

Book reviews

The Era of Cast Iron Pt I Casting of Iron in Sweden to the middle of the 19th century. By Martin Fritz. ISBN 91-87920-00-X. **Pt II Casting of Iron in Sweden 1850–1910.** By Bengt Berglund. ISBN 91-87920-01-8. Two volumes published (in Swedish with short English summary) by the Swedish Society for Foundry History, 1989. Price SEK 360 + postage for the two. 254 and 240 pp.

Obtainable from Lars Villner, Bymarksg. 45, 552 59 Jönköping, Sweden.

These two books have been produced under the auspices of the Swedish Society for Foundry History which, after its foundation in 1984, identified the neglected subject of the history of cast iron in Sweden as a priority for research. The development of the foundry industry depended on technology acquired from Britain and was closely linked to the expansion of the Swedish engineering industry with agricultural and domestic needs to help boost demand. At first the foundries were to be found near the blast furnaces, but during the second half of the 18th century, separate works using either reverberatory or cupola furnaces were established nearer the centres of population where the engineering industry was based. By about 1850, the quality of castings had improved, through technical advances, the use of chemical analyses and later by the greater understanding of metallography.

There were four major uses for iron castings. Agricultural tools were in great demand as new land was taken under cultivation; domestic uses, especially stoves; building and decorative work and above all for mechanical engineering. The expansion of Swedish shipyards and the growth of the railways created a huge demand for cast iron products.

In both volumes, examples from three different foundries are used to illustrate the range of scale and products typical of the period. It is difficult to do the books justice from the short English summary, but they seem to be a very comprehensive account of a less well known aspect of the Swedish iron industry. There are footnote references where appropriate and a bibliography in each volume. Part I has fewer illustrations and resorts to the familiar prints from Diderot to show gun casting, but part II has a wider range of illustrations, including photographs of work in progress and pages from manufacturers' catalogues. Few of the illustrations have reproduced especially well, but they are all carefully acknowledged so that originals could be traced if required.

Sue Cackett

Minerai, Scories, Fer/Erze, Schlacken, Eisen. By Cornel Doswald, Ludwig Eschenlohr, Walter Fasnacht, Marianne Senn, Vincent Serneels. *Association Suisse des Techniciens des Fouilles Archéologiques/Vereinigung des Archäologisch-Technischen Grabungspersonals*. 1991. A4, 46 pp., 16 figs. SFr 20, from ASTFA/VATG, Hausacker 47, CH-8706 Feldmeilen.

Les Bas Fourneaux Mérovingiens de Boécourt, Les Boulies (Ju/Suisse). By Ludwig Eschenlohr and Vincent Serneels. *Cahier d'archéologie jurassienne*, 3. 1991. ISBN 2-88436-001-8. 144 pp., 23 tables, 86 figs., 10 plates, 2 loose folded plates. SFr 44, from Société Jurassienne, Rue de l'Eglise 36, CH-2900 Porrentruy.

These two volumes are the result of close collaboration between a young and active group of Swiss archaeologists and archaeometallurgists. Both books are well produced, full of useful information and are very reasonably priced. Both should be on the shelves of everyone interested in the archaeometallurgy of iron.

The first volume is one of a series on the techniques of excavation and, as such, is primarily aimed at helping field archaeologists appreciate the variety and importance of metallurgical structures and residues. It is more than this, however, as it brings together a wide range of information and ideas, many not yet fully published, providing a very useful overview.

There are 11 sections, written by different combinations of the authors, covering processes, ores, smelting, refining, smithing, slags, terminology, a bibliography, a vocabulary and a series of illustrations. For English readers, the bilingual presentation is of particular value in guiding one through the nuances of French and German terminology.

The second volume is a report on a rescue excavation which produced well preserved evidence for early Medieval smelting and smithing. It is a model of collaboration between an archaeologist and an archaeometallurgist and the authors must be congratulated on the clarity and speed of reporting this important site. The report as a whole is one of the most important publications yet of an early iron working site, with discussions on several topics which are for the most part still poorly understood. In contrast to some academic publications in French, the report is easily understandable by anyone with even a basic grasp of the language.

