

Book news

1. Book reviews

● *Nonparametric geostatistics*, by S. Henley. London, Applied Science Publishers, 1981. xiv + 145 pp.

Reviewer: Douglas M. Hawkins

This interesting little book proposes the use of nonparametric procedures (for example those based on the ranks rather than the numerical values of grades). The seven chapters are entitled: Introduction, Geostatistics, The Nonparametric Approach, Nonparametric Geostatistical Estimation, Mining Applications, Further Developments, and Summary.

There are many applications in the earth sciences in which nonparametric methods might be preferable to their parametric counterparts. Broadly speaking, these applications are those in which *testing* rather than *estimation* is required. Nonparametrics may also be useful in those rather special estimation problems in which the relative rankings of several quantities, rather than their absolute values, need to be estimated, or where the variable under study is only on an ordinal scale.

Unfortunately (and contrary to Henley's claims), nonparametric methods cannot be used for more general estimation problems. Thus, for example, in a stationary deposit, linear kriging always gives overall unbiased estimators of the mean grade of a block, regardless of the statistical distribution of grades; Henley's median estimator (e.g. p. 106) is overall unbiased only if the distribution is of a special form (namely symmetric). Henley claims that the median is unbiased, and may leave the reader with the impression that linear kriging is biased for non-Gaussian data.

There are a number of statistical howlers, of which only one is of great local relevance. Contrary to the claim on p. 28, lognormal kriging (as used on South African gold mines), when applied to lognormally distributed grades, does indeed lead to the minimum variance unbiased estimate of the grade.

The book is worth reading for the interesting suggestions to be found in several places; however, the reader should be aware (and beware) of the incorrect and invalid claims the author makes for nonparametric procedures. Geostatistics is one of the few areas in which there is only one measure of statistical central tendency that is of any interest, and that is the arithmetic mean (which is the amount of mineral one will be taking out of the ground). The arithmetic mean is a highly parametric quantity, and nonparametric methods simply have little to tell one about it.

● *Mineral deposits and global tectonic settings*, by A. H. G. Mitchell and M. S. Garison. London, Academic Press, Geology Series, 1981.

Reviewer: J. Lurie

The idea that the present continents were once joined together as a super-continent, and that they subsequently split into separate parts that gradually moved apart, was put forward early in the present century. As the con-

sequence of a great deal of careful examination, especially of the ocean floor, this theory of continental drift developed into the hypothesis of plate or global tectonics some fifteen years ago. The hypothesis provides ready explanations of major geological phenomena such as the formation of rift valleys and deep-sea trenches, volcanic activity, earthquakes, and mountain building.

According to the hypothesis, the earth's crust consists of about a dozen slowly moving plates. Two plates may converge on each other and form either a collision zone when they are rammed together into a mountain belt, or a subduction zone when one plate is thrust beneath another forming deep-sea trenches and island arcs. Plates may slide past each other without destruction of plate material. The mid-oceanic ridges are sites where the plates are being added to in order to compensate for the plate lost in the subduction zone. Hot spots or plumes are believed to occur in the upper mantle, and it has been suggested that doming, volcanism, and rifting are related to these. A hot-spot track forms on the continent when the plates move over a plume.

In recent years, the literature on the genesis and distribution of ores relative to major tectonic settings has been voluminous, and the present book attempts to synthesize the published material in a digestible form. Early ideas are discussed in the first chapter, and the various tectonic settings and their associated mineral deposits are considered in the following chapters.

Deposits formed in continental hot spots, rifts, and aulacogens (interrupted or failed rifts) are dealt with in Chapter 2. The mechanism of development of the tectonic features is reviewed, and examples of specific mineral deposits are given. The latter include carbonatites such as those at Phalaborwa, diamondiferous kimberlites, and the Zimbabwe Great Dyke-Bushveld Complex association.

Chapter 3 concerns deposits formed on passive continental margins and in interior basins. The first category includes beach-sand deposits of ilmenite, rutile, and zircon (Richard Bay type), while the Rand basin is grouped under those of uncertain intracontinental settings.

Deposits formed in oceanic settings are divided into three types: those associated with oceanic ridges or basins, those associated with oceanic transform faults, and those of the oceanic linear island and seamount chains. Manganese nodules, the possible exploitation of which has been much researched in recent years, fall into the first of these.

Deposits of subduction-related settings are subdivided into seven sub-settings in Chapter 5, as are those of collision-related settings in Chapter 6.

