Geoscience Canada

Geostatistical Ore Reserve Estimation: Developments in Geomathematics 2

Brain W. Hester

Volume 5, Number 2, June 1978

URI: https://id.erudit.org/iderudit/geocan5_2br06

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Publisher(s)

The Geological Association of Canada

ISSN

0315-0941 (print)
1911-4850 (digital)

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Cite this review

Hester, B. W. (1978). Review of [Geostatistical Ore Reserve Estimation: Developments in Geomathematics 2]. *Geoscience Canada*, *5*(2), 91–92.

phic analysis of geological materials. The basic principles of the technique are clearly presented as are the discussions on instrumentation and sample preparation. Detection limits of elements commonly analyzed are listed and estimates of productivity are given. As well, the problems and the limitations of the method are adequately spelled out to avoid misuse of this powerfull analytical technique.

Stanton, in producing this second small volume, provides geologists, chemists and geochemists with a collection of analytical methods for the analysis of geological materials. Although the methods presented are well organized and easy to follow, the book falls short of its stated objective to bring the reader up to date on more modern and rapid methods of analysis. In the preface he states ". . . analysis by atomic-absorption spectrophotometry has become commonplace, and it is now the leading analytical technique in use for geochemical exploration." Discussion of the method in the following chapters, however, is incomplete (only 8 p.) relative to less commonly used methods of colorimetric analysis (19 p.) and cold extraction methods (11 p.) and occasionally he leaves the reader hanging with statements like "The range of elements that may by analyzed by this method overlaps that of colorimetric procedures, and for some elements the sensitivity is inferior to that obtained by colorimetry", with no follow-up of what the inferiorities might be. Likewise, on the topic of XRF, an overview of the usefulness of this technique in geological exploration would have added greatly. The major use of XRF in North America is for whole rock analysis. Unfortunately, not a word was said of this application. The topic of emmission spectrography was well presented but discussions of other multi-element techniques, such as argon plasma methods, would provide an updating of benefit

In all, this volume will prove interesting reading for those in geological exploration the world over and should be acquired as a companion to his first volume.

MS received February 28, 1978

Geostatistical Ore Reserve Estimation: Developments in Geomathematics 2

By M. David
Elsevier Scientific Publishing Co., 364 p., 1977.
Dfl. 110 (U.S. $44.95)

Reviewed by Brian W. Hester
Texasgulf Inc.
5934 McIntyre St.
Golden, Colo. 80401

Geostatistics is a branch of mathematics developed within the last 25 years to explain the distribution and statistical features of mine assays. Much of this work is due to G. Matheron who has developed the mathematical concepts and applied them to a wide variety of data, including assays, which are distributed in a regionalized manner instead of the random one required by classical statistics. Matheron's interest in the peculiarities of these distributions was aroused by papers on assay distributions by De Wijs in the Netherlands and Krige in South Africa published in the early fifties.

The author is both a mining engineer and pupil of Matheron's. For some years he has been associated with geostatistics groups at Ecole Polytechnique, Université du Québec à Chicoutimi, and the Mineral Exploration Research Institute from which he has travelled extensively to lecture on this subject both on this continent and elsewhere. His notes formed the basis for this book which is the first text on this subject in English. Geostatistics has earned widespread acceptance in the North American mining industry only in recent years. This book gives a good overall view of the subject although few of the mining engineers and geologists it is expressly intended for, will follow all the mathematics at the first reading. Some chapters, especially that on Estimating by Kriging, could have been explained at greater length to advantage. The broad principles, however, are layed out fairly clearly throughout the book with many examples from practical situations as well as illustrative computer programmes.

The subject is finding growing use with Canadian mining companies in solving evaluation problems at all stages of exploration, development and production. It is undoubtedly a major advance in estimation procedures and is here to stay. Any geologist involved with these functions and who is concerned with problems of sampling and estimation of reserves should have this book by his side.

Geostatistics offers a refreshingly new approach to sampling and reserve estimations as well as giving answers to problems never adequately explained previously. Examples of application include the explanation for relatively high grade blocks of ore yielding less valuable mineral than had been estimated from sample results, and conversely. Another is the procedures offered for calculating the best hole spacing for reserve calculations at predetermined confidence limits, and for relating confidence limits of estimates with the size of samples.

The body of the text is concerned with stating the principles and applications of geostatistics, but the first two chapters are devoted to what the author considers are the more useful concepts in classical statistics. This is very well done and about as good a summary as is to be found. Treatment of the 3-parameter lognormal distribution, however, is somewhat cursory in view of its common occurrence in earth sciences. The thirteenth, and last, chapter also digresses from the main subject to discuss statistical problems in sample preparation and crushing before analysis. This is a field not often covered in texts, but again is well presented here. It will be very useful to many readers, especially those not familiar with the works of Pierre Gy and Ingamells. These enable the size of sample to be calculated, as well as degree of crushing and pulverizing for assay values within various confidence limits.

