Book review

The Canadian Institute of Mining and Metallurgy. *Milling practice in Canada.* CIM Special Volume 16. 1978.

The purpose of this volume is to up-date *The Milling of Canadian Ores*, which describes Canadian mineral-processing plants and gives other metallurgical information, and was published by the Sixth Commonwealth Mining and Metallurgical Congress in 1957.

The book is divided into four sections, the first section comprising three review papers on world-wide developments in the art of comminution, tailings disposal in Canada, and instrumentation and control. The comminution review is by Bunting S. Crocker, well known to some in the South African mining industry, and several approving references to South African pebble and run-of-mine milling practice are certainly gratifying. Tailings disposal in Canada since 1957, as elsewhere, has been characterized by the rapidly increasing importance of environmental considerations, but has been helped by a tendency towards increasing coarseness of the tailings; it is also interesting to learn that polyethylene piping is now widely accepted for tailings disposal in Canada. The third paper, 'Mill Instrumentation and Process Control in the Canadian Mining Industry', contains a comprehensive statement of the scope of instrumentation to be expected in modern Canadian plants and the types of instruments now available; regarding data-loggers, the author makes the arresting statement that 'Data loggers are management tools, and they should not be put in unless management has the manpower, the need and the dedication to make profitable use of the generated data over an extended period of time', an opinion difficult to fault. However, further on he says that most Canadian mills now rely on the assumption that, other things being equal, 'the loading of a mill varies directly as the power consumption' and that consequently the primary control in Canadian mills is adjustment of feed rate by the power draft, a very questionable statement and one certainly not borne out by the subsequent plant descriptions.

The second section, 'Milling of Metallic Ores', is the real meat of the book. It comprises seven chapters, each containing fairly detailed flow-sheet and operating data for up to twenty-three different plants. Each chapter deals with one or two specific types of ore, e.g. gold and silver, copper and copper–molybdenum, nickel–copper, iron, uranium, so that a very comprehensive view of modern Canadian practice in each of these fields is presented. Such an enormous mass of information could easily have been overwhelming, but, because each contribution is brief and very much to the point, the text is very readable and easily referenced. South African gold metallurgists will be sorry to find that, owing to economic circumstances, there have been few changes in equipment or design in Canadian gold plants since the previous volume appeared in 1957; gains have resulted mainly from process improvements, particularly in solution technology, which now incorporates oxygen-demand monitoring and the regulation of free lime, pH, and alkalinity. There is an interesting account of gold recovery from leached roaster dust by the use of carbon-in-pulp as practised at Giant Yellowknife Mines, Limited.

Fortunately, the economic climate for the base and ferrous metals has, until recently, been less discouraging than for gold, and here Canadian mineral processing has kept well abreast of world progress. While the open-circuit rod mill followed by closed-circuit ball mill(s) remains the most common arrangement for sulphide ores, some of the newest plants have gone for semi-autogenous primary milling followed by secondary ball milling. But it is in the processing of iron ore that the autogenous or semi-autogenous mill has really come into its own, with mills increasing from 18 ft diameter by 6 ft to 32 ft by 12 ft (6000 h.p., wet), and even $34\frac{1}{2}$ ft diameter by 7 ft (7000 h.p., dry). One particularly striking operation is the Sept Isles plant of Iron Ore Company of Canada, where primary grinding is done in 30 ft by 10 ft peripheral-discharge mills driven by two 3500 h.p. motors. Each mill has a 20 per cent volume charge of 3-inch balls. The feed is all minus 2 inch and only 11 per cent plus 3 mesh. The ball consumption is 1,9 lb/per ton, the power consumption 10,2 kW.h per ton, and the feed rate 500 tons per hour. The section on metallic ores closes with a chapter on the processing of uranium ore, permitting some very interesting comparisons with South African practice, and one on the treatment of molybdenum and other metal ores.

The third part of the book is devoted to the processing of non-metallic minerals, namely potash, asbestos, tar sands, and coal — all carried out very efficiently and on a very large scale in Canadian plants. South Africans will no doubt be envious of Canada's 239 billion barrel reserve of 'synthetic crude oil', not to mention the coke, diesel fuel, etc., that accompany it!

The final section of the book is a very illuminating listing of thirty Canadian establishments for mineral-processing research that are available for contract work, together with the facilities they offer.

