that was drawn together during surveys conducted for the Lord Lieutenant of the county in 1588–90 after the Armada crisis had subsided, when the government were putting in place restrictions on ordnance production and export. Considerably more detailed than the lists of 1574, it is unfortunate that the corresponding lists for Sussex and Surrey have not, apparently, survived.

The other article recounts the business done with the Office of Ordnance by one of the ironmasters mentioned in the previous lists, Thomas Browne. As royal founder or iron ordnance and shot, he was responsible for deliveries of armaments to coastal fortifications, but also supplied the East India Company and was allowed to conduct some private business in connection with colonial ventures in Virginia and Bermuda. The article details the numbers of guns supplied to the Tower of London, reflecting the changing demand for guns during the first two decades of the 17th century, before Browne was succeeded by his more famous son, John.

In the Field Notes, discoveries of half a dozen bloomery sites are recorded in East Sussex, as well an interim note on the excavation of a domed bloomery furnace of the 2nd century AD near Mayfield. Also, details are given of the radiocarbon date of the insubstantial remains of an Iron Age bloomery hearth discovered during construction of a pond near Forest Row, East Sussex. A broad date of 360BC–AD30 at 95% confidence was recorded, but survival of the hearth base, which measured approx. 400mm across, was poor.

Wealden Iron Research Group News 2005

Jeremy Hodgkinson

In the Group's 2005 annual bulletin (*Wealden Iron*, 2nd ser., **25**), there are short reports on undated bloomery sites discovered at Peasmarsh and Maresfield, in East Sussex, and a note about a possible Romano-British occupation site close to a bloomery site at North Chailey in the same county. So-far fruitless searches for two documented blast furnaces, at Bournemill, near Tonbridge, Kent, and at Iping in West Sussex are discussed, and the possible location of the former charcoal store for Ashburnham Forge is described.

Evidence of late Iron Age and Romano-British ironworking in the Kent Low Weald is described in an article in which ironworking is linked to small settlement sites at Ulcombe and Headcorn. Also noted are the evidence for Romano-British ironworking at Rolvenden, and the opportunity to record a section of the slag-metalled surface of the Rochester-Bodiam Roman road at Sandhurst.

Two blast furnace sites come under scrutiny: Warbleton Priory furnace and Bungehurst furnace; both in East Sussex. When Ernest Straker described the former site in his 1931 monograph, *Wealden Iron*, he had been hampered in his recognition of its features by overgrown vegetation. Recent clearance has enabled a better assessment of the site's layout. In the case of Bungehurst, Straker's location was incorrect, and subsequent investigation identified another location, at which all evidence of ironworking has apparently been completely obliterated. The site which is the subject of the current survey is probably the one that Straker originally identified and has now been correctly located. Typical of many of the earlier (16th century) sites, it occupies a confined position in a narrow valley. However, the evidence of the working area has enabled the probable former sites of the furnace, wheelpit, spillway, slag heap and charcoal store to be identified.

An article on charcoal production around Darwell furnace, East Sussex, uses evidence of the size and distribution of burning sites and the possible consumption of wood to put forward a number of suggestions about the nature of charcoal supply from a defined area.

The career of John Browne, the seventeenth-century gunfounder, is described from the 1610s to the 1630s, and deals, *inter alia*, with the export of cannon, the problems caused by the export embargo and the monopoly of merchant ordnance supply granted to Sackville Crowe, his attempts to develop new types of gun, and his eventual forays into bronze casting. This is the first part of a longer article.

Finally, in a brief note, the identity of James Littleton, who supplied round shot in the 1660s, is revealed as son-in-law of the gunfounder, George Browne, and can be associated with Woodcock hammer in Surrey.

[The HMS News editor would like to apologise for the delay in including the WIRG2004 digest in the newsletter]

Bower Spring Cementation works

Christine Ball

Excavations have been carried out by ARCUS next to the remains of the cementation furnace at Bower Spring, off Russell Street, Sheffield (NGR SK 3527 8790). The cementation furnace, which is owned by the South Yorkshire Industrial History Society (SYIHS) and is a Scheduled Ancient Monument, was once part of the former Franklin Works, part of which is to be removed by the Inner Relief Road. They are the only remains in Sheffield where you can see a cross-section of a furnace.

