

Book news

1. Book reviews

- *Fundamentals of coal beneficiation and utilization*, by S.C. Tsai. Amsterdam, Elsevier, 1982. 376 pp. Dfl. 195.

Reviewer: N. Birtek

A product of intensified interest in coal since 1973, this book is intended 'not only as an introduction to coal beneficiation and utilization but also a brief review of current research'. As a result of its US origin, the book places strong emphasis on desulphurization.

The first two chapters deal with the physical and chemical structure of coal. Chapter 3 is a useful coverage of coal characteristics related to utilization. Combustion, pyrolysis, carbonization, and liquefaction are first described, and the characteristics of coal that influence the performance (e.g. maceral composition, ash composition, rank, volatile matter, and sulphur content) are then discussed. The usefulness of the book would have been enhanced if schematic illustrations had been extended to fuel-bed combustion, carbonization, and liquefaction equipment. Underground coal gasification is allocated one-fifth of this chapter, which is difficult to justify, as is the total omission of the synthol process.

Chapter 4 is entitled 'Coal characteristics related to beneficiation'. Density, grindability and friability are discussed briefly, and a short account of crushing is given. Magnetic properties of coal are presented. However, more could have been given in terms of coal flotation and agglomeration characteristics, instead of an extensive coverage of the surface phenomena. The description of float and sink testing with a reference to Van Krevelen's book does not do justice to the importance of that topic.

Chapter 5 is a comprehensive study of sulphur, its occurrence in coal, its detection, and reactions relating to desulphurization.

Chapter 6 is entitled 'Washing of coal' and is disappointing. First of all, the criteria of washery performance are not easy to follow (U.S. terminology is used exclusively) in the absence of formulae and illustrations. The author's complete disregard of the conventional washability diagram is difficult to justify. The reader would be assisted by a set of ideal values for these criteria. A serious omission is the operational principles of dense-medium vessels for coarse coal, which at present accounts for over 50 per cent of cleaned coal. Not a single illustration of these vessels is given.

Dense-medium cyclone, Dynawhirpool, hydrocyclone, spirals, jigs, and tables (treating fine to small-range coals) are given adequate coverage, usually with accompanying (USBM) operating data. However, screening and dewatering are omitted.

Chapter 7 deals with the cleaning of coal by flotation, agglomeration, and magnetic and electrostatic separation, as well as dry cyclone separation, while Chapter 8 is devoted to the chemical desulphurization processes developed in the USA.

Despite some of the shortcomings, the book contains useful information on coal and summarizes some of the

research work prior to 1982, particularly in terms of desulphurization.

- *Application of polarisation measurements in the control of metal deposition*, edited by I.H. Warren. Amsterdam, Elsevier, 1984. 314 pp. Dfl. 195.00.

Reviewer: R.L. Paul

In 1982, a conference on the application of polarization measurements in the control of metal deposition was held at the University of Victoria, British Columbia. The papers included in the monograph under review were, for the most part, presented at that conference. The contents can be summarized as follows: 2 papers on fundamental aspects of electrodeposition and electrocrystallization, 3 papers on the interpretation of polarization measurements and impurity control in zinc electrolytes, 2 papers on various aspects associated with the industrial deposition of copper, 5 papers on electroplating, electroless plating, and electrochemical techniques for the analysis of plating baths, 1 paper on overpotential measurements in lead electrorefining, 1 paper on the measurement of concentration profiles close to the electrode surface by laser interferometry, and 1 paper on the application of microprocessors to electrochemical instrumentation.

Although the quality of the papers is, on the whole, very high, the 3 papers on the electrodeposition of zinc are quite outstanding in the depth of information provided. The effects of various impurities on the current efficiency and morphology of the electrodeposit is covered extensively. A description of the usefulness of polarization measurements for monitoring the quality of the zinc electrolyte is provided in the paper by Biegler, which complements the paper by Kerby, in which the operation of a continuous electrolyte analyser is described.

However, none of the other aspects covered in the monograph is dealt with in the depth devoted to zinc, and this lack of detail is the main weakness of this publication. Readers who seek information on topics such as anodic stripping voltammetry, alloy electroplating, microprocessor techniques, and laser interferometry will be disappointed, and will undoubtedly seek the information elsewhere.

Nevertheless, the monograph makes for interesting reading for those who enjoy applied electrochemistry. It is clear that our knowledge of industrial electrodeposition processes has barely progressed beyond the empirical stage, and that much more research, particularly at the fundamental level, is required.

- *Mineral processing and extractive metallurgy*, edited by M.J. Jones and O. Gill. London, The Institution of Mining and Metallurgy, 1984. 750 pp.

