

Books

1. Book reviews

● *Platinum in South Africa*, compiled by A.M. Edwards and M.H. Silk. Randburg, Council for Mineral Technology (Private Bag X3015, Randburg, 2125 South Africa), 1987. 55 pp. US\$30.

Reviewer: R.H. Wintle

The publication provides a general overview of the history and present-day scenario of the platinum industry in South Africa. It is divided into four phases: the discovery of platinum deposits and the euphoria of the 1920s; the 1930s to late 1960s and the dominance of Rustenburg Platinum; renewed competition in the late 1960s and early 1970s; and the excitement of the 1980s. The areas covered vary greatly, from observations on the geology of the Bushveld Complex to the uses of platinum, market indicators, and current stockmarket activity. This diversity, coupled with the fact that the 55 pages are amply illustrated, indicates to what degree the work is an overview.

The development of the platinum industry in South Africa, by its nature, makes interesting reading, moreso when the fragments of history are concisely arranged (as is the case). The market for platinum-group metals (PGM) is followed from the boom period of the 1920s, through the recession of the early 1930s and the suspension of Rustenburg Platinum Mines' operations in 1932, and the re-starting of operations in 1933, to the various fluctuations in the market until the late 1960s.

The entry of Impala and Western Plats into the market, and the world economic events of the 1970s and their effect on the PGM market, are recalled. In the section covering the 1980s, a resumé is given of each of the new platinum ventures currently being either investigated or undertaken, and the expansion plans of the existing producers. This section also emphasizes the importance of establishing a route for the metallurgical processing of ore from the UG-2 Reef, and highlights Mintek's contribution to development in this area and others in the processing of Merensky ore.

This publication will no doubt be of interest to those involved in the new platinum ventures currently being undertaken, and should be of general interest to those in the existing industry, considering the diversity of areas covered.

● *Scientific and technological developments in extractive metallurgy—G.K. Williams Memorial Volume*. Parkville (Australia), The Australasian Institute of Mining and Metallurgy, 1986. \$A12 (incl. surface postage).

Reviewer: T.V. Owen

This volume contains the proceedings of the symposium that was held on the occasion of the official opening of the G.K. Williams Laboratory for Extractive Metallurgical Research at the University of Melbourne, Australia.

The first paper, by B.S. Andrews, reviews the life and work of G.K. Williams and the influence he had on the metallurgical industry in Australia. The account describes

the climate of the metallurgical industry in Australia from the early 1920s, the developments in the smelting and refining of lead and zinc being outlined with particular regard to the development of large-scale plant and equipment.

The paper 'Scientific and technological developments in extractive metallurgy' by Philip Gray describes the changing commercial scene and its effect on metallurgical technology in the period 1975 to 1980. The commercial scene as described is one of a rapid rise in costs without a corresponding rise in metal prices, an easing of primary-metal consumption, an increase in mineral resources beyond immediate requirements, the working out of the larger, more accessible deposits, and a wider spread of ownership of the mineral resources. The paper shows how the technology has changed to suit these conditions and to produce the required products more efficiently.

A review of the Hall-Heroult process for the extraction of aluminium, entitled 'Aluminium extraction', by John C. Nixon, outlines the most promising routes for the scale-up to larger low-energy cells.

The paper 'Scientific and technological developments in lead smelting and refining' by Denby H. Ward reviews the modern smelting and refining techniques being developed for lead in the light of the current industrial-hygiene and environmental requirements, and the necessity to improve energy utilization.

A contribution entitled 'Scientific and technological developments in the extractive metallurgy of copper and nickel' by John O. Reynolds and Ivy Y. Flavelle surveys the changes during the past twenty years in the technical status of the major copper-extraction and refining operations in the Western World. A brief description is given of modern continuous and semi-continuous techniques for the smelting and converting of copper concentrate, together with an outline of the growth and development of the hydrometallurgical extraction of copper oxide ores both in-plant or *in situ*. Solvent-extraction systems are also described, including innovations for the leaching of mixed oxide chalcocite ores. The bacterial leaching of low-grade sulphide copper ores is described briefly, as are refining practices and techniques to improve operating efficiencies and reduce costs.

A similar account is given for the metallurgical extraction of nickel, outlining the variety of approaches used, including pyrometallurgical, hydrometallurgical, and electrometallurgical techniques.

The paper includes a comprehensive reference list covering all the technology described.