Perhaps a few small criticisms will not be out of place. The first is that, to South Africans at any rate, the title is misleading, in that 'milling' in this country is generally understood to mean 'grinding'. The book would have been more correctly titled 'Canadian Mineral Processing Practice'. Secondly (and this criticism applies equally to almost all the information published about autogenous milling), it is far more instructive to give the full or even partial size distribution of feed to an autogenous mill than to state merely that the feed has all passed a crusher set to a certain size. Also, a statement of the relationship between kilowatt-hour per ton used in grinding and the fineness of grind produced, and, if possible, of the relationship between grind and recovery, would have been extremely illuminating to readers and possibly to plant management.

The book contains an excellent large coloured map of the principal mineral areas of Canada, and altogether most admirably achieves its object of placing modern Canadian mineral-processing practice on record. It is, in fact, an excellent reference to modern mineral processing generally, and as such will find a place in many mineral-processing libraries, private and otherwise.

G.G.S.

NIM reports

The following reports are available free of charge from the National Institute for Metallurgy, Private Bag X3015, Randburg, 2125 South Africa.

Report no. 1874

Activation analysis and classification to source of samples from the Kimberley Reef conglomerates. (10th Mar., 1977; released Jun. 1978).

Three boreholes were drilled in the west, central, and eastern sections of the Durban Roodepoort Deep Mine, and twelve distinct strata were intersected. Twenty-two samples from the three borehole cores were analysed in triplicate for twenty-six elements, and, including standards, a total of 2000 determinations were made. Statistical analysis of the results obtained for twenty-four elements shows a successful back-classification of 98 per cent, whereas, if the conglomerates or quartzites are treated separately, 100 per cent success is obtained. When the present data are used for classification of the samples from the three cores analysed during the first phase of this project, 100 per cent accuracy of classification is achieved by use of only ten selected elements. The objects of this investigation have therefore been met successfully, and extension to further strata and to sampling beyond the confines of the mine is justified.

Report no. 1926

The analysis of anode sludges by X-ray-fluorescence spectrometry. (5th Jun., 1978).

A method is described for the analysis, by X-ray-fluorescence spectrometry, of anode sludges for the determination of antimony, bismuth, copper, iron, lead, nickel, selenium, silver, tellurium, tin, and zinc. The preparation of the samples involves fusion with a flux of barium peroxide and lithium hydroxide, and with dichromium trioxide as the internal standard, in a zirconium or vitreous-carbon crucible and casting of the melt in an aluminium mould; the fused disc so formed is then pulverized and briquetted to form pellets. Calibration curves, which are straight lines for all the elements determined because the flux contains a heavy absorber, are established by measurement of pellets prepared from standard anode sludges, pure metals, compounds of the metals, or any combination of these materials.

The precision of the results varies between 2 and 15 per cent relative standard deviation, depending on the concentration of the element being determined. The accuracy of the results is comparable with that obtained by wet-chemical methods.

The laboratory method is given in an appendix.

Report no. 1936

The analysis of mineralogical and metallurgical materials. A guide to the analytical techniques and instrumentation available at the National Institute for Metallurgy. (5th Jun., 1978).

The increase in mineral processing in South Africa has led to an increasing demand for the determination of a wider range of elements at low concentrations, and this in turn has led to the greater use of instrumental analysis. The objects of this report are, first, to serve as a guide to the various types of instrumentation available for a range of analytical problems and, second, to indicate the facilities that are available at the National Institute for Metallurgy for use by industry in sponsored projects.

The analytical techniques available are considered from the points of view of basic principles, interferences, precision and accuracy, advantages, limitations, sample preparation, and possible applications.

Report no. 1959

The slag–metal equilibrium, and the activities of slag and metal components in the production of high-carbon ferromanganese. (15th May, 1978).

A laboratory investigation was made of the slag–metal equilibrium in the production of high-carbon ferromanganese. The solubility limit of SiO_2 at 1450 °C in slags containing MnO and SiO_2 was found to be 0,56 mole fraction, which is considerably higher than the accepted value.

The activity curves for MnO and SiO_2 at 1500 °C were corrected to take into account the higher solubility limit. Values of γ_{Si} in Mn–Si–C(sat) alloys were determined, and the value at infinite dilution was 0,0129. Values of a^2_{Mn}/γ_{Si} in Mn–Fe–Si–C(sat) alloys and of a^2_{MnO}/a_{SiO_2} in $MnO–SiO_2–CaO$, $MnO–SiO_2–MgO$, $MnO–SiO_2–Al_2O_3$, and $MnO–SiO_2–CaO–MgO–Al_2O_3$ slags were determined for a range of alloy and slag compositions, including the range encountered in the production of high-carbon ferromanganese.