Reviewer: R. Graham

These sixty-six papers form the proceedings of an international conference that was held in Yunnan Province, People's Republic of China, from 27th October to 3rd November, 1984. They describe metallurgical innovations and give process reviews on the international front, with a large input from China, which was the host country for the Conference.

General Papers

A general paper by M. Anthony accurately sets the perspective for the factors governing research and development in the mineral industry, the effects of recession being just as applicable today as in 1984. As a consequence, innovative projects have provided a background for some radically different approaches to minerals treatment in the future. Mentioned specifically under 'New techniques and equipment' are laser-based equipment for sub-micrometre particle sizing, the improved measurement of pH, Eh, and dissolved oxygen, ion-selective electrodes, the Leeds flotation cell, small-scale continuous autoclaves, computer equipment, microprobe analysers, and advanced techniques of chemical analysis.

Mineral Processing

Of the 28 papers on this subject, 6 deal with the recovery of tin. The operation of a mobile gravity-concentration plant is described, and a process evaluation is made of tin ores from Yunnan Province, China. Metallurgical operations at Wheal Jane tin mine in England are discussed, with useful information on operating costs and power usage. Alternative reagents for the flotation of cassiterite have been investigated in Belgium, which involves a preliminary flotation with an amphoteric collector for the removal of troublesome gangue minerals that adversely affect the sensitivity of the main collector. The overall tin recovery at Chang Po in Guangxi Province, China, was improved by 4 to 6 per cent on the installation of a cassiterite flotation plant. Gravity concentration of complex tin slimes of Chinese origin was improved by the use of a centrifugal separator, belt concentrator, and multiple-deck slime table developed by Chinese research institutes.

Gravity concentration formed the basis of papers on the shaking sluice, a centrifugal separator for the processing of tungsten ore slimes (together with WHIMS and wolframite flotation), fine-particle gravity-separation equipment (Bartles shaking-deck separator and the cross-belt separator), and a study on the design of spiral concentrators. These papers contain no revolutionary concepts.

A general paper on recent developments in the mineral-processing industry, presented as a Canadian contribution, includes in-pit crushing, SAG mills, large-volume flotation cells, on-stream analysis, carbon-in-pulp, treatment of refractory gold ores, liquid-solid separation with high-capacity thickeners, belt filters, pressure filters, and candle elements. The leaching of complex uranium ores is also covered, as is smelting with enriched air or pure oxygen. An interesting paper on energy utilization in a comminution circuit emphasizes the viability of directing more energy into the crushing section. A paper on mathematical modelling derives equations that quantify the performance of a spiral classifier. An Italian contribution describes geomechanical investigations that show the influence of rock-mechanics characteristics in comminution and how they can assist in the design of new equipment.

Base-metal concentrators and their operation form the basis of five papers, with the emphasis on flotation and the avoidance of overgrinding. One valuable paper demonstrates how improvements in economic returns are

possible by a judicious relaxation of grade control in beneficiation and an extension of conventional extraction technology by the use of add-on techniques to increase flexibility.

The processing of wolframite is covered in three papers contributed by Chinese authors and, apart from magnetophotometric sorting, relate to gravity concentration, flotation, and high-intensity magnetic separation. Heavy-medium studies are limited to one paper on the cycloning of non-ferrous ores in the particle-size range below 2 mm. Specialized papers deal with the use of superconducting magnets (on artificial mineral mixtures!), the use of flocculants and surfactants for liquid-solid separation, the recovery of high-grade rare-earth concentrates from a Chinese iron ore, and an investigation into the selective flotation of mercury- and antimony-containing sulphide minerals.

Pyrometallurgy

Again, tin ranks significantly among the metals studied, with 6 of the 16 papers on this aspect of metallurgy relating to that metal. In the reduction and fuming of tin slags, an innovation is described in which a simple paddle agitator is introduced into a submerged-arc electric furnace to improve the reaction kinetics. The wear characteristics were not determined. An excellent review of the pyrometallurgical concentration of low-grade tin ores was presented by Halsall, which covers the routes from chloride and oxide volatilization to sulphide fuming, a technique now used worldwide. The parameters of commercially operated plants are compared. Interestingly, Halsall found the chloride-volatilization route to be unworkable on a pilot scale because of reaction rate control in a kiln. On the other hand, Flett *et al.* in a paper on this subject project an optimistic outlook based on exhaustive laboratory testwork, although admitting that reaction control in the kiln was a problem area. The potential of chloride roasting is described in further contributions by Chinese authors, who treat the theory of the process exhaustively. It is shown to be an effective means of treating complex low-tin, high-iron materials, but the work was limited to bench-scale and pilot-scale (10 t per day) tests. With the emphasis on sulphide fuming, another paper details the application of this technique to tin minerals and slags, and specifically describes the Siros melt system. It concludes that small plants can be both practical and viable.