Nine chapters cover every aspect of the project, including a section of the mines and ores of the region (by B. Hiltbold). Of particular interest are the sections on charcoal, the furnaces (slag tapping, with two tuyeres), the tap slags (with some superb illustrations), and the smithing slags. Two chapters, on the analysis and quantification of the smelting and smithing slags,

are particularly elegant, demonstrating with conviction the contribution made to the slags by the ore, the fuel ash and the furnace clays.

The crowning glory of the publication is a magnificent A2 size drawing of the last slags tapped from furnace 2, which were found *in situ*.

Peter Crew

The Letterbook of Richard Crawshay 1788–1797.

Edited by Chris Evans with an introduction by G. G. L. Hayes. xxv + 206pp. ISBN 0 9508676 5 9. Cardiff: South Wales Record Society, 1990. £18.95.

Editing the letters of Richard Crawshay needs little justification; at Cyfarthfa in the 1790s there were considerable advances in the puddling process, and the money derived from Crawshay's success enabled him to invest in other developments and in the infrastructure of the area. He ended his days a prosperous businessman and an industrialist of some influence. If never entirely accepted by the local gentry, he did become a Justice of the Peace. The Letter Book covers the problems associated with the introduction of the puddling process, before and after Crawshay's move to Cyfarthfa in May 1792. It was a time of great strain, and the letters confirm the importance of his management and a feel for ironworking which eventually made the process viable and turned Cyfarthfa into a works of world renown. The survival of this volume, probably one of several, is therefore of considerable value both for the history of metallurgy and for local studies in South Wales.

This edition has some strong points: the introduction is a useful summary of Crawshay's life and work at this period, with notes on the prior history of ironworking in South Wales. The glossary contains numerous ironworking terms, and the bibliographical notes on individuals are helpful. There are ten illustrations, including one map of the Merthyr district in 1799 and two of Cyfarthfa.

There are however some questions. It is not possible to tell from the editorial note the degree to which the brief calendar entries have condensed the originals. Hence the reader cannot tell how much more information there is on, for example, finance or sales of iron. Moreover, emphases of some precis may be open to question: as an example, in the introduction (p. xv) it is noted that in October 1789 Crawshay was 'so disturbed by "bad management" that he could no longer "write, read or think"'. Yet in the letter referred to (no. 168) the calendar entry does not quite convey this, stating only:

'RC will visit Cyfarthfa himself, "let the consequences be what it may to my health or other Concern". RC is disappointed with Thompson: "I know he has some Common sense if he wd but use it & he was placed for the purpose of keeping our Accounts regular".

Cockshutt must respond to the questions RC's puts in his letters'.

As another example, the introduction contains in Crawshay's own words his view of how he solved the difficulties of puddling:

"I have at last overcome the Evils of pudling and am now at work making good iron, about 7 tons of blooms weekly from each air furnace. Our chief mischief was want of cleanliness. Our bottoms were made of sand mixed with common earth and the tops of clay were perpetually falling into the metal. I have substituted sea sand for the former and cast iron for the latter of 2" thick. Our iron from being black and redshort is white as silver, perfectly sound and tough" (p. xv).

Yet the precis (no. 427) states 'RC has "at last overcome the Evils of pudling"'. He has substituted sea sand for sand mixed with common earth in the furnace bowl and replaced the clay lining of the furnace roof with cast iron plates. He is now able to make 7 tons of blooms at each furnace weekly . . .

Thus a short but metallurgically vital piece of text regarding the appearance of the metal is missed out, and one wonders how many important points are lost from other letters to which the introduction does not refer.

If an edition is to be valuable in teaching the industrial-revolution period, there is a need for fuller transcripts than these. Further, record-society volumes should give the general reader more of a feel for the original than is the case here.

Richard Saville

Steelmaking in the 20th Century: From Black Magic to Technology. 1992. Published by the Iron and Steel Society, 410 Commonwealth Drive, Warrendale, P.A. 15086, U.S.A. ISBN: 0 932897 70 3. 106 pp. p/b. Price not stated.

