Book Reviews

The Royal Armoury at Greenwich 1515-1649, A History of its Technology by Alan Williams and Tony de Reuck. *Royal Armouries Monograph 4, Trustees of the Royal Armouries, London, 1995. 140pp, many figures, 4 in colour. ISBN 0 948092 22 X. £12-95 (pb) + £1-00 p&p UK, £3-50 overseas from Royal Armouries, HM Tower of London, London EC3N 4AB.*

Armour had been produced in Britain long before Henry VIII acceded to the throne in 1509. However, these local products, inferior to the output of master armourers on the continent, were clearly felt not to fulfil the important role of reflecting the prestige of a monarch of his abilities and ambitions. Under his patronage, Henry's court attracted a very wide range of artists and craftsmen. Not least of these were a succession of armourers, initially from the low countries and Italy, then Germany. Their 'Almain' armoury sited beyond the jurisdiction of the London Armourers Company, initially at Southwark but later at Greenwich, concentrated on the production of very high quality armours for the King's own use, for his diplomatic gifts and, under warrant and at an appropriately high cost, to other nobles of the court. Williams and de Reuck's book examines the technological background of this Royal Armoury from surviving examples of its products.

There is no shortage of texts on the development of plate armour, from the scholarly to the coffee table. Most, in the art-historical tradition, have chronicled stylistic developments. More rarely texts such as Pfaffenbichler's excellent, if brief, *Armourers* in the British Museum's medieval craftsmen series have provided a very readable insight into the lives of the individual armourers, their workshops and guilds. The metallurgical study of armour is not entirely the 'terra incognita' suggested in the introduction to Williams and de Reuck's book's; notable precedents include the early work of William Campbell in the United States who examined 25 samples during World War I to compare modern with ancient helmets. However, Williams and de Reuck's work is unique in the thoroughness of its approach to studying the development of workshop practices involved in armour manufacture. The core of the study is the examination by optical microscopy (metallography) of 64 samples of armour manufactured at the Greenwich Armoury between 1515 and *c*1635. These allow an assessment of the quality of iron or steel used and enable Williams and de Reuck to chart the changing workshop practices used in the hardening of the steels. Many of these changes can be attributed to the influence of individual craftsmen, the Masters of the Armoury who controlled production in the workshops.

Those coming freshly into this area of study will find that the two opening chapters provide fairly basic introductions to aspects of this study; 'Renaissance metallurgy' covers the extraction of iron, making steel, heat treatment of steel, steel armours, fire gilding and the proof testing of armour. The next chapter 'Modern metallography' explains the chemistry behind the extraction of iron, before moving on to describe the tools of the researcher; the measurement of hardness and strength, the heat-treatment of steel, blueing, sample homogeneity and the technique of metallography. This is followed by a chapter on 'Henry VIII's continental contemporaries' which combines an historical overview with a summary of Williams' previous metallographic studies, to set the scene of the production of high quality armour elsewhere in Europe, notably in the two centres of north Italy and south Germany.

The two following chapters draw on historical sources to investigate the location and structures occupied by the armoury, together with what is known of individual masters who worked there. The latter shows that the heavy dependence on Continental skills continued until the appointment of William Pickering as Master in 1608 which eventually healed the rift with the London Armourers' Company. Significantly, from this date the authors argue that, although fine quality armour continued to be produced, the creative years of the Armoury were past. The range of activities carried out is considered in relation to contemporary illustrations and inventories of tools. Difficulties in the interpretation of these are discussed, for example, a 'temperinge barrelle' of 1511 may refer, not to heat treatment, but to the cleaning of rusty mail.

Almost one half of this volume comprises an appendix with piece by piece descriptions and illustrations of both the individual armours studied and their microstructures. Whilst such a catalogue might be expected to make dull reading, this section actually includes much interesting detail. Moreover, the subjective element in metallography means that experienced practitioners will welcome the opportunity to compare their own interpretation of the structures with Williams' (sample 27 ... tempered martensite with ferrite! surely some mistake!). Williams must be forgiven if occasional micrographs are of poor quality, showing scratches and bevelling. Metallography is essentially a destructive technique and sometimes unorthodox methodologies, such as polishing and examining edges of plates *in situ*, were used to minimise damage to the armour.

The final chapter, 'The metallurgy of Greenwich

armour', pulls together all the evidence and proposes successive regimes of metallurgical practice in the Armoury. Initially 'Early Greenwich armour' (1515-44) was air cooled or ineffectively quenched. During the subsequent 'years of experiment' (1545-67) most armours show evidence of attempts to harden, but it is suggested that difficulty was experienced in overcoming the tendency of plate armour to warp during quenching. Armours produced during the 'peak of Greenwich achievement' (1567-1608), reveal highly controlled quenching and tempering, the latter often being combined with fire gilding to produce armour that was mechanically tough and visually impressive. Under the 'mastership of William Pickering' (1608-18) heat treatment was less consistently practised and from 1618, the 'years of decline', poor quality workmanship parallels the financial difficulties experienced by the workshops.