The works was built c1825 by Turton Bros and sold to Moss & Gamble, who were merchants and makers of steel and files, in 1853. The works was visited in 1858 by Walter White who wrote a lively (and accurate) description of the processes he observed. The site was damaged by the 1864 Dale Dyke Dam flood and, in the new online Flood Claims database (www2.shu.ac.uk/sfca/databaseLinks.cfm), we have been able to find much detail of layout, room functions, personnel, wages lost and equipment damaged.

ARCUS were digging for three weeks and have uncovered the rest of the works site, including most of the original 20 crucible holes. Sadly, some of these will be lost to the road, but most of the rest, and their cellars, should be able to be preserved. The crucible holes are adjacent to the remains of the westernmost furnace and an extension to the scheduled area will enable their protection. It is proposed to backfill, cover and pave the part of the site between the road and the scheduled area.

We are liaising with the City Council, the South Yorkshire Archaeology Service and with English Heritage to preserve more of the remains and display them to the public. English Heritage has offered to contribute funds for the conservation of the remains and the SYIHS is looking to raise the extra money needed.

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HMS 2005 Conference Review

Lorna Anguilano, Aude Mongiatti and Claire Cohen

The annual Historical Metallurgy Society conference this year was held in Middleham, North Yorkshire on the 9th–11th of September 2005. The conference theme outlined the importance of conserving, preserving and understanding archaeometallurgical sites within the Yorkshire Dales, highlighting the importance of lead mining and smelting within antiquity.

Friday night was dedicated to mining and smelting sites in the Yorkshire Dales. The first two presentations were focused on the importance of the archaeological park and emphasising the knowledge archaeometallurgy has gained on lead smelting in the last 40 years. Tom Gledhill presented his investigations into an industrial iron smelting site. Initial surveying has revealed the selection of specific charcoal species at the industrial sites studied. Tom presented the inter-related use of varying charcoal and cultural context of the site giving an insight into the degree of knowledge and selectivity that the smelters were using when selecting smelting material.

Figure 1. A hush seen from the valley floor

The fieldtrip organised on Saturday took the conference participants to sites characteristic of lead production: Kelt Head Smelter, Wetgrooves Mine and Turf Moor Hush, giving participants the opportunity to see how these sites are preserved and visible (if you know where to look!) in the landscape, and what remains of these smelting activities. Wetgroove Mines showed clear botanic evidence that lead smelting and beneficiation took place, indicated by the presence of typical white lead flowers. The presence of two branched underground mines linked with a shaft (unfortunately unexcavated and partly filled and collapsed) shows complex and large scale exploitation of lead in the area. Exploration of Turf Moor Hush led by the guide Martin showed that hushing is an invasive method deeply modifying the surrounding landscape. Within Turf Moor Hush it is evident that geological faults have been partially deleted by large scale industrial mining processes and as a result scar the surrounding countryside. They remain an enduring reminder of the importance of lead processing within the region.

After a full day of hiking and exploring the Dales, Saturday night was dedicated to short presentations on broader subjects and ongoing projects. Participants heard

presentations on: Mycenaean lead production during the Bronze Age (Sue Mossman), and medieval lead smelting (Lynn Willies). Silver production was addressed with two presentations; medieval silver mining in southern France (Peter Claughton), and rich silver ores exploitation from the Renaissance onwards in Scotland (John Pickin). To finish, recent excavations in North Yorkshire were presented outlining an 18th century industrial structure for iron working, and lead ingots and furnaces in Roman and medieval times. After a conference dinner most of the younger members of the conference headed for a well deserved pint after a tiring but enjoyable day.

Figure 2. Looking back into a hush

The final morning of presentations started with what remained the main theme of the conference: medieval bole or bale smelting, with one report about lead and silver production in Imperial Roman Serbia (John Merkel) and one archaeological report from recent fieldwork in Wales where furnaces under a timber structure have been excavated (Simon Timberlake). A comprehensive archaeometallurgical study of lead smelting debris in Cwmystwyth, Wales followed (Lorna Anguilano) and the conference was concluded by two presentations about combined archaeological and metallurgical studies of post-medieval silver production, one in Bolivia (Claire Cohen) and the other in Austria (Aude Mongiatti).