The equilibrium data can be used in the prediction of the Si content of the alloy for a particular slag composition, or the MnO content of the slag for a particular alloy composition. At constant temperature, the factors that affect the MnO content of slag are the Si and Fe contents of the alloy, and the CaO, MgO, and Al_2O_3 contents of the slags.

Report no. 1965

Analyses, by several laboratories, of three ferromanganese slags. (22nd May, 1978).

This report describes the analyses, by twelve laboratories, of three slags encountered in the production of high-carbon ferromanganese. The results, their statistical treatment, and the methods of analysis used are reported. Preferred values are given, together with their 95 per cent confidence intervals and certification factors.

Report no. 1968

The influence of carbonaceous reducing agents on the rate of reduction of representative manganese and chromium ores. (28th May, 1978).

The influence of the properties of typical South African carbonaceous reducing agents on the reduction of representative South African manganese and chromium ores is reported. The ores were Mamatwan manganese and Winterveld chromite ores, and the carbonaceous reducing agents were Iscor coke, Lurgi char, Rand Carbide char, gas coke, anthracite, and graphite. Because the mechanism of reduction of hematite is well known, some runs were carried out with Thabazimbi hematite.

The percentage reduction of the ores in mixtures of ore and reducing agents was determined from thermogravimetric analyses and from chromatographic analyses of the off-gas.

For the Mamatwan and Winterveld ores, microscopic and X-ray-diffraction examination revealed no differences in the mode of reduction with the different reducing agents. However, it was found that the initial stages of reduction of the higher oxides of manganese to manganese oxide in Mamatwan ore proceed more rapidly as the reactivity of the reducing agent towards carbon dioxide increases. In the second stage of the reduction, manganese oxide is converted to manganese carbides and higher contents of fixed carbon in the reducing agents give higher final percentage reductions. The initial stages in the reduction of Winterveld chromite proceed more rapidly as the reactivity of the reducing agent towards carbon dioxide increases. In the later stages of reduction, the reduction is influenced both by the reactivity of the reducing agent towards carbon dioxide and by its content of fixed carbon.

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GUIDE TO THE PREPARATION OF PAPERS FOR PUBLICATION IN THE JOURNAL OF THE SOUTH AFRICAN INSTITUTE OF MINING AND METALLURGY

The following notes have been compiled to assist authors in the preparation of papers for presentation to the Institute and for publication in the *Journal*. All papers must meet the standards set by the Council of the Institute, and for this purpose all papers are referred to at least two referees appointed by the Council.

Although the worldwide readership of the *Journal* results in a preference for papers in English, the Council treats papers in Afrikaans on an equal basis, but, to meet the needs of the majority of readers, an English summary of some 500 to 750 words should be provided.

STANDARDS FOR ACCEPTANCE

To merit consideration, papers should conform to the high standards that have been established for publication over many years. Papers on research should contain matter that is new, interpretations that are novel or of new significance, and conclusions that cast a fresh light on old ideas. Descriptive papers should not be a repetition of well-known practices or ideas but should incorporate developments that would be of real interest to technical men and of benefit to the mining and metallurgical industry.

In some cases, a well-prepared review paper can be of value and will be considered for publication. All papers, particularly research papers, no matter how technical the subject, should be written with the average reader of the *Journal* in mind, to ensure wide interest.

The amount of textbook material included in a contribution should be the minimum essential to the argument. The length of a paper is not the criterion of its worth, and it should be as brief and concise as possible consistent with the lucid presentation of the subject. Only in very exceptional circumstances should a paper exceed 15 pages of the *Journal* (15 000 words if there are no tables or diagrams). Six to ten pages is more normal.

NOTE: Papers in the *Journal* are printed in 10 point type, which is larger than the 8 point type used on this page. For special publications, Council may decide on page sizes smaller than A4 used for this *Journal*.

The text should be typewritten, double-spaced, on one side only on A4 size paper, leaving a left-hand margin of 4 cm, and should be submitted in triplicate to facilitate the work of the referees and editors.

LAYOUT AND STYLE

Orthodox sequence

Title and author's name, with author's degrees, titles, position.

Synopsis, including a brief statement of conclusions.

An Afrikaans translation of the synopsis.

Introduction.

Development of the main substance.

Conclusions, in more detail.

Acknowledgements.

References.

Title: This should be as *brief* as possible, yet give a good idea of the subject and character of the paper.