This book consists of four papers which were presented at the 75th Steelmaking Conference of the Iron and Steel Society held in Toronto, Canada during April 1992, and can be looked upon as a commemorative volume to 75 years of existence of the standing conference.

Possible purchasers of the volume could be misled by the title for the papers take as their starting date 1925, and by that date at least, the chemical background to open-hearth steelmaking was fairly well understood and black magic had largely disappeared, but mythology was still prevalent and, even some twenty years later, students were still having trouble distinguishing between fact and fiction when considering the merits of basic and acid open-hearth steelmaking.

The four papers deal with the development of integrated steelmaking, steel refining and product quality, a history of continuous casting, and finally, advances in refractory science and technology.

The paper by P H Danby on Integrated Steelmaking has a novel style, linking the social and industrial changes in the United States over the last seventy-five years, whilst a series of excerpts from steelmaking conferences make excellent reading, as does a chronology of steelmaking landmarks from 1855 to 1991—the final entry being the closing of the last open hearth melting shop in the U.S.A. (Geneva Steel, Utah).

John R Stubbles has written a short, but interesting, paper on "Steel Refining and Product Quality", outlining the improvements from open hearth to ladle refining, and how, in the 1980's, the American steel industry had to reorganise itself to meet the challenge of the improved steels imported from Europe and Japan. It appears that the United States has the same problem facing the steelmakers of Europe, of how to convince bright young men and women that the steel industry provides a challenge for their capabilities. Sadly the review does not include the development of Super Clean Steels, for this is one area of development which, at least in its origins, can be traced to the U.S.A. through the vision of the recently deceased Bob Jaffee.

The History of the Continuous Casting of Steel is dealt with by M M Wolf of Switzerland. This is a comprehensive review, and by far the longest paper in the volume, running to some fifty-four pages. It is a document that all future historians of metallurgy will find of great value; the bibliography has 309 references and there are photographs of thirteen pioneers of continuous casting, together with short personal biographies. The importance of continuous casting is shown clearly in one graph indicating that during the last 20 years, of the total steel produced in the world, the proportion which is continuously cast has risen from 5 to almost 65%.

The fourth paper deals specifically with developments in the United States of refractory sciences and technology and is written by R E Moore. By definition, the paper is limited in scope, and perhaps is even more limited by the fact that most of the steelmaking developments of the last seventy-five years have not originated in the U.S.A. and, by the time new processes were operated there, the refractory problems had been solved. Perhaps four pages is therefore adequate to deal with the issues.

Jack Nutting

B G Scott, *Early Irish Ironworking. Ulster Museum, Belfast, 1990. ISBN 0 900761 25 3. £25.*

This book by the former Keeper of Conservation represents the results of almost 20 years gathering

information on early ironworking in Ireland. The period dealt with runs from the introduction of the first iron artefacts in the late Bronze Age through to the 9th century AD. The book is very clearly written, from the view point of the metallurgist rather than archaeologist or the art historian, but with the archaeology integrated with the metallurgy. The emphasis is on outlining the changes or the lack of change in ferrous technology over the period under consideration. To make the data presented accessible to readers coming from an archaeological background as well as those versed in the metallurgical terminology, the first chapter gives a concise account of ferrous metallurgy, together with a glossary of blacksmithing techniques. This section of the book provides a rather better introduction to ferrous metallurgy than D A Scott's recent publication, *Metallography and Microstructure of Ancient and Historic Metals*, which one assumes was specifically aimed at a non-metallurgical readership.

In his introduction Scott points out the traps and pitfalls associated with the interpretation of the metallography of early iron, including the problems involved with trying to identify weld sites in material as inhomogeneous as bloomery iron. He also notes that banding due to carbon segregation aided by elements such as phosphorus and arsenic has also led to a certain amount of confusion in the past, with various authors interpreting these structures as welds. Going on to discuss artefacts showing strong banding, he advocates replacing the term piled or faggotted structure with fold-welded. He is almost certainly correct in thinking that some of these structures were produced by the repeated folding and welding of a relatively small number of pieces of iron as it is very difficult to fire weld thin sheet. However, recent experiments involving the forging down of experimentally produced blooms to a finished artefact have shown that similar structures can be produced simply by the elongation of the natural inhomogeneity within the bloom. Unfortunately, his argument is further damaged by the segregation patterns of arsenic and phosphorus seen in the supposedly fold-welded Castlereban shaft-hole axe which does not indicate the use of such a technique.