Inevitably, despite the inclusion of introductory chapters and attractive illustrations, Williams and de Reuck's book will be of limited appeal to those without a strong interest in the detail of historical metallurgy. However, this volume and its authors deserve praise for a remarkable achievement. Metallography is too often viewed as an unglamorous technique, overshadowed by powerful and sophisticated analytical instrumentation. In this study directed to a particularly appropriate topic, against a deep understanding of the historical and material background, it provides a lucid insight into our metallurgical past. In such carefully directed hands the metallurgical microscope is indeed a powerful research tool.

David Starley

Martin Frobisher's Northwest Venture, 1576-1581. Mines, minerals and metallurgy by D D Hogarth, P W Boreham and J G Mitchell. *Canadian Museum of Civilisation (Mercury Series Directorate Paper 7), Quebec. xiii+181pp, 235x175mm, 36 figs, 9 tables, index. ISBN 0 660 14018 7. Can$21-95 from the Museum, 100 Laurier Street, PO Box 3100, Station B, Hull, Quebec J8X 4H2.*

The voyages of English adventurers in the years 1576 to 1578, under the command of Martin Frobisher, marked the first European penetration of the sub-Arctic. Although the initial objective was to discover a northern passage to Asia, the 1576 expedition returned with the news that an ice-blocked passage had been found (it was in fact only what we now call Frobisher Bay). However, the chance analysis of a fist-sized black rock brought back led to the conclusion, to which several assayers testified, that it had a high gold content. This led to a major rush to invest in a gold-seeking project which attracted royal support in the informally-organised Company of Cathay under the direction of the prominent merchant, Michael Lok. The three ships of the 1577 expedition concentrated on mining some 200 tons of rock from Kodlunarn Island, off the mouth of the Bay. These minerals were hastily assayed and, without adequate study, formed the basis for one of the largest English expeditions ever attempted into Arctic waters. Experienced miners from the Forest of Dean and Cornwall, equipped with primitive tools, mined over 1,000 tons of rock, partly from Kodlunarn Island but also from Baffin Island, and brought ladings from twelve ships to England, and one to Ireland, in the autumn of 1578. In preparation for the smelting of what was hoped to be a most valuable cargo, a major smeltery was being built at Dartford in Kent, based on a water mill. The ore was assayed in small quantities, with varying results, but when transported to Dartford in bulk and pulverised was found to be entirely lacking in gold. The whole venture, with an investment of some £20,000, proved to be a wretched failure though it has the interest of being the first industrial venture in the early expansion period for North America as a whole, and was without parallel until the development of the Saugus ironworks in New England in the 1640s.

A contemporary pamphlet by Dionise Settle, *A true reporte of the last voyage into the West and Northwest regions* (London 1577), was widely circulated in Europe, being translated into French, German, Latin and Italian during the following years. Interest largely focused on the Inuit man brought to England, whose asiatic features and kayak, illustrated in an engraving, strongly suggested that there was a passage to Asia by this route. The alleged gold discovery was also a unique advertisement for English overseas enterprise. The site remained unknown until the early 1860s when C F Hall picked up tales of a European expedition from the Inuit and located the sites of the Frobisher venture on Kodlunarn Island from which he collected surface artifacts. He sent substantial samples of his finds to the Smithsonian Institution and the Royal Geographical Society, and a lecture by him was read to the latter body before the publication of his popular *Life among the esquimaux* (1864). His artifacts were never properly investigated and were subsequently lost by both institutions; however, the contemporary narratives were reprinted for the Hakluyt Society in 1867. Much had also appeared in successive printings of Richard Hakluyt's *Principal navigations* (1589-1600 and 1812), so that the basic outline of the voyages was a well-known part of the history of early English overseas enterprise. Canada declared Kodlunarn a National Historic Site in 1964, and an expedition from the Royal Ontario Museum under W A Kenyon made a preliminary survey in 1974. However, the first systematic expedition to the area was made in 1981 under the auspices of the Smithsonian Institution, led by William Fitzhugh. A detailed survey of Kodlunarn Island was made, the location of sites used by Frobisher recorded, and some test excavations made; preliminary

reports circulated in typescript.

