

# Book news

## 1. Book review

● *Assay and analytical practice in the South African mining industry*, by W.C. Lenahan and R. de L. Murray-Smith. Johannesburg, The South African Institute of Mining and Metallurgy, 1986. R100 (R80 to Members).

**Reviewer: N.G. Randolph**

The authors have brought together tried and proven methods of analysis used in the analytical laboratories of the South African mining industry. As this industry covers practically all fields of mining activity from base metals (including antimony, copper, lead, nickel, tin, and zinc), through coal, gold, and the platinum-group metals, to uranium, there must be very few, if any, metallurgical analytical requirements that are not covered in this book.

The book is divided into twenty-one chapters and has four appendices. The contents listing at the front and the comprehensive index make the finding of specific information quite straight-forward and simple. Each chapter ends with a list of references that directs the reader to further reading should this prove to be necessary.

### Design and Equipment

The first chapter deals with laboratory design and is, of necessity, fairly general. It is followed by a chapter on the preparation of mine samples, which describes the procedures used in most South African laboratories.

Chapter three gives the requirements of the furnace room, and is well illustrated with photographs. Special emphasis is placed on the necessity for good fume extraction from the furnaces in order to minimize the health hazards resulting from lead fumes.

Chapter four gives a short account of balances and the measurement of mass. It points out that there has been a strong swing in South African laboratories from mechanical to electronic balances, and devotes a section to the care and use of the balance.

### Determination of Gold

The fifth chapter covers the fire assay of gold in a variety of matrices. These range from the fairly straight-forward Witwatersrand ore to complex sulphide ores containing arsenic, antimony, and bismuth. The text states that samples of the latter must be roasted prior to fire assay, but laboratories that routinely analyse such samples normally use fluxes that eliminate the necessity for pre-roasting.

The sixth chapter is devoted to sampling and the preparation of samples from metallurgical plants. It discusses correct sampling procedures as derived by Gy and others. Discussed in some detail are the preparation of mill discharge as the head sample and of final residue. Perhaps a word of caution should have been given with regard to the lock-up of gold in milling circuits and the fact that mill discharge may therefore not be a true head sample.

The determination of gold in cyanide solutions is described in chapter seven, which deals with methods ranging from the preferred method of atomic-absorption measurement after solvent extraction to methods using several fire-assay procedures.

The eighth chapter, that on particle-size analysis, details procedures using sieves. Because alternative pro-

cedures such as Coulter counters and cyclones are not used routinely in South African laboratories, these are not described.

### Determination of Uranium

Chapter nine discusses the analysis of uranium in samples derived from prospecting, mining, and extraction plants. It gives an extremely comprehensive account of analytical techniques for the analysis of uranium in a wide variety of matrices. However, the detailed discussion of X-ray fluorescence theory seems out of place in a book of this type. At best, this and the theory of other instrumental techniques such as atomic-absorption and inductively coupled plasma methods, which is found in chapter seventeen, should have been combined in a separate chapter. The atomic-absorption procedures would have been more useful if the recommended wavelengths had been given, especially as the working ranges of the calibrations are prescribed.

Chapter ten, which describes the assay of gold bullion and some associated methods of analysis, details the analyses required in the operation of a gold refinery, such as the Rand Refinery.

Gold analyses are also dealt with in chapter eleven, which discusses special methods for the assay of complex materials and geological prospecting samples in terms of gold. Useful techniques are given for the analysis of more difficult types of samples.

### Analysis of Mining-associated Materials

Chapter twelve gives a detailed discussion on the analysis of mine air, ranging from *in situ* testing using specific detector tubes to laboratory analyses using sophisticated instrumental techniques such as gas chromatography and infrared spectrophotometry.

Chapter thirteen, that on pH and electronic measurements, is the weakest chapter in the book and could probably have been omitted.

The treatment and analysis of water and effluent, dealt with in chapter fourteen, is discussed with direct reference to South African criteria of water quality. However, this does not detract from its usefulness, because all that is necessary is for the analyst to substitute his local specifications as appropriate. The worldwide movement to impose stricter effluent standards increases the relevance of this chapter.

The sample preparation, analysis, and testing of coal (and coke) is covered by chapter fifteen. Although the newer instrumental, and probably automated, methods are mentioned, the emphasis is on the more classical procedures.

Chapter sixteen, which deals with the analysis of miscellaneous mine materials, describes the quality control of the more important chemical reagents that are used on a gold mine.

### Determination of Base Metals and PGM

Chapter seventeen, which describes the determination of base metals in ores and related materials, gives procedures for the analysis of twenty base metals. These are mainly atomic-absorption and inductively coupled plasma techniques, but a number of classical procedures are also

given. Although it is one of the longest chapters in the book, complete justice could not be given to the subject in the space available, and a comprehensive set of 122 references is therefore included.