Modern copper smelting and refining practice in Poland utilizing both shaft- and flash-smelting processes is described, and their relative advantages and disadvantages are outlined.

A concise but informative paper from a Japanese source details the Mitsubishi Continuous Copper Smelting and Converting Process. In-house modifications and improvements have almost doubled the treatment capacity. The Chinese Bai-Yin copper-smelting process differs from the traditional reverberatory process in that copper concentrate is directly smelted with air blown into the melt. A partition wall divides the reaction area from the matte-settling area. The smelting capacity is more than double that of the normal reverberatory furnace.

The basic problem in the pyrometallurgy of zinc is to produce a furnace gas from which liquid zinc can be con-

densed. An account is given of a commercial unit in Sweden using the Plasmazinc concept. In this process for the treatment of low-grade materials, the heat required for the endothermic reduction reactions is supplied by a small quantity of hot gas superheated in a plasma generator. This gives a furnace gas with a relatively high partial vapour pressure of zinc and no carbon dioxide that can be condensed to liquid zinc.

A continuous refining technique has been developed for lead. The main advantage of a continuous system is that the plant is smaller, and good hygiene is easier and cheaper to attain.

The Outokumpu flash-smelting method and its application to the production of nickel and lead is described. In this process, the concentrate is smelted directly to metallic lead by the use of high oxygen enrichment or tonnage oxygen, depending on the heat balance and the raw materials. It produces high-quality lead bullion with a high recovery of valuable metals.

Other contributions deal with the process of vacuum distillation to extract thallium from thallium-cadmium-lead alloys (a Polish paper) and the experimental verification of theoretical predictions. Tests on a Brazilian pyrochlore concentrate indicate that the production of high-grade niobium pentoxide can be achieved. Snelgrove *et al.* give an interesting account of the need to modify a non-ferrous smelter to increase its capacity, improve the recovery, reduce costs, improve the energy utilization, and meet new environmental standards. Lastly, an investigation is described on the transformation of sulphide particles with oxygen in a dispersed reaction and smelting system.

Hydrometallurgy

All continuous processes are regularly interrupted in practice for various operational reasons. General guidelines are given in one of the 10 hydrometallurgical papers for optimizing the shutdown and startup of such processes. Useful comment is given on the advantages and disadvantages of surge capacity between processes and the predominance of mechanical rather than metallurgical limitations. A Japanese contribution relates the Sumitomo process and operation for the recovery of arsenic trioxide from arsenic residue, with a product purity of 99,9 per cent.

A paper by Atmore *et al.* reviews the role of solvent extraction in copper hydrometallurgy. The point is made that, with the new generation of extractants, the process need no longer be limited to liquors of low tenor from oxidic materials. Pyrometallurgical routes can now be partially replaced by solvent extraction. In the separation of gold from platinum-group metals, a novel approach has been developed in which the precious-metal concentrates are first leached in aqua regia and gold (III) is selectively extracted into dibutyl carbitol. The reduction of gold (III) to the metal is accomplished by the use of gaseous hydrogen at 120°C and 200 lb/in². Sumitomo has developed an efficient method for the recovery of valuable metals from copper-lead anode slimes. Lead, bismuth, silver, and high-purity selenium are produced, together with an alloying facility for extremely pure tellurium.

Zinc metallurgy receives attention in an account of the

latest developments in zinc electrolysis in Belgium. Two important handicaps that limited the success of the extraction process until 15 years ago, i.e. the leaching of ferrites and manual operations in the tankhouse, have both been overcome. Recommendations for process improvements are made. A Chinese paper considers new technology for the recovery of indium, germanium, and gallium in an electrolytic zinc plant. The chemical reactions in the leaching of cemented residue and the synergistic extraction mechanism are discussed. Other Chinese contributions cover the conventional electrolytic refining of copper at high current density, the physical chemistry of the adsorption of copper, nickel, and cobalt on lignite from ammoniacal solutions, and the kinetics of the precipitation of tungsten and molybdenum oxides by high-pressure hydrogen reduction.

Combined Techniques

A number of papers discuss a combination of pyrometallurgical, hydrometallurgical, and sometimes mineral-processing extraction routes.