D D Hogarth, a geologist in Ottawa University, was then attracted to the sites and in successive annual visits, with his assistants, made a geological map of Kodlunarn Island in 1984 and began publishing papers on the subject. He was in contact with the Smithsonian team in these years and, in 1988-89 he had a sabbatical year in England when he identified ten unpublished manuscripts in London which threw much light on the voyages and provided a basis for his geological studies. He had some specimens of rock from Kodlunarn Island with him, but was fortunate in finding many specimens of the black rock brought back in 1578 at Dartford, much of it built into a surviving wall. He also made the striking discovery that the *Emmanuel,* returning in 1578, had barely made the crossing to Smerwick Harbour in Co Kerry and had discharged 100 tons of rock before foundering. After the ore was found to be useless it was incorporated into the so-called Golden Fort and Hogarth was able to find characteristic specimens on the shore and in the crumbling walls. This gave him a further group of specimens and a narrative. He also contributed items on the chief investors in the voyage and a list of crew members so that the basic data on the 1578 expedition was succinctly laid out.

The book then proceeds to examine in detail the 16th century assays made of the black rocks and also of a red sand which seemed especially promising. Most of them had returned high values for gold, and it remains unclear whether this was due to deliberate chicanery or to the additives brought from the north of England which may have had a gold content. In any event, when mass testing was done at Dartford, the rock was found to contain no gold whatever.

The description of the Dartford activities owes much to R E Boreham who is curator of the Dartford Museum and is responsible for assembling most of the surviving material on the sites. The key scientific interest however, is the work of Hogarth on the specimens from the sites themselves (and through Hogarth's association with the Smithsonian expeditions of 1990-92). The basic geological analysis was done in England in association with Professor J G Mitchell. Hogarth established that the 'black ore' was a hornblende, which under analysis he broke down into its constituents, finding above all that the presence of gold, silver and platinum was minimal and only 'approached the mean value of ultrabasic rocks' (p.137), although this leaves the failure of the contemporary assays as a mystery and without a final conclusion on why this occurred.

His tables show the composition of the rock and his figures are conclusive in their detail. There is one exception only. A small amount of red 'ore' (which could not be matched in recent explorations) could, he considers, have justified the high, gold-yielding result of one assay and have produced the results claimed for it, provided it was 'gossan ... weathered sulphides from the basic rock' (p.54).

The book as a whole is a very effective combination of historical, archaeological and mineralogical research and provides a most attractive introduction to the achievements and failures of this pioneer industrial venture using North American material for the first time.

D B Quinn

Brass and brassware by David J Eveleigh. *Shire Publications (Shire Album 311), Princes Risborough, 1995. 32pp, many figs. ISBN 0 7478 0274 2. £2-25 (pb).*

This booklet deals mainly with 17th century and later English brassware, with only a brief mention of the earlier usage of various copper alloys, many of them imported. The manufacture of brass gets a mention too, especially Champion's Bristol-based industries, but attention concentrates on the more widespread production of brass objects by founders and braziers; numerous examples are illustrated. Birmingham developed as a major centre for manufacturing in brass, and the alloy was made here too from the mid 18th century. Specialisation increased during the late 18th and 19th centuries and there were many technical innovations. Some are these and the increased range of functional and decorative brassware produced are described.

A 'further reading' list is provided for those who want more information than can be squeezed into this brief introduction. The recommended books range from standard histories to collectors' handbooks.

Justine Bayley

Twenty by fourteen – a history of the South Wales tinplate industry 1700-1961 by Paul Jenkins. *Gomer Press, Llandyssul. 1995. 269pp inc index, appendices and bibliography, 109 plates, 13 diagrams, 17 tables. ISBN 1 85902 203 0. A5 h/b £15.*

Paul Jenkins begins his book with an introduction to the uses of tin through the ages, culminating with its present extensive use for protecting steel from corrosion by food and drink. The first chapter continues the history with an account of the early attempts to found a British tinplate industry, culminating with success at Pontypool. In the second chapter he deals with the beginnings of the industry at Pontypool. The introduction of rolling mills by the Hanburys to shape the iron sheets improved the uniformity of the sheets being produced at the time. Tinning these sheets produced a product superior to any other tinplate in the world. The export market that this

eventually created led to the establishment of tinplate works in many places. The demise of the copper industry in the Swansea area provided an opportunity to employ workers experienced in factory work. Other reasons for the concentration of the industry in the Swansea area were the ready availability of suitable coal and sulphuric acid, and the port facilities developed for the copper trade. The introduction to the area of the Siemens Open Heath process, which provided a supply of high quality raw material at a reasonable price, helped too. Statistics are given showing the rise of the trade from 4,000 tons in 1805 to 586,000 tons made on 525 mills in 1890. More than half of these mills were in the old county of Glamorgan, with almost another quarter in old Carmarthenshire. Most of the rest were in old Monmouthshire with less than 10% in the rest of England. This is surprising when the biggest market was originally in the Midlands. The structure of the companies involved in this expansion was largely parochial, with the local middle class providing the capital. Compared with other industrial undertakings a small tinworks was inexpensive.