In his paper, entitled 'Zinc extraction and refining', Amel R. Gordon gives a comprehensive account of developments within the zinc industry in Australia. These developments are covered under the broad headings of 'Roasting and acid manufacture' and 'Leaching', which gives a comparison between various leaching flowsheets (Risdon, Pure Jarosite, VM Goethite, and Hematite). Purification and electrolysis are also covered. The paper continues with a brief description of the Imperial Smelting Process and the developments at the electrolytic zinc plant in Port Pirie.

Ion exchange and sorption processes in hydrometallurgy, edited by M. Streat and D. Naden. Chichester, John Wiley & Sons, 1987. 229 pp.

Reviewer: B.R. Green

This book, which is the nineteenth volume in a series entitled *Critical Reports on Applied Chemistry*, comprises four reviews.

Extraction of Uranium and Precious Metals

The first two are about mature processes that were each developed over a number of decades and on which much work was done during that time. In spite of a comment made by the authors of the first review (on uranium extraction) that progress is still being made, it has been possible for them, as well as for the authors of the following review (on the extraction of precious metals with activated carbon), to give comprehensive and well-rounded accounts of their subjects.

The account of uranium extraction by Michael Streat and David Naden covers, firstly, methods for the leaching of various types of ores, and the chemistry and characteristics of the leaching solutions, which dictate the particular exchange process to be used. It then deals with ion-exchange resins and their loading, elution, selectivity, and rates of reaction. It describes significant equipment (from the simple packed bed to the more complex multistage countercurrent fluidized-bed column) and the operating conditions of some commercial plants. Finally, it discusses various approaches to the design of continuous ion-exchange processes.

Gloria McDougall and Christopher Fleming review the use of activated carbon to extract precious metals, the emphasis being on gold. Their account tells of reagent-activated carbon and the methods used in its preparation, its nature, and physical and chemical properties, and the particular properties that make it favourable for the recovery of gold. Proposed sorption mechanisms for the loading of various complexes of gold are given, and the kinetics and modelling of sorption and elution processes are discussed. The chapter ends with an account of the practical application of the carbon-in-pulp process.

Refining of PGMs

Unlike the first two reviews, which cover very widely accepted and used technologies, the third article, by Abraham Warshawsky, explores an area of metal refining—that of platinum-group metals (PGMs)—where ion exchange plays a rather minor role at this stage.

Mention is made of classical methods for the refining of the PGMs, and of the use of solvent extraction, which has been implemented in some refineries. A discussion of the ionic forms of transition metals including PGM chlorides is followed by an account of the interaction of these complexes with ion-exchange resins, particularly with one that contains an isothiouronium group. Other special resins that have been reported in the literature to be useful for the recovery of the PGMs are reviewed. The article ends with a description of a proposed refining process that would use ion exchange to upgrade the PGMs after maximum dissolution of a PGM concentrate. The metals would then be separated by distillation of the oxides and liquid-liquid extraction. Currently used

refining processes that employ ion exchange to a limited extent are given by way of process flowsheets.

Chelating Ion Exchangers

The book concludes with a chapter on chelating ion exchangers. These are materials that form complexes or chelates (as opposed to ion pairs) with metals, and should be more selective than conventional ion exchangers. The field is vast, and the author, Abraham Warshawsky, has been selective in his presentation. Methods for the synthesis of resins and physicochemical studies are described. Miscellaneous topics involving applications of chelating resins are dealt with. These include analytical uses, the selection of resins for particular applications, the extraction of metals from the sea, the recovery of metals in hydrometallurgy, and chelating membranes.

General

The book is pleasant and easy to read from both the stylistic and presentation points of view. All the chapters are adequately referenced, with 483 references in all.

The object of the *Critical Report* series is to reflect the current state of the art and to provide an overview and introduction to the subject of the particular volume. This objective has been accomplished. However, a topical area that might have been included is that of ion-exchange resins for the extraction of gold-cyanide. In addition, the application of chelating resins in hydrometallurgy could have been dealt with in more detail. Although application in this area has been very limited, some investigative work has been done, and a shift of emphasis away from the synthetic routes and structures of resins to hydrometallurgical uses would have been more in keeping with the title of the book. This chapter, however, is particularly well referenced, making the subject easily accessible to interested readers.

● *Role of Government in mineral resources development*, edited by Michael J. Jones. London, The Institution of Mining and Metallurgy, 1985. 180 pp. £40.