In the second chapter, The Foreign Background to Irish Ironworking, Scott outlines the various theories on how iron metallurgy started, and why iron took over from copper alloys. He argues that the non-conventional theory that the first smelted iron used was produced as a result of the decarburizing of cast iron cannot be dismissed without a good deal more research. After dealing with the possible routes by which iron technology reached Ireland, comes to the central section of the book consisting of three chapters of similar format, which contain metallographic reports on 62 objects. The first of these deals with the earliest iron in Ireland, covering the period of the Later Bronze Age (Dowris period ca 9th–7th centuries BC) and Scott's Earlier Iron Age A (ca 7th–3rd centuries BC). The second covers the period he describes as Earlier Iron Age B (ca 3rd century BC–5th century

AD), during which iron technology became established, and the third, Late Iron Age A (ca 6th–10th century AD) which he defines as the period in which iron artefacts became common. All of these chapters have the same structure: an introduction describing the archaeological background and artefact typology, the metallographic reports, and finally a section summarizing and drawing conclusions from the evidence. The terms for these chronological divisions tend to be confusing on first reading as they immediately bring to mind Hawkes' ABC division of the Iron Age in England. Here the continental influences were much stronger and the Iron Age was terminated by the Roman invasion. The changing pattern of iron use and technological skill seen in Scott's three periods is similar to that occurring in southern England through the Early, Middle and Late Iron Ages, however the changes in Ireland lag behind those in England by a number of centuries.

The following two chapters are not quite so successful. In the chapter on ores, mining, ironworking residues and structures, Scott is pre-occupied by the use of 'bowl' furnaces. He admits that all the experimental work would seem to prove that it is extremely difficult to smelt iron in an open 'bowl' furnace, and therefore suggests a reconstruction with a shallow conical superstructure giving a roughly spherical enclosure. This is not realistic without the use of high quality refractory materials, for which there is absolutely no evidence, as the cover immediately above the tuyere would collapse almost immediately, blocking it. In this reviewer's opinion it is time that the term 'bowl furnace' as applied to iron smelting was dropped, so Scott's advocacy of the term is most unhelpful. It is virtually certain that all Iron Age iron smelting furnaces in the British Isles had some form of vertical shaft structure. These furnaces could be run as non-tapping or as slag-tapping furnaces; tapped furnaces were used in south east England at the same time as non-tapping furnaces were in use in north Wales. Thus the lack of tap slag from Ireland is not surprising considering the trend for smiths to be more technologically conservative the further they were from continental influence.

The chapter on the linguistic evidence is interesting and thought provoking. The evidence drawn from *Blat Ord Indeóin* (The exemption of the hammers is the anvil – a manuscript defining when a smith was exempt for paying compensation for injuries) clearly shows that whoever drew up the document had an intimate knowledge of the blacksmiths' forge and all the sort of accidents that could occur (suitably illustrated). It is difficult to know, as Scott admits, how much reliance one can put on the evidence of carburization, quenching and tempering found in the 'Celtic' legends and myths. Scott puts more emphasis on the evidence than is really justified.

The final chapter is disappointing, not for its content

but for its predictions. As might be expected from Scott, he clearly shows that there are a number of lines of research to be followed, and he exhorts archaeologists to improve their recording of metallurgical debris to create a reasonable data-base for future researchers to work from. However, it is the last few paragraphs that are most disappointing. In these he deplores the lack of any archaeo-materials specialist employed on a full-time basis in Ireland. He argues that Irish archaeology needs an Institute of Archaeological Research which would bring together archaeologists trained in the traditional methods with specialists in various scientific fields. However, he predicts that any progress towards this ideal is extremely unlikely.