The volume is clearly printed and stoutly bound. Care has obviously been taken in typesetting the mathematical symbols and it is a pity such care was not exercised in editing the text. Certainly, this would have reduced the numerous errors of spelling, punctuation and consistency. Individually, these are trivial, but collectively can annoy the reader and should be corrected in a second edition. There has been a pressing need for a text such as this for some time, so it should win wide acceptance.

The bibliography is comprehensive and appears to contain references to most of the major contributions in this field. As it stands, the book is a valuable addition to the library of any economic or mining geologist and is to be generally recommended despite the formidable price.

MS received March 1, 1978

Principles of Isotope Geology

By Gunter Faure
J. Wiley and Sons Inc., 464 p. 1977,
$19.95

Reviewed by R. H. McNutt
Department of Geology
McMaster University
Hamilton, Ontario L8S 4M1

This is a book written for the student, and as such, succeeds admirably. It is the most comprehensive book yet written on the subject, and will make an excellent text for a course at the senior undergraduate or graduate level. I also recommend it for lay scientists and indeed professionals in the (isotope geology) field.

The book consists of 21 chapters, two appendices and an author and subject index. References are given at the end of each chapter and total approximately 900 (the author index has over 1,000 entries). Literature coverage is up to early 1976.

As I read this book I was again reminded of the impressive role Canadian scientists have played in the development of this field, beginning with the pioneer work of Rutherford and Soddy at McGill. Since that time there have been many significant contributions particularly in the area of Pb and S isotope studies. In the index, approximately 40 authors are listed whose work was carried out in Canadian laboratories.

Chapters 1 to 5 cover the fundamentals of physics and chemistry that are a necessary background to the remainder of the book, i.e., the internal structure of atoms, radioactive decay, mass spectrometry and neutron activation analysis. These chapters will be of particular value to students without a strong science background. Faure presents the pertinent mathematical derivations in great detail, exactly what the student needs in a textbook, but often does not receive. Chapters 6 through 17 deal with the important radioactive decay schemes and the interpretation of the daughter isotopic compositions. Naturally, most attention is given to the Sr, Pb and Ar daughter systems, but a brief chapter of Os, Hf, and Ca is included. A separate chapter deals with each of fission track dating, the U-series disequilibrium method and C-14 dating. Chapters 18 to 21 cover the stable isotopes of H, O, C and S. Faure breaks the discussion on H and O into two chapters, concerned respectively with isotopic fractionation in the hydrosphere and atmosphere and in the lithosphere. Two of the more difficult topics in isotope geology, namely model Pb ages and U-series disequilibrium are well presented and made as clear as possible in such a textbook treatment.

Each chapter is followed by a set of problems (and answers) with data taken from the literature. Thus the student is confronted with real situations.

Appendix I lists a Fortran IV program for statistical analysis of Rb/Sr isochrons using the York (1969) treatment. It is fairly standard and similar to many programmes now used by workers in the field. Appendix II is the Phanerozoic time scale with age estimates from five sources.

The text is remarkedly free of typographical errors. The tables and diagrams are clear and uncluttered and most figures have extensive captions. The index has approximately 900 entries and seems adequate.

Finally at $19.95 (U.S.), the price is right.

MS received February 28, 1978

Chemical Petrology with Applications to The Terrestrial Planets and Meteorites

By Robert F. Mueller
and Surendra K. Saxena
Springer-Verlag New York, Inc.,
394 p., 1977.
$29.80

Reviewed by J. J. Fawcett
Department of Geology
University of Toronto
Toronto, Ontario M5S 1A1

The judicious blending of information gained from field observations, from mineral and rock analyses, from textural observations and from chemical theory has been a goal of many petrologists (geochemists?) for almost a century. Undoubtedly many significant advances in petrological concepts have resulted from the adoption of chemical considerations in problems of rock genesis. Frequently the first application of innovative techniques from areas of basic science to petrological problems has been initiated by scientists with extensive training in that basic discipline. It does not necessarily follow that the best geologist is the one with the greatest capability in basic science. However, one of the more sensitive aspects of geological training is probably the balance to be achieved between geological content and basic science content. Perhaps fortunately for our science each of us views that balance from a slightly different perspective. Hence any attempt to produce a single volume bringing together aspects of petrology and chemistry is almost certain to draw fire on the selection of subject matter. This certainly applies to the Mueller and Saxena's *Chemical Petrology*. Although the text makes no claim to be comprehensive, it includes short sections on a number of standard topics in igneous and metamorphic petrology but omits items such as the role of carbonate and oxide minerals, the behaviour and patterns of minor element abundances in natural assemblages, the role of fluid inclusions in petrogenesis and the significance of isotopic studies. Admittedly each of these could