The authors attempt to summarize the relationships of mineral deposits to tectonic settings by treating the various types of deposits as part of their enclosing host rocks, and describing a sequence of mineral formation and emplacement events in terms of the orogenic cycle.

The text contains tables giving the characteristics of the various types of deposits with examples of each,

and these are very useful for rapid reference.

The heading of the final chapter 'Plate Tectonics as a Guide to Mineral Exploration' holds more promise than the substance of the chapter warrants. It is obvious that only very generalized guide-lines can be tentatively laid down at this stage, and that substantially more data and understanding must accumulate before a really meaningful synthesis of this aspect can be made.

● *The mining and mineral laws of South Africa*, by B. L. S. Franklin and M. Kaplan. Durban, Butterworths, 1982. Cloth, 240 × 150 mm, Lxxcii + 853 pp. R197,50 + GST.

Reviewer: M. J. Martinson

The South African minerals industry has grown steadily in importance since the discovery of diamonds in Griqualand, and of gold on the Witwatersrand, in the second half of the nineteenth century, and has in particular shown exceptional growth since World War II. For much of the first half of the present century, Nathan's *Gold and Base Metals Laws* provided guidance on important aspects of South African mineral law — although the coverage was not as extensive as the title might at first sight indicate — but, even within the limited field canvassed by Nathan, major changes have been effected in the law since the last edition appeared in 1944. As Mr Justice Trollip remarks in a foreword to the book reviewed here,

It is truly remarkable that, despite the vast growth in the extent, intensity, and importance of the mining industry in this country during the past century, and the manifold legal problems that that has caused and will continue to cause, such a treatise (on the multifarious laws relating to minerals and mining in South Africa) has not made an earlier appearance.

In many jurisdictions, including South West Africa and Zimbabwe, all minerals are owned by the State, and the body of statutory rules regulating access to minerals for prospecting or exploitation purposes is as simple or complicated as circumstances and the local legislature prescribe. South African law, on the other hand, recognizes private ownership of minerals, but the common law principles relating to minerals have been extensively modified by an unwieldy complex of statutory provisions dating back, in the Cape, to Sir John Cradock's proclamation of 1813; depending on the circumstances, contemporary statutory provisions may at one end of the spectrum have negligible impact on common law rules, but at the other end may ostensibly submerge the common law.

The difficulties facing anyone attempting to rationalize this confusing body of law are formidable, and the authors of the new book deserve to be congratulated for producing a book that will undoubtedly remain the definitive work on the subject for a long time to come, and will be an indispensable reference for landowners, legal practitioners, government officials, and a wide range of personnel in the minerals industry who come into contact with aspects of mineral law in the course of their work. For a book of this size and complexity, it is particularly praiseworthy that most of the important statute

law amendments effected in 1981 are incorporated in the text.

As the title suggests, the contents can be divided into two parts. By far the larger portion (12 out of 15 chapters) is devoted to mineral law, broadly covering ownership of minerals and the means by which prospecting and mining rights can be acquired in respect of both private and State land. In this part the chapters analysing the Mining Rights Act 20/1967, the Precious Stones Act 73/1964, and the Mineral Laws Supplementary Act 10/1975 are particularly useful, even though the full texts of the acts in question are understandably not reproduced in the book. The sequence in which some of the material on mineral law is presented could perhaps be rearranged in the interests of clarity, and at the same time more stringent editing is needed to reduce the number of repetitious passages (for example, the commentary on section 44(4) of the Mining Rights Act, dealing with deproclamation of proclaimed ground, on pages 44, 84–85, and 396), but these and similar matters will no doubt be rectified in future editions.

The main statutes affecting mineral law in South Africa place extensive powers in the hands of mining commissioners, the Mining Leases Board, and the director-general and minister of Mineral and Energy Affairs, and the scarcity of litigation relating to the exercise of these powers probably reflects favourably on both the law and the manner in which it is administered. Nevertheless, there is a considerable body of case law on other aspects of South African mineral law, and there can be few relevant cases not included in the 809 cases cited by the authors.

The three chapters relating to mining operations are scattered in a seemingly random fashion among the chapters on mineral law, and deal with

- damage caused by mining operations;
- regulatory statutes and regulations (Mines and Works Act 27/1956, Water Act 54/1956, and Atmospheric Pollution Prevention Act 45/1965);
- taxation, lease consideration, transfer duty, and rating.