Tantalum concentrates from a Canadian source contain significant quantities of tin. Smelting is carried out with soda ash as the flux, which converts aluminosilicates into soluble compounds. These are leached out in a dilute alkaline leach. The insolubles are a fine-grained tantalum product, and tin is produced in a saleable metal form. A description is given of the Outokumpu nickel-refining process at Rio Tinto in Zimbabwe, together with some innovative development work. The latest developments at Zhuzhou Zinc Smelter in China are also discussed.

The development of lead-electrofining processes at Shenyang Smelter is briefly described. A new process for the continuous removal of copper from crude lead is applied in place of drossing. The lead content of the electrolyte is stabilized by control of the lead content of the anode to about 98,3 per cent.

It is apparent that antimony smelting and refining techniques have been improved in China in that the furnaces have been adapted for high-temperature volatilization. A new hydrometallurgical process that has also been developed consists of an alkali sulphide leach and diaphragm electrolysis.

The recovery of precious metals from copper anode slime is described. Pretreatment in sulphuric acid with sodium chlorate results in the dissociation of precious-metal compounds, oxidation of base metals, chloridization of silver and some gold, and formation of some new compounds. Gold is precipitated by cementation with copper scrap, and flotation is used for the separation of precious metals from the dissolved base metals.

Special Aspects

Four specialized papers complete the proceedings: a review of process simulation and control developments at Mount Isa Mines Ltd, Australia; water and solution recycling in the Canadian mineral industry; advances in on-stream analysis in mineral-processing plants; and the recovery of mercury from mercury-bearing gases.

General

All-in-all, these papers reflect an interesting international metallurgical conference, with a significant contribution from the host country.

● *Tin in antiquity: Its mining and trade throughout the ancient world with particular reference to Cornwall*, by R.D. Penhallurick. London, The Institute of Metals, 1986. 271 pp. US \$48.

Reviewer: P.A. Burton

One of the most popular and romantic stories concerning tin in history is that of the trade between the Cornish tin mines and the sea-faring Phoenicians in the times before Christ. In this book, Roger Penhallurick dismisses this notion as a fanciful myth and backs his argument with substantial evidence. The comprehensiveness of the factual data gathered by Mr Penhallurick to support his view is typical of the thoroughness he employed throughout his investigation of tin in the centuries before the Middle Ages.

The book, which contains a wealth of facts on all aspects of tin in ancient times, is aimed principally at the archaeologist or the mining historian, although anyone with a scholarly interest in the Cornish tin industry will find this book a valuable and informative reference work.

The major portion of the book is devoted to Cornwall, not simply because of the author's Cornish ancestry, but mainly because of the wealth of information proving that tin has been worked in Cornwall continuously over the past 4000 years. As Penhallurick states, 'There is more evidence from Cornwall than from the rest of the world's tin-fields put together'.

The two other sections of the book cover Africa and Asia, and Europe—the other regions of the ancient world in which tin was worked, fashioned, or traded. Evidence of a tin industry in each of these geographical areas is presented, and all aspects are discussed from geological occurrences, through mining, mineral processing, and smelting to crafting and trading. Of great interest is the detailed examination of likely trade routes in ancient times, and Penhallurick presents some convincing hypotheses as to the logistics of ore and artefact trading.

The book is well presented, and great care and attention have been paid to its compilation. It represents something of a 'labour of love' for the author since it took some eight years from commencement to publication. The text is well written and contains many references and bibliographical notes, being fully supported by location maps, drawings, diagrams, and rare, old photographs. The author's uncompromising attitude towards unsupported beliefs is evident throughout, and his relish in searching for and establishing the factual truth is fully apparent.

This very comprehensive volume presents for the first time a history of tin metallurgy which, although not for the casual reader, will be highly regarded by archaeologists and mining historians alike.

● *Randfontein Estates—the first hundred years* by Anthony Hocking. Sandton (Transvaal), Media House Publications, 1986. R33,60 (including GST).

Reviewer: P.A. von Wielligh

This book gives a historical review, not only of Randfontein Estates, which celebrates its centenary this year, but of much that is of interest in the development of the Witwatersrand Goldfield.

The author obviously devoted much time to research into the transformation of a primitive mining industry into the giant it is today. Interesting references are made to most, if not all, of the major events that influenced this transformation or development. Ample attention is given to political, exploration, exploitation, and financial events, and to labour unrest. This attention is not confined to the transitional phases of Randfontein but, as is inevitable, includes much of the interlinking developments in the Witwatersrand Goldfield.

Those associated with the mining industry, particularly the stalwarts of yesteryear, will find that this book allows them to relive the events that they had experienced at first hand.

Even people currently associated with the complexities of administering a modern-day mining undertaking can derive some consolation, however mild it may be, that problems of apparently insurmountable magnitude were encountered throughout the history of the industry, particularly at Randfontein Estates. Solutions were found, albeit through decisions not easily taken.

