

Book reviews

Edward J. Stephenson. *Extractive metallurgy. Recent advances*. Park Ridge (New Jersey), Noyes Data Corporation.

The detailed information in this book is based on U.S. patents issued since 1975 that deal with extractive metallurgy.

The first section deals with copper under the following headings:

- Smelting and Roasting
- Acid Leaching
- Ammonia Leach Process
- Cuprous Chloride and Ferric Chloride
- Recovery of Copper Values from Solution.

Processes dealing with other metals including nickel, cobalt, lead, zinc, molybdenum, manganese, uranium, titanium, rhenium, gallium, precious metals, and those included among ocean floor nodules are dealt with in the second section.

The extractive technology described originated in all parts of the world. The content is concise and technically orientated, eliminating legal jargon and juristic phraseology.

Many of the processes described are in commercial use, and in total comprise more than 230 novel techniques for the recovery of metals.

Organizations involved in research aiming at the development of new techniques or modifications to existing processes will gain substantial benefit from the descriptions of technical possibilities. Considerable data are also available that could initiate changes in conventional circuits.

The Noyes Data Corporation, using their advanced composition and production methods, have succeeded in presenting an extremely competent up-to-date review of industrial technology related to the recovery of metals from their metallic compounds.

D.A.V.

James L. McCall and P. M. French (eds.). *Interpretive techniques for microstructural analysis*. 1977.

This book provides good practical information for students and workers in all fields of optical microscopy. The subject matter is presented clearly, with adequate diagrams and illustrations. Of special interest to practical metallographers are the sections concerning the range and selection of photographic materials that are available today, and the emphasis on obtaining and maintaining optimum results from any given system. For students, this book should give a good insight into the range of optical instruments that are available, along with clear operational guides when such instruments are encountered in practice.

Like most practical books of this type that detail specific systems, it will date quickly as new processes are designed; but, as a guide to the present day state of the art, it is invaluable.

J.M.B.

Institution of Mining and Metallurgy. *Prospecting in areas of glaciated terrain*. London, the Institution, 1977. £16 (\$U.S. 30).

This volume consists of the papers presented at a symposium organized by the Institution of Mining and Metallurgy, with the co-operation of the Geological Survey of Finland, from 15th to 17th August, 1977. This was the third in a series of symposia on the theme of prospecting in glaciated terrain.

The seventeen papers and two summaries discuss prospecting, mainly in Scandinavia and Finland. The papers are subdivided into three main categories:

- till transport and till stratigraphy,
- dispersion of base metals in till and boulder beds, and
- the application of geophysical methods in areas with conductive overburden.

Although of limited application in South Africa, some of the principles discussed can be useful in a study of the transportation of Dwyka tillite, as well as in prospecting in areas with conductive overburden.

R.O.W.K.

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. 1928

A liquid-nitrogen monitor for lithium-drifted germanium detectors. (21st Nov., 1977).

An instrument has been developed that makes use of a load cell to monitor the liquid nitrogen in the Dewar flask of a lithium-drifted germanium detector. The contents are recorded on a chart recorder, and an alarm is sounded when the previously set content has been reached. A signal switches off the high-voltage power supply 30 minutes after the alarm is triggered.

The calibration of the load-cell monitor is described in an appendix.

Report no. 1931

The equilibrium between the slag and the metal in the production of low-carbon ferromanganese. (14th Nov., 1977).

An investigation was conducted into the reactions between the slag system $\text{MnO-CaO-MgO-SiO}_2-(\text{Al}_2\text{O}_3)$ and the alloy system Mn-Fe-Si-(C) . Separate studies were made of the slag and alloy phases so that the oxidation state of the manganese in the slag (which results from the premelting of the slag-forming components) and the oxidation characteristics of the alloy could be determined. Synthetic slags representative of plant melts and a plant alloy were reacted in alumina crucibles at temperatures of 1400, 1450, 1500, and 1600°C. In similar experiments, slags were used that comprised a South African manganese ore with various amounts of

lime and several synthetic alloys with various silicon contents and manganese-to-iron ratios. These experiments were conducted in a vertical molybdenum-wound resistance furnace with full temperature control. Slag-to-alloy ratios were also varied during the tests.

The rate of reduction of the Mn_2O_3 and the MnO from the slag by the silicon in the alloy was extremely rapid, most of the reaction being completed within five minutes. The strongly exothermic nature of the reaction resulted in considerable generation of heat at the slag-alloy interface, causing convectional stirring of the contents of the crucible and promoting the rate of reaction.

Equilibrium was usually attained after fifteen minutes. The major limitation governing the recovery of manganese is the need for the silicon content of the alloy to meet a maximum specification of 2 per cent. Higher concentrations of silicon in the final alloy of between 8 and 12 per cent favour good recoveries of manganese from the slag, but, since such an alloy is not salable, lower recoveries must apparently be tolerated. In alloys of 2 per cent silicon, low activities of the silicon are responsible for poor recoveries of manganese.

The activity of MnO in the slag can be increased by moderate additions of CaO and small amounts of MgO, i.e., by increase of the basicity of the slag.

Report no. 1934

The spectrometric analysis of chromium-bearing materials with particular reference to ferrochromium slags and chromite ores. (30th Nov., 1977).

A direct-reading spectrochemical procedure using an induction-coupled plasma source is proposed for the analysis of ferrochromium slags and chromite ores.