Another lengthy chapter is that on the determination of the platinum-group metals (chapter eighteen). The various collection procedures, including that involving nickel sulphide, and analytical techniques used in the analysis of the platinum-group metals are discussed. Recommended methods are given for the analysis of these elements in concentrations ranging from parts per billion to high percentages.

#### **Analysis of Cyanide and Sulphur**

Chapter nineteen, on the analysis of cyanide solutions, is almost completely specific to the gold-mining industry. It provides methods for the determination of various forms of cyanide, together with others for complex metal cyanides and the other analyses required in cyanide solutions. An example of the use of the most modern analytical techniques in South African laboratories is ion chromatography for the analysis of complex cyanides in solution.

The analysis of sulphur in all its forms is described in chapter twenty, and the final chapter, chapter twenty-one, deals with the statistical control of analytical practice, giving a brief discussion of the simpler statistical procedures used in analytical laboratories. Emphasis is placed on twin-stream analysis and the use of control charts, the charts described being of the Shewhart type. Cusum graphs are also extremely useful and should have been mentioned.

#### **A Useful Well-produced Book**

The authors are to be congratulated on the way they have covered such a wide subject matter in the confines of a single volume. The reviewer noticed very few typographical errors, none of which is serious. The analytical procedures described range from probably the oldest method of analysis still being routinely used, fire assay, through to the latest instrumental techniques such as inductively coupled plasma and ion chromatography. The major advantage of this book to the practising analyst is the knowledge that all the methods described are used routinely in metallurgical analytical laboratories in a major mining industry. The book is well illustrated with photographs of equipment and tables of data. The book can be highly recommended to anyone involved in this type of analysis anywhere in the world, and should be an essential addition to the libraries of analytical laboratories.

## **2. Canadian publications**

● *A market profile for industrial minerals in Canadian manufacturing sectors*, by M. Prud'homme and D. Francis. 1987. Micromedia Limited (144 Front Street, Toronto, M5J 1G2, Canada).

The Paint Industry	(MRI 87/1)
The Plastics Industry	(MRI 87/2)
The Fertilizer Industry	(MRI 87/3)
The Glass Industry	(MRI 87/4)
The Rubber Industry	(MRI 87/5).

These reports provide information regarding the five Canadian industries listed and the industrial minerals used in each sector. The objective is to show manufacturers where industrial minerals are located, as well as to show producers of those minerals where potential markets exist in Canada. The application of industrial minerals in paints, plastics, fertilizers, glass, and rubber is explained with a description of the physical characteristics of the major minerals used.

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

● *An analysis of Japanese coking coal procurement policies: The Canadian and Australian experience*, by D.L. Anderson. Feb. 1987. \$25.

This study assesses the structure and impact of the Japanese coking-coal procurement system on suppliers, especially those located in Australia and Canada. It also explores policy options available to producing nations to mitigate any adverse effects of collective buying practices on their economies. The author finds that the Japanese procurement strategy has been a mixed blessing for Australian and Canadian producers: it has fostered development that might not otherwise have occurred; but, on the other hand, the financial wisdom of some of the recent investments is increasingly suspect. Furthermore, it has led to public pressure for collective selling responses to ensure that the owners of the resources, the citizens of Australia and Canada, receive adequate compensation for exploitation of their non-renewable resources. However, this study suggests that the nature of the coking-coal market virtually precludes the introduction of effective anti-oligopsony policies. The study draws attention to a policy issue that has largely escaped serious public discussion in market economies. In their increasing desire to deregulate markets and to rely on the private sector to generate growth, governments should not lose sight of the fact that some export markets may not be conducive to individual selling activities. The coking-coal market, however, does not appear to be a candidate for collective action.

● *Technology policies in the Canadian mineral industry*, edited by M.J. Wojciechowski. Sep. 1986. \$20.

This volume contains proceedings of the 16th CRS Policy Discussion Seminar on technological challenges facing the Canadian mineral industry, and on corporate and public sector policies that might help to meet these challenges. Some presentations focused on barriers to innovation and technology transfer, and on how some of these barriers might best be overcome. Speakers also looked at the role of industrial and government research and collaboration, and a panel of experts spoke on the role of 'external institutions'—universities, consultants, mining-equipment companies, and foreign-based multinationals—in upgrading Canadian mineral technology. In the course of discussions, participants identified a number of key areas in urgent need of support and attention, including mining technology, new products and materials, marketing, and mining and process equipment, particularly at the demonstration and commercialization stages. They also agreed that a coordinated and coopera-

tive effort involving all interested parties on a national level, could greatly improve the effectiveness and timeliness of innovation efforts.