The book is well written and reads easily, and can be enjoyed, not only by those associated with the mining industry, but also by those who have little or no knowledge of what happened on the Witwatersrand during the past century. It is not only a classified history of Randfontein Estates but, of necessity, includes much about the Witwatersrand Goldfield as a whole.

2. Recent publications

● *Lithium: An imported mineral commodity*. Hull (Canada), Printing and Publishing Supply and Services, *Mineral Bulletin* MR 212. \$9.00.

This report looks at one of the relatively few raw materials for which Canada is currently almost totally dependent on imports. It is the sixth in this series.

● *Tin and its uses* no. 150. Uxbridge (England), International Tin Research Council, 1986.

This issue contains articles on canned petfoods, tin alloy coatings to protect automotive parts, soldering equipment, research at the International Tin Research Institute, and vapour-phase soldering.

● *Mine infrastructure and economic development in north Australia*, by Ciaran O'Faircheallaigh. \$12.00.

In Australia, very substantial amounts of public funds have been invested in providing the infrastructure required for mining operations. The use of public funds to support privately-owned projects in remote areas has largely been justified in terms of the broader economic and social benefits expected to accrue from the provision of this infrastructure. Case studies of four mining projects in north Australia provide empirical evidence to examine whether mine infrastructure in remote areas has in fact contributed significantly to more broadly-based economic and social development. The use of special infrastructure items is reviewed, and the employment structure of resource town/regions is analysed.

- *Intergovernmental mineral commodity arrangements*, by W. Keith Buck. \$8.00.

This study brings together, in summary form and under one cover, pertinent details of the post-World War II history and current status of intergovernmental commodity arrangements in the field of minerals. It does not include the large number of company associations/organizations/institutes, which have varying mandates for consultation, data gathering and dissemination, market development and promotion, research and development, etc., or even those of a cartel-like nature.

CRS publications

The following publications are available at the prices indicated from the Centre for Resource Studies, Queen's University, Kingston, Ontario K7L 3N6, Canada.

- *Effects of location on the competitive position of mineral exploration and development in Canada*, by Brian W. Mackenzie, Dallas W. Davis, and Michel L. Bilodeau. \$8.00.

Differences among the various regions and provinces of Canada undoubtedly affect their relative attractiveness for capital investment and economic development. This case study finds that large disparities exist for mine development economics and exploration potential as a result of the interaction of several key locational variables. These include wage rates, power charges, mining-tax write-off provisions, regional differences in the investment credit for income tax, provincial corporate income-tax rates, and several non-profit taxes. Because variable economic conditions that exist within Canada have a direct bearing on competitive position and on the allocation of financial resources, this study and the methodology developed by its authors will be of interest to corporate planners and government policy makers.

- *Structural changes: Implications for Canada*, edited by Margot J. Wojciechowski. \$20.00.

This volume contains the proceedings of the 15th CRS Policy Discussion Seminar. Structural changes over the last decade or so have profoundly and permanently changed both supply and demand patterns in world mineral markets. The seminar looked at these changing patterns, both in general and for several specific commodities, discussed related economic, trade, and currency-related issues, and identified strategic responses that have been taken and might be taken in future to assist the Canadian mineral industry in adjusting to the new circumstances.

- **CRS 1985-1986 Annual report.** Available free.

- *Catalog handbook of fine chemicals, 1986-1987.* Milwaukee (U.S.A.), Aldrich Chemical Co. Inc., 1986. 1830 pp.

This catalogue contains over 20 000 products of which over 4000 are new. These listings include organic and inorganic chemicals, biochemicals, stains and dyes, deuterated compounds, spectrophotometric solvents, reagents

for hydroboration, organometallic reagents, polymers, catalysts, ion-exchange resins and adsorption media, atomic-absorption standards, precious-metal salts, HPLC solvents, pure elements, spin labels, optically active compounds, an expanded specialized glassware and equipment section, and several new product lines, including gases, chemical standards kits, and carbon-13-labelled compounds.

3. Mintek reports

The following reports are available free of charge from the Council for Mineral Technology, Private Bag X3015, Randburg, 2125 South Africa.

- **Report M246**

The leaching of low-grade base-metal sulphide mattes to produce elemental sulphur, by B. Verbaan. Nov. 1986. 36 pp.

This report describes a method for the hydrometallurgical treatment of low-grade smelter mattes that contain base-metal sulphides and iron sulphides.