A very interesting and stimulating conference enjoyed by all the participants. Thank you HMS and special thanks go to Peter Claughton who did an excellent job organising and running the conference!

Mines et Métallurgies anciennes du Plomb dans leurs environnements

A 3 day colloquium on the mining and metallurgy of lead will be held at Florac (Lozère) in the southern part of the Massif Central 8th–10th September 2006. The area has been the subject of recent collaborative research into the mining of lead and its impact on the environment.

If you are interested in participating then contact
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Northern Pennine Silver in the Late Medieval Period

A seminar will be held at the North Pennines Heritage Trust Centre, Nenthead, Saturday 8 April 2006.

The evidence for silver production from the northern Pennine orefield in the late medieval period has been addressed by both historians and geologists in recent years. Whilst there is strong documentary and statistical support for the position that an area in the north Pennines, encompassing parts of Cumberland (now Cumbria), Northumberland and County Durham, was the major source of newly mined English silver in the late medieval period, that is not backed up by the geological evidence. The majority of the ores mined in the modern period were low in silver and there is, as yet, no evidence for significant quantities of silver-rich minerals at the shallow depths accessible to the medieval miner.

Although the quantity of silver produced during the 12th century can be estimated with some confidence we do not know the precise location of the workings. Neither can we be certain as to the nature of the ores worked, where they were processed, nor the quantity of lead which might have been produced as a by-product. Information is available on the organisational structure under which mining was carried out but there is currently little to indicate how it fitted into the social framework and upland agricultural practice.

This seminar is being held to consider the evidence for silver production and discuss how our understanding of mining in the area during the late medieval period might be advanced. The intention is to hear presentations from all those with an interest in the area — geologists, historians, archaeologists and mine explorers.

If you are interested in contributing, please contact Dr Peter Claughton, Blaenpant Morfil, CLYNDERWEN, Pembrokeshire, Wales SA66 7RE; tel. 01437 532578;
Email: P.F.Claughton@exeter.ac.uk

There will be no charge for the seminar itself, commencing at 10:30 — lunch will be available in the Centre café. To book, please contact Sheila Barker, The Rise, ALSTON, Cumbria CA9 3DB;
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Grey Gold 2

The Story of the Greenside lead Mine 1825 to 1962 (second edition)
Sam Murphy

Back in 1996, my book (Grey Gold: Men, mining and metallurgy at the Greenside lead mine in Cumbria, England 1825–1962) was reviewed in the HMS journal 30(1) pp50-51. This hard-back book has been out-of-print for several years now, but I have just produced a much revised and completely reformatted digital version called 'Grey Gold 2: The story of the Greenside lead mine 1825–1962', which now includes additional data arising from recent research and is published as an electronic book on CD-ROM (ISBN 0-9526360-1-8). It gives a very detailed description of mining and metallurgical developments during the 19th & 20th centuries which was enthusiastically commended by the reviewer in the HMS journal.

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HMS Archive

Eddie Birch

The Historical Metallurgy Society's own archive has been professionally catalogued by consultant archivist Christopher Williams. The work was made possible by a grant from 'Awards for All' which paid Mr Williams' fee and for about half the cost of materials. The archive is housed at the Ironbridge Gorge Museums Library, and can be consulted by application to the Librarian. The catalogue will be appearing on the HMS web site fairly soon. At present the collection consists of 458 packets of papers. Around 80 of these relate to the history of the Society itself, and most of the balance is papers from the collection of Charles Blick. To give a flavour of the collection some of the packet contents are:

Packet 70
Correspondence and papers re drafting of HMS constitution. 1971–73.

Packet 92
West Midlands iron industry: correspondence and papers concerning various early blast furnaces (including sites in Montgomeryshire). 1981–91.

Packet 158
Alderley Edge: correspondence, papers, publications and photographs concerning copper mines. 1988–89.

Packet 220
Charlcot charcoal blast furnace: papers and photographs. 1964–6.

One of the reasons to catalogue the collection properly was to encourage donations of suitable collections. While there is no room for major collections (for which the History Committee will try to help find suitable homes if they would otherwise be lost) smaller collections can now be accommodated. As they will be added to the catalogue, they will be available for consultation. We have in fact already had a contribution of selected papers of metallurgical interest from the collection of ICI Billingham. Had it not been for HMS input, many of these papers would have been lost.

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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