In summary, despite the presence of a number of areas in which the reviewer would disagree with Scott's point of view, (it is clear from the introduction and asides within the text, he was well aware that his views were controversial), this is a comprehensive review of the first millennium and a half of Irish ironworking. It is certainly a welcome change to see the metallurgical evidence getting pride of place in what is, in many respects, an archaeological publication. Considering the number of illustrations and the wealth of information it contains, this book is good value for any one who is interested in early Irish ferrous metallurgy, or ferrous metallurgy in general. The retirement of Brian Scott from archaeometallurgy is a great loss to those who welcome open debate and discussion of the problems associated with the archaeology of iron. At least he has left a firm base from which future researchers can work.

Chris Salter

Justine Bayley, **Anglo-Scandinavian non-ferrous metalworking from 16–22 Coppergate** *The Archaeology of York*, Vol 17/7. 1992. Council for British Archaeology for York Archaeological Trust. ISBN 1 872414 30 3. 113 pp. p/b £18.75.

Technological information has often lurked within the fascicules that make up Vol 17 (The Small Finds) of *The Archaeology of York*. However, this is the first fascicule devoted solely to technological information, though there have been large sections in some previous fascicules, eg in Vol 17/6. Hopefully the success of this volume and any similar works will make the anomaly of the absence of a volume devoted to technology obvious to York Archaeological Trust.

This fascicule is an authoritative run through of evidence recovered from the Coppergate excavations (1976–1981) for metal working and the pyrotechnical processes involving non-ferrous metals: lead, tin, copper alloys, silver and gold. The most impressive aspect of this work is the sheer volume of material which the author has been able to identify and analyse, and thus the consequent impression of the scale of this industry which was present at 16–22 Coppergate during the mid 9th to mid 11th century.

One problem which the reader immediately encounters upon starting to read this fascicule is the need to refer to other fascicules in this series. Richard Hall's archaeological introduction, and the sections on copper alloy small finds and silver coinage suffer from this frequently. The fact that a number of these fascicules have not yet been produced, 11 years after the completion of the excavation, therefore makes a full understanding of the non-ferrous metalworking technology, or any other aspect of the Coppergate excavation, difficult to achieve.

The first half of the main body of the text is composed of sections describing and illustrating different forms of evidence for metalworking, eg litharge cakes, cupels, parting vessels, crucibles, ingot moulds, haematite polishers, tools, metal casting waste and other pieces of non-ferrous metal bearing evidence of manufacture. These sections are largely factual reporting and contain general information which is relevant to the study of other similar groups of finds. They will thus be of use to archaeologists attempting to identify metallurgical finds and understand which processes were being carried out on their sites. There are also some areas of deeper investigation, eg the lithology and distribution of steatite and talc schist for ingot moulds, and the different forms and fabrics used for crucibles (Type A, Stamford Ware and 'Other').

The second half of the main body of the text is composed of appraisals of the individual non-ferrous metalworking industries; gold, silver, copper alloy, lead, tin and pewter. These sections are somewhat brief and it would have been useful to expand and broaden these discussions, though without fuller published details about the Coppergate site, and the lack of other work or workers in this field (evidenced by the number of references Bayley has to make to her own work in this area) this may be difficult to achieve.

One area in which this work might have been improved is with the addition of few judicious quantitative analysis. If, as is suggested, silver was being refined using cupellation for use in coin production, then analyses of some of the trapped globules of silver still on the cupellation vessels might have given some idea of the degree of silver purity obtained, and thus the efficiency at which the cupellation process was being run. This could have gone some way towards answering the question of whether the 90–95% silver content of the silver coins from the reign of Aethelstan (McKerrell and Stevenson 1972) was the result of the purity of the metal obtained from cupellation or whether it was a deliberately debased alloy. If it was deliberate debasement, it might also have been useful to compare the analytical composition of the copper alloys with which the coinage was debased with the analytical compositions of the copper alloys recovered from the layers and areas associated with the coining activities on the Coppergate site. These analysis would have started to more closely define the coining activities which represent one of the most important features of this

site, and one rare instance where we have some evidence of the coinage industry.