● *Value-added taxation: Issues and impact for Canadian mines*, by B.J. Dyack. Nov. 1986. \$7.

This paper discusses a number of concerns that have been raised about value-added taxation's potential impact on the mineral industry. Its potential impacts on profitability and on competitive position both domestically and in export markets are considered, as well as a wide variety of concerns about compliance costs and administrative complications. Overall, the analysis supports the view that the form of value-added tax proposed by the federal government, the business transfer tax (BTT), will be of net benefit to the industry. The author provides examples of methods of calculation of the tax, which are much simpler to understand and administer than the manufacturers' sales tax (MST), which it is expected to replace. She also finds that replacement of the MST with the BTT will probably reduce the overall tax burden of the mining industry somewhat, as any MST that is hidden in the cost of production and not shifted to consumers will be eliminated.

### 3. Mintek reports

The following reports are obtainable from the Council for Mineral Technology, Private Bag X3015, Randburg, 2125 South Africa.

● **Report M295**

*A mineralogical investigation of refractory gold ores and their beneficiation*, by P.M. Swash.

A mineralogical investigation of the main causes of refractoriness of metallurgically complex gold ores in South Africa is reported. It is suggested that this refractoriness is related to the presence of submicroscopic gold, carbonaceous material, pyrrhotite, and base-metal sulphides.

Means by which problems in the beneficiation of these ores can be overcome were also investigated, and some possible solutions to these problems are offered.

A study of beneficiation products from the Fairview Mine showed that submicroscopic gold is associated mainly with arsenopyrite, the gold content of which can be up to 2700 g/t. During milling of the ore, the grains of arsenopyrite, which are smaller than 150  $\mu\text{m}$  and have a low resistance to attrition, are selectively broken down. The response of the ultrafine sulphide particles to flotation is relatively poor, and they are preferentially lost to the final tailings together with the gold they contain. It is suggested that the overgrinding of auriferous sulphides can be minimized by the removal of the coarse sulphides from the comminution circuit by flotation or gravity separation.

At high rates of aeration in the scavenger and cleaner flotation cells, ultrafine gangue and pyrrhotite are selectively recovered. This material may be recirculated and build up in the flotation circuit, where it may have a

detrimental effect on the flotation of the sulphides. Hence, if the amounts of these components can be minimized, the recovery of the gold and the sulphides in these refractory ores can be improved. Means by which this might be accomplished are suggested.

● **Report M296**

*The determination, by distillation-spectrophotometry, of chlorine in apatite-type materials containing fluorine*, by M. Solomons.

A distillation-spectrophotometric method, which is suitable for the determination of chlorine in naturally occurring calcium phosphate (phosphate rock), has been devised.

The method, which combines the more advantageous aspects of previously used analytical methods, involves the steam distillation of chloride from a solution of phosphoric acid, and the treatment of an aliquot portion of the distillate with ferric nitrate and mercuric thiocyanate to form a ferric thiocyanate complex. The absorbance of this complex, which is proportional to the amount of chloride, is measured at 460 nm. The lower limit of determination of the method using 1 g of sample is 50  $\mu\text{g/g}$ .

The analysis of a sample of phosphate rock with a chlorine content of 637  $\mu\text{g/g}$  at a relative standard deviation of 0,050 gave a result of 595  $\mu\text{g/g}$  at a relative standard deviation of 0,025.

● **Report M297**

*The interference of zirconium in atomic-emission spectroscopy using inductively coupled plasma*, by P.J. Wright.

The spectral interference of zirconium on the various channels of the 5 kW ICP-AES system, consisting of a Radyne R50P generator and a Hilger Analytical Polyvac E1000 spectrometer, was investigated. Zirconium is introduced into the sample solutions during the sodium peroxide fusion of solid samples in zirconium crucibles and, after leaching, the solutions contain zirconium in concentrations ranging from 100 to 300 mg/l. The aspiration of synthetically prepared zirconium solutions showed some evidence of interference on nine channels, i.e. those of silver, chromium, copper, iridium, niobium, palladium, tin, titanium, and vanadium. However, with the exception of the silver channel, the interference was negligible. Consequently, only the effect of zirconium interference on the determination of silver was investigated in detail.

The effects of the flowrate of intermediate gas, the flowrate of aerosol gas, the height of the observation zone, power variations, the solution feed rate, and different profile settings were also studied. Under a set of compromise optimum plasma-operating conditions, silver can be determined successfully after the results have been corrected by the use of a valid zirconium-correction graph.