Reviewer: K.E. Ducat

This soft-cover, A4-size publication covers the 25 papers presented at a conference held in Bangkok, Thailand, in 1983. The views of contributors ranged from 'all government involvement in mining is to be deplored' to 'all mining activity should be state-owned'.

There are six papers from countries that rely essentially on the private sector; four papers from countries that rely partly on the private, and partly on the public sector; eight papers covering specific aspects of mineral exploration and development; two papers devoted solely to government-company relations in a broad international context; five papers dealing with the international aspects of minerals; and three dealing with the problems of mineral exploration and development under federal systems of government.

Three authors from South Africa contributed a paper, which made the point that the investment decision-making process in the South African gold-mining industry is in the hands of the private sector, which must, in the first instance, provide the capital required and bear the

attached risks. The authors also provided a very useful summary of the tax regime for the South African gold-mining industry.

Author C. Stobart, writing on the economics of base-metals industries, made the point that government protection, subsidies, and debt finance collectively damage the interests that they are designed to serve.

A delegate from India said that the Indian government was involved in 96 per cent of the value of the mineral production of the country. He praised the system highly, except in one sentence: 'The efficiency of the sector, especially in terms of productivity, leaves much to be desired'.

A classic example of the harmful effects of government interference in private enterprise was quoted by an Australian delegate. In 1938 his government placed a ban on exports of iron ore to conserve their meagre resources for the local steel industry. This effectively ended all exploration for new iron-ore resources, and prolonged the shortage that it was intended to overcome. Only when the ban was lifted did iron-ore exploration resume—with the dramatic results known to the entire world.

This book is a useful reference work both for those who shape government policy on mineral resources development and for those who need to make representations on the subject to the authorities.

2. Recent publications

● *Annual report 1987*. International Tin Research Institute, Kingston Lane, Uxbridge, Middlesex UB8 3PJ, England, 1988.

This report gives full details of the research and development, and other activities, of the International Tin Research Institute for 1987.

● *Tin and its uses* no. 156. Address as above. This issue contains articles on 'Fusible alloys in aero engine manufacture', 'Tin as a promoter for pearlitic iron castings', and research news of the Institute.

3. Mintek reports

The following reports are available from the Council for Mineral Technology, Private Bag X3015, Randburg, 2125 South Africa. The reports are free of charge to South African addressees, but there is a handling charge of US\$25 for reports sent abroad.

● **Application Report no. 5**

The production of andalusite and other refractory minerals. 1988. 16 pp.

This report reviews the development of the andalusite industry in South Africa, briefly covering the three main areas of occurrence and listing the reserves and resources.

The early methods of beneficiation are discussed, and the role played by Mintek in the development of the beneficiation techniques since about 1962 is documented. Mintek played a significant role in improving both the recovery efficiency and the grade of the product, and was instrumental in introducing heavy-medium separation techniques as a standard beneficiation operation. It also developed standard procedures of sample evaluation, and designed mill modifications and improved flow sheets. The importance of the pilot plant at Randburg is also mentioned. In most instances, the pilot plant was the instrument by which the technology was transferred, in that the mine owners or engineers, having seen the successful operation resulting from a certain improvement, had the confidence to apply the technology in their own plants and, in so doing, frequently to adapt it to their requirements and improve on it.

Under the heading of 'The results of the research', the development of the industry is sketched, and local and export sales figures in five-yearly intervals are given.

● **Application Report no. 6**

The development up to commercial application of a process for the recovery of lead, copper, zinc, and silver from the Black Mountain deposit. 1988. 14 pp.

This report briefly describes the petrology and mineralogy of the lead-copper-zinc-silver mine owned by the Black Mountain Mineral Development Company (Pty) Ltd and located on the farm Aggeney's in the northern Cape, and the part played by Mintek in the development and implementation of a process to provide salable concentrates.

The work done by the Mineralogy Division since 1975 is outlined, particularly the identification and typing of the various orebodies, which allowed the areas that would provide the ore most amenable to viable concentration to be selected.

The important role played by the Analytical Science Division in developing techniques for the rapid and economical analysis of the products of the pilot plant and the commercial plant is reviewed.

The work of the Ore-dressing Division and, in particular, its pilot-plant work from 1972 up to and after the commissioning of the main concentrator, is described.

The transfer of the technology is discussed and, in the summary of the results of the research, the importance of the operation to the South African economy is briefly reviewed. The cost of the Mintek research effort is mentioned.