The motive for including the three chapters is understandable, but some readers may feel that the topics are out of place in a book primarily devoted to a specialized topic in property law. Looking at each in turn, the chapter on damage represents an excursion into the law of delict, but the treatment is fairly narrow; despite the hazardous nature of mining, a section on the liability of a mining company for personal injuries to mine employees surprisingly fails to discuss the company's liability for occupational injuries — and the chapter might have to be read in connection with, say, McKerron's *The Law of Delict*.

Again, some readers may find the chapter on regulatory measures useful, but the measures in question are relatively straightforward and scarcely call for detailed analysis, since the provisions are in general administered benevolently and litigation in relation to mining operations is very rare. Finally the potpourri of financial imposts is also useful, but some at least of the material is readily available elsewhere.

As noted earlier, no mineral law practitioner can afford not to have a copy of *The Mining and Mineral Laws of South Africa*, and for the time being the monumental price is unlikely to deter many potential purchasers. However, to remain competitive in future, the authors and the publisher might give some thought to reducing the physical mass and volume of the book by omitting the three chapters mentioned above and streamlining wherever possible the material on mineral law.

● *Aluminium—Volume II*, by M. H. Govett and J. Larsen. Sydney, Australian Mineral Economics (Pty) Ltd, 1982.

Reviewer: D. G. Maxwell

The first volume of *The World Aluminium Industry* dealt with the supply of bauxite, alumina, and primary and secondary aluminium metal. This second volume focuses on the consumption of the raw materials used to produce aluminium metal and on the demand for semic fabricated products as a basis for the analysis of present and future supply-demand balances in the industry.

Attention is given to the secondary aluminium market and recycling, and there is also a chapter on prices that examines the history and structure of the prices of raw materials and products, and forecasts in a general way possible future developments.

The study runs to some 350 pages, and represents a thorough and detailed examination of the subject, including a wealth of statistics and diagrams on production and consumption, imports and exports, prices, recycling, stocks, world industrial production index, population, GNP, growth rate, etc. There are also schedules of estimated U.S. production costs for three alumina production processes, namely alumina from clay using the hydrochloric acid-ion exchange process, alumina from anorthosite using the lime-soda sinter process, and alumina from bauxite using the Bayer process.

This study serves to enhance the already high reputation of the publishers in the field of mineral economics, and is a publication that all students of the aluminium industry and market will wish to have on their shelves.

● *International technology for the nonferrous smelting industry*, by Noyes Data Corporation.

Reviewer: D. A. Viljoen

The information in this book is from documents prepared by T. K. Corwin, T. W. Devitt, M. A. Taft, and A. L. Worrell.

The book describes current and new production processes and pollution-control technology in the primary non-ferrous smelting industry in the U.S.A. and abroad.

Technology outside of the U.S.A. is covered in the first section of the book. The descriptions are divided into five categories: pyrometallurgical processes, hydrometallurgical processes, electrolytic processes, air-pollution control processes, and water-pollution control processes. In most instances, the process descriptions include a discussion of economic, environmental, and energy considerations, as well as of basic principles.

The U.S. technology for primary copper-lead and zinc smelting is detailed in the remaining sections of the

book. The primary copper, lead, and zinc industries as defined for this study consist of mining, beneficiation, smelting, and refining. Various routes for metal production are provided in a series of process flow diagrams and detailed process descriptions. Each description includes available data regarding input materials, operating conditions, energy and utility requirements, waste streams generated, and control-technology practices and problems.

2. New publications

● *Coal transport—an analysis of technical and economic factors*, by Dag Pike. London, Financial Times, 1982. £86 (U.K.), U.S. \$175 (overseas including first class airmail postage).

The report reviews the many different modes of coal transport currently in use worldwide in terms of efficiency, costs, safety, and environmental considerations. It also looks at the growing involvement of the international oil companies, and concludes that they could be the key to this currently fragmented industry developing a fully integrated and efficient transport system. It highlights the advantages and disadvantages of each transport mode, the transport facilities available in each of the main coal-producing and consuming countries, the effects of different terrain on transport systems, the likely future, advances in technology and their impact on the industry, the economic factors for system viability, investment in long- and short-term developments, and the upgrading necessary to meet an increased volume of coal movement. In addition, the report contains tables listing loading and discharging ports capable of handling high-tonnage carriers.

● *Small solute concentration differences determined by interferometry*, by H.E.L.G. Schweigart. Pretoria, CERG—CSIR (P.O. Box 395, Pretoria), 1982.