In conclusion, this fascicule is clearly an important, well written and well presented contribution to the understanding of the pyrotechnical processes used in the non-ferrous metalworking industries. The subject of industrial debris from archaeological contexts will require many more clear and concisely presented studies such as this, if it is to progress as an area of archaeological research. This report and a recent report from Winchester (Biddle 1990) together with forthcoming work from Flaxengate, Lincoln are providing the basic data for the development of this subject. They indicate clearly to archaeologists the valuable evidence which their sites contain and provide valuable reference works for comparison and identification of this type of evidence. However, we also fundamentally require higher levels of academic analysis, work done in conjunction with a much wider variety of social and economic evidence in order to fully understand the true importance of this industry in its historical context. It can be argued that it was only through the development of industry and the subsequent trade of its products that urban settlements came into existence. The York Archaeological Trust and other urban archaeological units need to give sufficient emphasis and resources to technical studies of industries if they are ever to develop a coherent understanding of urban industry, and thus do more than 'flesh out' historical accounts of the work of medieval guilds with a few finds for museum display.

Chris Caple

W. Rostoker and B. Bronson, **Pre-Industrial Iron: Its Technology and Ethnology**, *Archeomaterials Monograph No. 1*, Philadelphia, 1990, 232 pp, \$ 55.

This is an unusual book as it combines purely technological discussion of all stages of the pre-industrial scale production of iron artifacts with anthropological and historic examples of the processes in use in non-industrialised societies. The authors are a scientist and an anthropologist who set out "not . . . to revise history, but rather to construct a stronger foundation upon which better history can be written . . ." In this they have certainly succeeded as the book will be of immense value, in particular to those archaeologists who are faced with understanding iron objects which they have excavated or those museum curators with iron artifacts in their care.

The scope of the book is pre-industrial iron, and the term 'pre-industrial' is used to describe the period up to the advent of steam and electrical power for machines. This means that the book deals with Europe up to the early nineteenth century but discusses primitive iron making in other parts of the world up to the present. What the book does not cover in any depth at all is the making of iron and steel before the Middle Ages.

Rostoker and Bronson have divided the book into sixteen chapters ranging from "Iron as a Material", "The Varieties of Iron" and "Smelting Furnaces", through "Fuels", "Slags" and two chapters on smelting, to "Economics and Geography". Other chapters deal with minerals, refractories and steel making.

The book is approximately A4 in size with a double column format on glossy paper. The paper was presumably chosen to enhance the quality of the illustrations, but these are the one criticism of the book as many of them have been culled from secondary sources and reproduced at too small a scale. Examples are the woodcut from Agricola reproduced on p.51, which could at least have been a full column width without affecting the design of the book. On p.129 there are two microstructures which could have been 50% larger by using the full width of the column; as reproduced they are inadequate. On p.175 is probably the worst illustration of all where a Japanese sword is illustrated on a photograph only 3" wide! Alongside it is a so-called detail, yet none of the detail on this amazing example of technology and art is actually visible because of the smallness of the scale.

But do not be put off by the illustrations as the book as a whole is a valuable contribution to the literature of archaeology, anthropology and the history of science. It complements the recent books by the late Ronnie Tylecote, and is a valuable mine of information on all aspects of iron and steel making before the onset of true industrialisation.

Andrew Oddy

Science Museum. **Guide to the history of technology in Europe. 1992.** Available from Dillons at the Science Museum, Exhibition Road, London SW7 2DD. ISBN 0 901805 51 3. 142pp. 245 × 175 mm p/b. £8.00 plus p&p £1.20 UK, £2.92 Europe or £4.23 N America.