Known as the COMAT leaching process (i.e. cobalt from *matte*), the method can be used to dissolve more than 99 per cent of the nickel and cobalt, and about 95 per cent of the copper, in these mattes. Sulphide sulphur is oxidized to elemental sulphur, and the soluble iron precipitates out of solution during the leaching as an easily filterable and washable goethite precipitate, thereby achieving substantial separation between the base metals and the iron.

The effects of certain variables, like concentration of sulphuric acid, stirring speed, temperature, fineness of grind, and partial pressure of oxygen, are discussed. Since the presence of baffles caused serious flotation problems, most of the work was carried out with a vortex reactor for the redispersion of floatable solids into solution. Finally, the leaching characteristics of five different low-grade mattes are compared, and the reaction stoichiometry for the leaching process is described.

- **Report M276**

The determination of gallium in carbonaceous materials by atomic-absorption spectrophotometry, by G.D. Marshall.

The experimental work leading to the development of a method for the determination of low levels of gallium in carbonaceous material is described. The sample was dissolved in a mixture of hydrofluoric, nitric, and perchloric acids, after which it was measured by atomic-absorption spectrophotometry using electrothermal atomization (ETA-AAS). The working range was found to be 0.5 to 50 µg/l.

The measurement, by flame atomic-absorption spectrophotometry, of solutions containing gallium in the concentration range 1 to 100 mg/l is also described.

A method for the separation of gallium from aluminium and indium using an ion-exchange resin was also investigated.

The laboratory method is detailed in an appendix.

● **Report M278**

Uranium-thorium silicates, with specific reference to the species in the Witwatersrand reefs, by G. Smits. Jan. 1987. 40 pp.

(U,Th)-silicates form two complete series of anhydrous and hydrated species with general formulae (U,Th)SiO₄ and (U,Th)SiO₄·nH₂O respectively. The end-members of the anhydrous series are anhydrous coffinite and thorite, and those of the hydrated series, coffinite and thorogummite.

Although the silicates are relatively rare in nature, coffinite is a common ore mineral in uranium deposits of the sandstone type. In the Witwatersrand reefs, (U,Th)-silicates are extremely rare in most reefs, except for the Elsburg Reefs on the West Rand Goldfield and the Dominion Reef. In these reefs detrital uraninite has been partly or entirely transformed to (U,Th)-silicates of coffinite composition, but thorite and thorogummite of detrital origin are also found in the Dominion Reef.

In leaching tests on polished sections of rock samples containing (U,Th)-silicates, a dilute sulphuric acid solution, to which ferric iron had been added, was used as the lixiviant. It appeared that the dissolution of coffinite is less rapid than that of uraninite and uraniferous leucocoxene. However, the reaction of silicates of high thorium content is much slower, and was not completed during the tests.

● **Report M281**

A mineralogical examination of antimony-bearing gold ore and its beneficiation products, by P.M. Swash. Nov. 1986. 13 pp.

In the ore and beneficiation products from the Consolidated Murchison Mine, aurostibite is found either as naturally occurring inclusions within antimony-rich minerals, or as synthetic reaction rims, which form round grains of gold that are roasted in intimate contact with antimony-bearing minerals. These particles can have a poor response to flotation and a low rate of dissolution during cyanidation.

An examination of samples of the final flotation tailings indicated that losses of antimony and gold occur mainly in the size fraction smaller than 25 μm. Further antimony is lost as middlings particles and as free particles of berthierite and stibnite, which may be coated with antimony oxide.

The use of gravity-separation methods is recommended to maximize the recovery of gold and antimony. These methods will

- (i) remove antimony minerals from the plant circuit as early as possible, thus preventing over-grinding, and
- (ii) remove any grains of free gold from the sulphide gravity and flotation concentrate, thus minimizing the formation of gold-antimony alloy.

● **Report M283**

A revised ion-chromatographic method for the determination of free cyanide, by C. Pohlandt-Watson.

The ion-chromatographic procedure for the determination of 'free' cyanide has been revised to exclude the cyanide contributed by the partial decomposition of some of the metal cyanide complexes. The resulting method

gives a more accurate account of free cyanide present in waters, effluents, and process solutions. The precision (relative standard deviation) is 0,0289 at concentrations of 100 μg l⁻¹ in simulated tap water.

● **Report M284**

The separation and determination of borate and carbonate by ion-exclusion chromatography, by A. Cameron and C. Pohlandt-Watson. Oct. 1986. 10 pp.