The sample is fused with sodium peroxide, and the fusion is dissolved in nitric acid. The solution is transferred to a volumetric flask, a fixed amount of scandium is added as the internal standard, and the solution is made up to volume. The solution is then introduced into the plasma source, the integration time being related to a predetermined number of counts for the internal standard line. The precision (relative standard deviation) obtained ranges from 0,5 to 1,0 per cent for the elements measured as major constituents (i.e., the elements present in a concentration of more than 4,0 per cent) and up to 4,0 per cent for minor constituents. The elements determined (expressed as their oxides) are iron, silicon, aluminium, magnesium, chromium, and calcium.

Report no. 1935

The construction and testing of a small mixer-settler for use in the laboratory. (30th Nov., 1977).

The problems encountered in the construction and

operation of a small mixer-settler are described. The main problems were unreliable pumping action and stable emulsions. Other problems were leaks and corrosion of bolts and bearings, but, despite these problems, the unit was used successfully for process testing. Recommendations for improvements are given.

Report no. 1933

The determination of trace elements by thin-film X-ray-fluorescence spectrometry, and its application to zirconium. (30th Nov. 1977).

The trace elements are separated from their matrix by precipitation and are collected in concentrated form on a thin film, which is measured by X-ray-fluorescence analysis. The technique can be used for the simultaneous determination of many elements, and its precision ranges from 0,27 per cent for titanium to 13 per cent for uranium at concentration levels from 1 p.p.m. to 1400 p.p.m.

Analyses of reference materials by this method are compared with values obtained by wet-chemical, instrumental neutron-activation, and optical emission spectrographic analysis.

The details of the proposed procedure are given in an appendix.

Report no. 1942

The accuracy of assays for platinum-group metals and gold. (30th Nov., 1977).

In an attempt to obtain reference materials for use in flotation tests on platinum ores from the Merensky Reef, two samples of flotation tailings from these ores were submitted to various laboratories for assay of the total noble-metal content by the conventional fire-assay method (with lead as the collector).

The results obtained by these laboratories, which varied considerably, were analysed statistically, and it was found that the variation of results in any single laboratory was fairly small, and that the results obtained by a single analyst in one laboratory in any one day varied so little that repeated analyses were of doubtful value.

Assays for the individual noble metals using nickel sulphide collection indicated that the range for the total noble metals in these samples should be 0,76 to 0,84 g/t. It was interesting that all the laboratories except one had some values falling within this range, and that all the assay values of one particular laboratory were within this range.

It was concluded that reference samples would be of considerable value both in reducing the variations within the results of different laboratories and in reducing the variations within the day-to-day results of a single laboratory.

Courses on geostatistics

In view of the continuing demand, the University of Leeds will offer two further courses on geostatistics in 1978, each covering ten working days (3rd to 14th April, and 3rd to 14th July).

Geostatistics began with the study of mine-sampling data, and led to what has now become known as the theory of regionalized variables, i.e. variables whose magnitudes are controlled to some extent by their positions. In mine sampling, for example, the phenomena of high-grade and low-grade areas and of pay-shoots are commonplace, and obviously assay values are not scattered at random throughout a deposit. It requires a special kind of statistics to deal with such phenomena, and geostatistics has been developed for this purpose.

Geostatistics recognizes both features of mine sampling data. Firstly, the structural aspect, as revealed by high- and low-grade sections. Secondly, the random aspect, in that there is always the possibility of taking a low-grade assay in a high-grade area, and *vice versa*. It also accounts for other structural features of the mineralization, such as the anisotropies common to alluvial data, the range of influence of a sample value, and the trend.

A further important point concerns the volume of an individual sample because the characteristics of the regionalized variable alter with changes in this volume; geostatistics enables the effects of such changes to be calculated in advance. The basic tool of geostatistics is the semi-variogram, and from this a coherent theory has been evolved covering all aspects of practical mine valuation. The semi-variogram, for example, allows the effectiveness of future sampling programmes to be evaluated before the samples are taken, by calculating the confidence limits of estimates based on any chosen sampling arrangements. It also answers such questions as the optimum sampling interval, or whether there are any

practical advantages to be gained in changing to a larger size of drill core.

Each course is intended to be a PRACTICAL introduction to the study of geostatistics. Practical exercises taken from real situations will be used to introduce or reinforce the theoretical background of the subject. The course is designed for engineers and geologists concerned with the valuation of mineral deposits and stoping blocks, and a minimum mathematical background is assumed. As far as possible the approach to the subject is via geology and familiar practical situations, and the mathematical content is introduced in this manner. However, it will be helpful both to course members and lecturers if members do some recommended reading beforehand. An excellent book is *Introduction to Statistical Method* by Brookes and Dick, publisher Heinemann.

Members are encouraged to bring their own data for ore-bodies in which they are interested. The data should either be on computer cards, or ready to be punched onto cards. Anyone contemplating using this facility is advised to write to Mr A. G. Royle at the address given below, who will advise on the format required for the data cards, and whether the jobs are suitable for the time allowed. This preliminary check is essential because there is little time on the course for getting data into a suitable format for card punching, and the data set should be of adequate size for the task. A data set comprising the co-ordinates and assays at 300 sampling points, set on a regular grid if possible, is the optimum.

Every member is recommended at least to have a try at producing a semi-variogram for an ore-body with which he is concerned, as this should form the basis for much valuable practical work on returning to his company.

Further information is obtainable from the Director of Special Courses, Department of Adult Education and Extramural Studies, The University, Leeds LS2 9JT, England.