Studies of the adsorption of solutes, for instance flocculants, on solids are usually hampered by the difficulties of measuring the small quantities concerned. This problem was overcome by the use of the developed interferometer, in which a coherent light beam is split into two beams polarized perpendicular to each other and passing through samples of solutions with different optical densities (e.g. before and after adsorption of a solute). The resulting phase change is determined by effecting interference of the two beams and measuring the rotation of the plane of polarization of the recombined beams. From this the difference in refractive index, and consequently the concentration change, can be derived. Concentration changes of the order of 1 p.p.m. were measured accurately on aqueous polyacryl amide solutions. Such measurements can be made independent of the level of concentration.

3. Mintek reports

The following reports are available free of charge from Mintek, Private Bag X3015, Randburg 2125, South Africa.

● *Report M8*

A determination, using solid zirconia electrolytes, of the

activities of chromium oxide in ferrochromium alloys and slags at 1650°C.

The report describes the development of a method in which solid zirconia electrolytes are used in the determination of the activities of chromium and chromium oxide in ferrochromium alloys and slags at 1650°C. Problems related to the cracking of electrolytes as a result of thermal shock, the dissolution of electrolytes in slags, and electrical contacts are discussed. Results for the iron-chromium system at 1650°C are found to be in good agreement with published findings. A limited number of results are reported for slag, but these are inconclusive because there was contamination from container materials. A 'gas-phase' cell is described that overcomes most of the problems encountered.

● *Report M31*

Software for the design of multivariable control systems by use of the Inverse Nyquist Array.

A computer programme, HMOVINA, has been developed by the Council for Mineral Technology (Mintek) for the design of multivariable control schemes by techniques involving the Inverse Nyquist Array (INA). HMOVINA is part of a suite of software at Mintek for the computer-aided design of control systems. This report describes the INA techniques used in HMOVINA and gives detailed information about the programme.

● *Report M37*

A literature survey of the metallurgical aspects of minerals in Witwatersrand gold ores.

This survey reviews the information in the literature on the auriferous rock formations in the Witwatersrand-Orange Free State gold-mining area, the gold-bearing horizons, and the mineralogy and petrography of the different ore types. The metallurgical aspects of the gold, silver, uranium, platinum-group elements, cobalt, nickel, copper, and chromite in these ores are examined and, on the strength of this information, a list is given of those problems in metallurgical extraction that are of a mineralogical nature. Finally, a number of research projects, aimed to support current research at the Council for Mineral Technology, are suggested.

● *Report M39*

The use of masking agents in the determination, by hydride generation and atomic-absorption spectrophotometry, of arsenic, antimony, selenium, tellurium, and bismuth in the presence of noble metals.

The effectiveness of thiosemicarbazide, tellurium, and potassium iodide as masking agents to eliminate interferences was assessed. Thiosemicarbazide was found to be effective in eliminating or reducing the interferences on arsenic, antimony, and bismuth, and tellurium reduced the interferences on selenium. The interferences on tellurium could not be eliminated.

Arsenic, antimony, selenium, and bismuth were determined in metal sulphide concentrates that were spiked with the noble metals (defined here as gold plus all the platinum-group metals except osmium). The relative standard deviations for arsenic, antimony, bismuth, and selenium were 0,061, 0,017, 0,029, and 0,145 respectively. The values obtained for all the analytes agreed favour-

ably with the preferred values for two in-house reference samples.

The laboratory method is detailed in an appendix.

● *Report M40*

The use of X-ray-fluorescence spectrometry in the determination of uranium, cobalt, and sulphur in materials from mine dumps.

A pressed-powder method has been developed for the determination of uranium and cobalt in samples taken from mine dumps. Prior to milling, the samples are mixed with a binder in a ratio of 9:1. Firmly bonded briquettes can be pressed without the use of a reinforcing backing or an aluminium cup.

The precision of the method for U_3O_8 is 7 and 0,9 per cent at concentrations of 16 and 387 p.p.m. respectively, and for cobalt it is 0,86 per cent at a concentration of 510 p.p.m.

In an assessment of the accuracy of the method, the results for U_3O_8 were compared with those determined by other methods involving X-ray-fluorescence spectrometry. The results for cobalt were compared with those obtained by atomic-absorption spectrophotometry and colorimetric methods.

The lower limits of detection are 4 p.p.m. for cobalt and 2 p.p.m. for uranium. The lower limits of determination in the samples taken from mine dumps are 13 p.p.m. of cobalt and 4 p.p.m. of U_3O_8 .

● *Report M44*

An on-line dilution system for spectrometry using an inductively coupled plasma source.