Carbonate and borate in waters, hydrometallurgical process solutions, and effluents are determined, individually or simultaneously, by ion-exclusion chromatography. For the simultaneous determination of the anions at concentrations in the milligram per litre range, the time per analysis is 15 minutes. The procedure is faster and more accurate than classical methods of determination, and is also free from interferences. The precision of the method is good, as indicated by the relative standard deviations (s_r), which were found to be 0,029 for borate and 0,032 for carbonate. Preparation of the sample requires only a dilution step.

● **Report M286**

The development and evaluation of an instrument for the measurement of resin concentration in air-agitated pulp, by A.E. Holton and J. McEwan.

The instrument, which measured the attenuation of ultrasound at 1MHz, is calibrated *in situ* for a fixed pulp density in the range 1,45 to 1,60 g/cm³. During measurement, the pulp density should not be allowed to vary.

The prototype instrument was designed to operate in a plant environment where it would be required to withstand temperature fluctuations in the range 0 to 40°C. It was found suitable for the measurement of resin concentrations from 0 to 12 per cent by volume to an accuracy that was dependent on the homogeneity of mixing.

● **Report M287**

The determination of cadmium in sulphide materials, by M. Solomons. Nov. 1986. 12 pp.

A spectrophotometric method was developed for the determination of cadmium in sulphide materials containing up to 200 mg of copper, iron, lead, or zinc individually or 100 mg of each of these four elements in admixture. In the method, an initial liquid-liquid extraction of cadmium from the matrix into a solution of tri-*n*-octylamine in benzene is followed by stripping into nitric acid. The cadmium is measured spectrophotometrically as the dithi-zone complex in chloroform at 518 nm.

For a sample of 0,5 g, the range of the method is 2 to 24 μg of cadmium per gram of sample. The relative standard deviation and accuracy of the method were determined on a reference material of lead concentrate with a certified lead content of 64 per cent and cadmium content of 143 ± 5 μg/g (95 per cent confidence level). The accuracy of the method was found to be about 97 per cent, and the relative standard deviation was 0,018.

● **Report M288**

Direct reduction of hematite fines with coal in a fluidized bed, by J.C. van den Berg and R.J. Dippenaar. Dec. 1986. 24 pp.

A preliminary investigation was undertaken on the direct reduction of hematite fines in a single-stage fixed fluidized bed. Coal was combusted *in situ* as a means of supplying the heat and producing the reducing gas. It was found that the type of coal used had a significant effect on the behaviour of the fluidized bed. With the reactor used and a selected type of coal, a reduction of 11.1 per cent was obtained. Various fundamental principles underlying the process were investigated. On this basis, ways of improving the reduction are suggested.

● **Report M289**

The rapid acid digestion of activated carbon and resin in a microwave oven, by G.M. Russell.

A rapid and inexpensive procedure for the dissolution of activated carbon and resin is described. The ashed samples are placed with a mixture of acids in Teflon bottles, and are heated in a microwave oven for 5 minutes. Gold, silver, and base metals are determined by atomic emission spectrometry using inductively coupled plasma, but the dissolution procedure can also be used with other measurement techniques. The method is accurate and precise, with relative standard deviations of between 0.38 and 1.40 per cent.

● **Report M290**

The electrodeposition of lead from chloride electrolytes, by A. Wright. Nov. 1986. 31 pp.

The effects of current density, temperature, nature of the substrate, pulse plating, and addition of levelling agents on the electrodeposition of lead from chloride electrolytes is described.

At low current densities ($100 \text{ A} \cdot \text{m}^{-2}$), lead was deposited as a fine, loosely adherent powder whereas, at

higher current densities (greater than $500 \text{ A} \cdot \text{m}^{-2}$), severe dendritic growth occurred. An electrolyte temperature higher than 69°C was required to avoid the precipitation of lead chloride in the cell, and optimum current efficiencies were obtained at 80°C . Pulse plating and reverse-pulse plating offered no improvement over direct-current deposition with respect to the morphology of the deposit and the current efficiency of the process. The use of a combination of additives, namely Quebracho extract, nonylphenyltetraglycoether, and cuprous ions, resulted in a smooth compact deposit in short deposition times. However, after extended periods of deposition, dendritic growth occurred.

● **Report M294**

A mineralogical investigation of potential gold-sorbing minerals and shales, by C.T. Logan. Dec. 1986. 12 pp.

The equilibration of gold-bearing cyanide solutions with samples of various minerals in rolling bottles produced results suggesting that the phyllosilicate minerals pyrophyllite, kaolinite, phlogopite, and illite do not sorb detectable amounts of gold from cyanide solution.

Samples of shales from a gold mine on the East Rand, which were known to sorb gold from cyanide solution, were also tested, and it is concluded that finely divided carbon, for the most part enclosed in chlorite, is responsible for the sorption of the gold. The gold loading on the carbon does not have to be unusually high compared with that on activated carbon in order to explain the amounts of gold sorbed from the cyanide solution.