This guide lists the names and addresses of over 600 researchers and also includes details of key journals (including *Historical Metallurgy*) as well as relevant libraries, museums and universities in each European country. It has lists of researchers, arranged by interest, and of journals and institutions arranged by country. There are indexes of both institutions and researchers. The coverage is wide and includes production technologies, materials and processes, motive power, energy sources, instrumentation, civil engineering, transport and biotechnology. The section on 'Mining, metallurgy and metallography' is one of the larger ones with 50 researchers and their interests listed, several of them HMS members. The coverage is however far from complete as many active researchers are omitted, particularly those dealing with earlier periods; the contribution archaeology is making to the early history of technology is barely recognised. This guide is a first attempt to record activity in a relatively new study area and should help to build and strengthen networks. The compilers accept that a first edition will necessarily be incomplete and have included a

questionnaire for new entries for inclusion in the second edition. I recommend this book to all those with active research interests in the history of technology; I hope the second edition will be considerably larger and thus even more useful.

Justine Bayley

Jean-François Belhoste, Yannick Lecherbonnier, Mathieu Arnoux et al. **La Métallurgie Normande, XII–XVII siècles: La révolution du haut fourneau.** 270 × 210 mm. 322pp. ISBN 2 9506162 0 8. *Inventaire Général, Cahier 14. Caen. 1991. 400FF.*

This is the third in the series of regional surveys of the archaeology and archive history of the medieval and post-medieval French iron industry. It follows studies of the Chateaubriand area and of the Ardennes. The Alpine volume is in progress. There are four main parts to the book: the background of regional ore resources and of the medieval industry, the introduction of the blast furnace at the end of the middle ages, expansion over the 16th and 17th centuries and, finally, a section containing a survey of archaeo-metallurgical research, a series of key documentary extracts, a gazetteer of sites, and lists and genealogies of ironmasters.

The iron industry of Normandy was based on scattered ores and a countryside rich in woodlands. There was a medieval tradition of production to the east and west of the Seine, and it was in these regions, the Bray and the Perche respectively, that changes in methods took place around 1500. The blast furnace and finery forge were already in operation elsewhere in France; early examples were at Précy (Cher), where German workers used the new methods as early as 1402, and Bèze (Cote d'Or) where terms indicating the indirect process are recorded in 1427. In Normandy, the blast furnace is associated with Walloon ironworkers: at Le Becquet near Beauvais works were built by men from the Namur and Liège areas in 1451, the first of about fifteen recorded in the area by 1500. This growth was paralleled in the Perche, south west of the Seine, where about twenty ironworks using furnace and finery are known by the same date. The iron industry of the Bray was short lived, for by the middle of the 16th century only two works appear still to have operated, a reduction probably due to competition for coppice-woods. Despite its short life, the industry of the Bray is significant as the source of the migration of ironworkers to south-east England in the half century after 1490. This movement is well documented, and an appendix by Brian Awty sets out the connections between France and England in the form of a list of ironworkers, their known places of work in England and their points of origin in France.

Across the Seine, the iron industry expanded westwards, through the region of the Bocage, where competition for forest products was less intense than in

the more densely populated Seine-Maritime. The industry of central and western Normandy, around Alençon and Domfront, prospered over the period 1550–1660, archive and cartographic evidence providing rich sources of detail. Although some new works are recorded late in the 17th century, and others were rebuilt during the 18th, the industry as a whole dwindled in face of competition from Burgundy and Champagne, where furnaces and forges, destroyed in the Thirty Years War, were rebuilt in up-to-date form.

The physical remains of the industry are most plentiful in the west of Normandy. The forge at Aube (Orne) is a fine survival, where the finery, chafery and hammer are preserved. At its neighbour, Champsecret, there are spectacular examples of the characteristic forge

chimneys illustrated in the 18th-century encyclopedias and of which none remain in Britain. Also at Champsecret is a blast furnace, built late in the 18th century. The gazetteer provides outline histories, and descriptions of standing remains and of earthworks, but lacks modern surveys or maps. A system of locational referencing by grid would make this section more usable. There is no such shortage of contemporary maps: the main chapters are amply illustrated with first-class colour reproductions and indeed the standard of all illustrations equals that set earlier in the series. The volume is a fine demonstration of the levels of expertise in field and particularly archive research which the Inventaire Général maintains.

David Crossley