An on-line dilution system that uses a two-channel peristaltic pump to feed a GNK Babington type of nebulizer is described. By the use of a diluent containing the appropriate concentrations of acid, sodium, and internal standard element, which was fed at a constant rate to the nebulizer, the system produced analytical results that are not significantly different (less than 3 per cent relative) from those obtained with the normal dilution technique. However, a considerable saving in time is achieved, as well as a saving in the use of expensive reagents.

● *Report M47*

The separation of trace elements from iron, and the analysis of iron-rock ores for use as reference materials.

Iron(III) chloride is separated from the trace elements in iron ores. After dissolution of the sample, the iron in 6 M hydrochloric acid solution is separated, by liquid-liquid extraction with methyl isobutyl ketone, from the alkali metals, alkaline earth metals, lead(II), aluminium(III), titanium(IV), chromium(III), nickel(II), copper(II), cobalt(II), manganese(II), and zinc(II).

After concentration of the aqueous phase by evaporation, the trace elements are measured by the use of atomic-absorption spectrophotometry or direct-reading spectrometry with excitation from an inductively coupled plasma source, or both. The separation procedure is rapid, resulting in a reduction in the time required for analysis by the direct method because only a limited number of dilutions are necessary and the method of additions is not needed to compensate for interferences from the iron.

The extractions of chromium(III), copper(II), nickel(II), strontium(II), rubidium(I), cobalt(II), manganese(II), zinc(II), barium(II), lead(II), aluminium(III), and titanium(IV) are at least 96 per cent.

● *Report M49*

A programme in BASIC for the appending of computer files.

A computer programme for the appending or joining

of computer files has been written in BASIC. Although the operational time for the programme is longer than that required for a programme written in the file-management language of any particular computer, it is much faster and more accurate from the operator's point of view because only one set of instructions needs to be entered. It is suggested that a similar programme could be devised for a series of files that are to be separated.

Australian coal

The editors of *World Coal* and *World Mining* have announced plans to sponsor the IVth International Coal Exploration Symposium. The symposium will be held in Sydney (Australia) from 15th to 19th May, 1983.

Australia continues to be one of the most active coal-exploration centres in the world. The Australian coal-mining industry, immediately following the very successful IIIrd Symposium in Calgary (Canada) in August of 1981, invited *World Coal* and *World Mining* to hold the IVth International Coal Exploration Symposium in Australia.

The invitation has been accepted and the IVth Symposium is scheduled for May 1983. The technical papers will be presented from May 15th to 19th. Immediately preceding the symposium, there will be two

technical tours to visit coal mines in the Upper Hunter Valley of New South Wales and the Bowen Basin in Queensland, from 12th to 14th May.

Coal exploration papers will be presented by internationally known geologists from all parts of the world. A series of Australian papers will review the discovery, development, and production of Australian coal deposits; recent exploration for brown coal deposits in South and Western Australia; and case histories of locating buried igneous sills in Australian coal beds during coal exploration.

Complete information on the symposium is available from the Coal Exploration Chairman, *World Coal/World Mining*, 500 Howard Street, San Francisco, California, 94105, U.S.A.

Small mine economics

The editors of *World Mining* and *World Coal* have announced plans to sponsor the Second International Symposium on Small Mine Economics and Expansion in Helsinki, Finland, from 12th to 16th June, 1983. The first symposium was held in Taxco, Mexico, in May 1981. Delegates from over 34 countries attended.

High interest rates, volatile metal prices, and lower demand make large-scale mine development a greater financial risk than at any time in recent history. More companies are concentrating their exploration and investment funds in small and medium higher-grade prospects and mines. In the 1960s and 1970s, the development of mine technology and equipment were being directed towards large open-pit as well as large underground mines. Larger equipment for both mining and processing, creative financing for huge-tonnage operations, and reductions of unit costs through increased

volume were at the forefront of mining engineering throughout the world. In the past few years, though, more effort has been devoted to improved mining and processing methods for smaller-scale operations. Grass-roots exploration for huge low-grade deposits has been replaced by targeted exploration in areas of known mineralization to delineate reserves that can be mined profitably on a smaller scale.

A preliminary selection of technical papers has been started by the programme committee. Readers interested in presenting papers should send an abstract of the proposed paper no later than 15th January to Donald A. Pazour, Symposium Chairman, 500 Howard Street, San Francisco, California 94105, U.S.A.

Registration and other details of the Symposium can be obtained from Albert F. Kaba at the same address. Telephone: (415) 397 1881. Telex: 278273.