The results of the investigation emphasize the ability of carbon fines to sorb significant amounts of gold from cyanide solution, even when present at low concentrations.

Computer software

The Fifth IFAC/IFIP Symposium on Software for Computer Control (SOCOCO 88) is to be held in Johannesburg from 26th to 28th April, 1988.

The objective of this Symposium is to present and understand both the technical and management aspects of software for computer-based automation and control systems. Discussion will focus on the specification, design, implementation, and maintenance of software for computer control.

The following topics will be discussed:

- Applications and Case Studies
- Development of Resources for Applying Emerging Technology
- Software Engineering
 - Real-time languages
 - Operating systems
 - Safety and reliability
 - Man-machine interfaces
 - Distributed systems

● **Control Systems**

- Computer-aided design (CAD)
- Advanced controllers
- Self-tuning and adaptive control

● **Intelligent Knowledge-based Systems and Their Applications**

● **Software for Computer-aided Manufacture (CAM).**

Enquiries should be directed to The Symposium Secretariat S.354

Attention: Carol Arnold

P.O. Box 395

Pretoria

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Telephone: National (012) 86-9211

International + 27 12 86-9211

Extensions 3191 (Carol Arnold) or 2077

Telefax: National (012) 86-2856

International + 27 12 86-2856

Telex: SA3-21312. Telegrams: NAVORSLIG.

Tunnelling 88

The Institution of Mining and Metallurgy, with the cooperation of the British Tunnelling Society, the Institution of Mining Engineers, and the Transport and Road Research Laboratory, Department of Transport, is pleased to announce the fifth international symposium, Tunnelling 88, which will be held in London, England, from 18th to 21st April, 1988.

The theme of the Symposium is the design and construction of tunnels in the fields of civil and mining engineering worldwide.

Papers are invited on practical developments in the safety, technology, and cost-effectiveness of all types of tunnelling. The programme of technical sessions will include the following topics:

- *Machines and methods*—shields, roadheaders, full-facers, drill/blast, automation and robotics, pipe-jacking, cut and cover, immersed tube, and research and development.
- *Geotechnical topics*—site investigation, ground treatment (e.g. by dewatering, grouting, or freezing), lining and support, ground movements, and measurements.
- *Services*—planning, surveying, contractual and legal aspects, materials supply and handling, and safety and health.
- *Complete projects*—design and construction of underground excavations for mining and civil purposes, management and control of time, cost, and quality.

Abstracts of 250 to 300 words should be submitted to the Conference Office, Tunnelling 88, The Institution of

Mining and Metallurgy, 44 Portland Place, London W1N 4BR, England.

During the week beginning on 24th April, 1988, a technical tour that will include visits to major tunnelling operations in the United Kingdom and France will be held.

In association with the Symposium, the Tunnelling 88 Exhibition will be held in London. The exhibition will feature plant, equipment, material processes, and ancillary services for tunnelling and underground excavation for the mining, civil engineering, and construction industries internationally. Full details can be obtained from

Mack-Brooks Exhibitions Ltd.
Forum Place
Hatfield
Hertfordshire
England.

Telephone 07072 75641; Telex 266350 MACBEX G;
Fax 07072 75544.

All enquiries in connection with Tunnelling 88 should be addressed to

The Conference Office
The Institution of Mining and Metallurgy
44 Portland Place
London W1N 4BR
England.

Telephone 01-580 3802; Telex 261410 IMM G.

Ion-exchange processes

ION-EX '87, an international conference and industrial exhibition on the industrial, analytical, and preparative applications of ion chromatography and ion-exchange processes, will be held in Wrexham (North Wales) from 13th to 16th April, 1987.

The programme will be divided into the following four main sections. Each will be reviewed by recognized authorities in the field, and will be followed by shorter individual contributions.

- Inorganic Ion Analysis
- Organic Acid and Base Analysis
- Theory of Ion Exchange and Novel Developments
- Industrial Ion-exchange Procedures Including Effluent Treatment.

In addition, time will be set aside for poster sessions, and participants are invited to submit an abstract of up

to 250 words for consideration by the Organizing Committee up to one month before the Conference date. It is the intention that poster presentations will be refereed and submitted for publication in *Adsorption Science and Technology*.

Please address all correspondence to

ION-EX '87
Conference Secretariat
Research Division
The North East Wales Institute
Deeside, Clwyd, CH5 4BR
Wales
U.K.

Telephone: 0244 817531 Ext 276
Telex: 61629 NEWI G.