The third chapter deals with the difficulties caused by the conservatism of the Welsh manufacturers and the introduction of strip rolling and continuous tinning in America. The mergers that took place between the Wars and the closures of some of the least efficient plants set the scene for the introduction of strip rolling. The most significant merger was between Grovesend and Richard Thomas that brought William (later Sir William) Firth to the board of Richard Thomas and Company. After the failure of negotiations with other companies for a joint venture he persuaded the Company to build a strip mill on its own. Originally intended for Redbourne, government pressure and money had it moved to South Wales. Ebbw Vale was chosen because it was an unemployment blackspot. Unfortunately the unemployed were mostly miners and much of the labour moved in from steelmaking areas. The works, which opened in 1938, was a success and was followed by a works at Shotton. Tinning continued by the hot dipped process, although mechanised pots were used. Tinning was not fully modernised until 1948, when the revolutionary electrolytic process was introduced, again at Ebbw Vale. After the War it became clear that another hot strip mill was needed. Richard Thomas and Baldwins were again involved, with other partners this time: The Llanelly Associated Tinplate Producers and John Lysaght. Together they formed the government backed Steel Company of Wales. The Margam and Abbey Works was commissioned in 1951. This new company built two tinplate works besides the steelworks and the days of the handmills were numbered. The last closed in 1961, and the last hot dipped tin in South Wales was made in 1982.

Chapter 4 takes up a third of the text and describes the processes involved in the production of hot dipped tinplate. There are some inaccuracies in the historical part dealing with the production of steel plate before the blast furnace was introduced. The author then describes in some detail the early processes including a translation of an article from Diderot's *Encyclopedie...* which provides some interesting detail of the manufacture of sheet steel in 1740. The introduction of steam power allowed a considerable increase in productivity as well as removing the problems of freezing and drought. By the beginning of this century the mills were powered by engines of around 1500 horsepower. This raised the output to around three and a half tons per shift, compared with around 100 lbs with a tilt hammer. The process, and the design of the mill were, however, little changed from the Hanbury days.

The tinworks received the 'tinbar', about 9″ by $^{3}/_{8}$″-$^{7}/_{8}$″, in random lengths of up to 20′. It was sheared to lengths corresponding to the width of the sheet, and charged into the heating furnace. The red-hot bar was passed to the rollerman, who presented it to the mill. The Behinder caught it as it came out at the back and passed it back to the rollerman. When it was partly rolled it was doubled (by the Doubler) to give two thicknesses, and squared up. It was reheated, rolled and doubled twice more and then rolled to the thickness required. The final product of the hot mill was squared up, the curl was cut off, and it was cut into two to make two packs of blackplate. The sheets were separated and pickled to remove the scale. The sheets were then 'black annealed' to soften them. Three passes at room temperature through the cold mills improved the surface and flatness of the sheets. The sheets were annealed again (white annealing) to soften them after the cold rolling, this time at a lower temperature for a shorter time. The sheets were pickled to ensure that they were absolutely free from oxide (white pickling) and then tinned and polished. Full descriptions are given of these processes and the machinery employed, and there is a profusion of photographs. There is much detail of the all important tinning machinery from the simple dipping pot to the last automatic tinning machine. The chapter concludes with details of some interesting sites and a description of the Duffryn Works in Morriston.

Chapter 5 is an account of the initial failures of workers and employers to co-operate to the general good of the industry. An account is given of the struggle for recognition of the Unions. The formation and dissolution of the early unions is chronicled, and the eventual formation of the Joint Conciliation Board that helped to maintain the industry until nationalisation and the formation of British Steel.

The final chapter summarises the changes made after the War, and those due to the introduction of the hot strip mill

into South Wales.

The book is completed by an extensive bibliography and appendices listing the South Wales tinplate works, the numbers employed from 1800-1964, the numbers on the payroll in 1939 and 1941, and the number employed in the old handmills from 1946-1957. The last appendix is a report on a visit to Moscow by Tom Griffiths in 1913. It is followed by a useful glossary.

The book ends with a quotation from Andrew Yarranton 'Reader it's possible, thou hast not all in this book that thou didst expect, and on the other hand, I tell thee, here is more than I intended.' Whatever Paul may have intended this is a first class history of the Welsh tinplate industry. It is well worthy of the support it had from BS Tinplate and I recommend it to anyone who is interested in the subject.

Peter Hutchison