Style: Writing should conform to certain prescribed standards. The Institute is guided in its requirements by:

Collins, F. H. *Authors & Printers' Dictionary*—Oxford University Press.

Hart, H. *Rules for Compositors and Readers*—Humphrey Milford (familiarly known as the *Oxford Rules*).

Fowler, H. W. & F. G. *The King's English*—Oxford University Press.

General: A few well-selected diagrams and illustrations are often more pertinent than an amorphous mass of text. Overstatement and dogmatism are jarring and have no place in technical writing. Avoid the use of the first person, be objective, and do not include irrelevant or extraneous matter. Avoid unnecessary use of capitals and hyphens; punctuation should be used sparingly and be governed by the needs of sense and diction. Sentences should be short, uninvolved, and unambiguous. Paragraphs should also be short and serve to separate basic ideas into compact groups. Quotation marks should be of the 'single' type for quotations and "double" for quoted matter within quotations.

Interpretations in the text should be marked off by parentheses ( ), whereas brackets [ ] are employed to enclose explanatory matter in the text.

Words to be printed in italics should be underlined *singly*. For small capitals they are to be underlined DOUBLY and for large capitals TREBLY.

If there is any problem in producing formulae accurately by typewriter, they should be handwritten in ink.

Abbreviations and symbols are laid down in *British Standard* 1991. Abbreviations are the same for the singular and plural, e.g., cm for centimetre and centimetres, kg for kilogram and kilograms. Percentages are written in the text as per cent; the symbol % is restricted to tables. A full stop after an abbreviation is used only if there is likely to be confusion of meaning.

Metric System: The Système International d'Unités (SI) is to be used for expressing quantities. This is a coherent system of metric units derived from six basic units (metre, kilogram, second, ampere, kelvin, and candela), from which are derived all other units, e.g., the unit of force is the newton (N) for kilogram metre per square second (kg m/s^2). Always use the standard metric abbreviations.

The comma must be used as a decimal indicator and must not be used for separating groups of digits. For ease of reading, digits should be grouped in threes counting from the decimal indicator towards the left and right. However, where there are only four digits to the left or right of the decimal indicator, there should be no grouping.

Illustrations: Drawings and diagrams are to be in black India ink and should be about 18 cm wide. When submitting graphical representations, avoid a fine grid if possible. Curves should be in heavy line to stand out. Lettering too should be bold, as a reduction in size is often involved in the printing process.

Numbering of tables should be in Roman numerals: I, II, etc., and figures in Arabic numerals: Fig. 1, Fig. 2, etc. (Always use the abbreviation for figure.) Photographs should be black and white glossy prints.

As a guide to the printer, the author should indicate by means of notes in the typescript where tables and figures, etc. are to appear in the text.

Paragraphs: A decimal system of numbering paragraphs may be used when the paper is long and complicated and there is a need for frequent reference to other parts of the paper.

Proof correction: Galley proofs are sent to authors for the correction of printers' errors and not for the purpose of making alterations and additions, which may be expensive. Should an author make alterations that are considered excessive, he may be required to pay for them. Standard symbols as laid down in *British Standard* 1219C should be used.

SYNOPSIS

It is most important that the synopsis should provide a clear outline of the contents of the paper, the results obtained, and the author's conclusions. It should be written concisely and in normal, rather than abbreviated, English, and should not exceed 250 words, except when an English summary of an Afrikaans paper is involved. While the emphasis is on brevity, this should not be laboured to the extent of leaving out important matter or impairing intelligibility. Summaries simplify the task of abstractors and therefore should present a balanced and complete picture. It is preferable to use standard rather than proprietary terms.

FOOTNOTES AND REFERENCES

Footnotes should be used only when they are indispensable. In the typescript they should appear immediately below the line to which they refer and not at the foot of the page.

References should be indicated by super-script, thus . . .[1] . . .[2]. Do not use the word *Bibliography*. When authors cite publications of other societies or technical and trade journals, titles should be abbreviated in accordance with the standards adopted in this *Journal*.

GENERAL

The Council will consider the publication of technical notes taking up to three pages (maximum 3000 words).

Written contributions are invited to the discussion of all papers published in the *Journal*. The editors, however, are empowered by the Council to edit all contributions. Once a paper or a note has been submitted to the Institute, that document becomes the property of the Institute, which then holds the copyright when it is published. The Institute as a body is, however, not responsible for the statements made or opinions expressed in any of its publications. Reproduction from the *Journal* is permitted provided there is full acknowledgement of the source. These points should be borne in mind by authors who submit their work to other organizations as well as to the Institute.