*Canadian Mineralogist*
Vol. 25, pp. 379-381 (1987)

# BOOK REVIEWS

*MINERAL RESOURCES APPRAISAL (Mineral endowment, resources, and potential supply: concepts, methods, and cases).* By DeVerle P. Harris. Oxford University Press, Don Mills, Ontario, 1984, 445 pages. $93.74(CDN), $69.00(US), hardbound.

The appraisal of mineral resources is a subject that makes many an exploration geologist shudder. The very thought of calculating a "number" that quantifies the "mineral wealth" of an area, region, or country is enough to bring on a wave of cynicism and disbelief. The attempts to assign a future value of mineral production in areas where the geology is incompletely known, with loosely constrained geological models, for commodities whose future value is uncertain, seems doomed to failure. Nevertheless, this seemingly impossible task is exactly what governments ask their hard-pressed geological surveys and mineral resources branches to carry out. This book, Mineral Resources Appraisal, is a critique of the various methods and approaches to the problem.

The book is divided into fifteen chapters, beginning with definitions of the many terms used and abused and continuing with an overview of the various techniques. Each succeeding chapter tackles a different aspect or approach to the subject and builds logically one upon the other, as the appraisal techniques become more sophisticated. The chapters are entitled: Resource appraisal by models of economic activities; Quantity–quality relations (models); Deterministic geological methods; Geostatistical models of metal endowment – a conceptual framework; A multivariate model for wealth (a value aggregate of metals); Occurrence models; The crustal abundance geostatistical approach of Brinck; Univariate lognormal crustal abundance – geostatistical models of mineral endowment; The bivariate lognormal deposit model of PAU – a crustal abundance geostatistical model; The statistical relationship of deposit size to grade – a grade–tonnage relationship; Size and grade dependency and an explicit treatment of economic truncation: theory, method of analysis, demonstration, and a case study (New Mexico uranium); Resource analyses which used geological analysis and conventional assessments of subjective probabilities for mineral occurrence and discovery: concepts, methods, and case studies; Psychological, psychometric, and other issues and motivations in the perception of and the assessment of subjective probability; and Formalized geological inference and probability estimation.

Five broad categories of resource models are recognized in the book: economic, quantity–quality, geological, geostatistical, and compound. Each of these methods of appraisal is flawed, as is pointed out by Harris. In most cases, the amount of information required to carry out a rigorous analysis is not available and is unlikely to become available in the future. The use of geostatistical techniques is in itself an admission that geologists do not know all the critical factors involved in the formation of an ore deposit. Perhaps the most promising appraisal technique is that of formalized geological inference and probability estimation, the subject of the last three chapters. Unfortunately, this method is also the most complicated and requires a great deal of skill in its application, which, as Harris points out, has not been the case to date.

Each chapter begins with an introduction or overview, proceeds to a detailed, often mathematical, discussion and criticism of the various approaches, and finished with a summary. This is a useful method for those of us who are interested in the subject matter and the basic assumptions used, but are not interested in the detailed mathematical techniques used to derive the answer. It is not an easy book to read, but then, it is a difficult subject. The failure of many techniques to provide a satisfactory answer lies in the inadequacies of our understanding of the relationships between geology and resources. However, even the most sophisticated techniques used to date are unlikely to answer the ultimate question owing to the uncertainties involved with commodity prices and demand. For example, several of the case histories presented in the book attempt to determine the ultimate uranium resources of New Mexico. The change in the price and demand for uranium has been so substantial since these "appraisals" were completed that any economic significance can no longer be derived from them.

A topic that should be of interest to all geologists is a discussion in Chapter 14 on heuristics and biases in mineral resource appraisal, and a discussion in Chapter 15 on the logic used in the PROSPECTOR computer program. Bias is a problem that has plagued most of us, and a little thought given to some of the issues raised could lead to new approaches in research on many resource questions.

This is a book for specialists and represents a comprehensive treatment of the subject for anyone brave enough to work on such an appraisal. A copy should be in the library of every government's mineral resources department, for use when the politicians want to create yet another park. The book is well edited and has numerous charts, diagrams, tables, and listings of computer programs. It should wear well, and the subject matter will not rapidly become

dated. At $93.74, it is not cheap, and therefore is more destined for library shelves than a professional's private library.

I recommend this book to anyone contemplating a resource appraisal. However, my thoughts on resource appraisals are expressed by the author himself in the following quotation from Chapter 13: ". . . Surprising as it may seem, geologists commonly place little credibility in their fellow geologists when it comes to resource estimation or exploration decisions. This tendency seems to follow from the exploration failures experienced by the exploration geologist. Because an exploration geologist must live with these failures on a day-to-day basis, he is strongly aware of the inadequacies of his understanding of the geology–resource relationships . . ."

I could not have said it better.

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*EARTH RESOURCES.* By Brian J. Skinner. Prentice-Hall, New Jersey, 1986, 3rd edition, 184 pages. $14.95 (U.S.)

This short paperback is one of the Foundations of Earth Science series published by Prentice-Hall. A first edition was published in 1969, and a second in 1976. The current edition has been partly rewritten and rearranged, some figures have been added or dropped, relevant statistics have been brought up-to-date, and an epilogue touching on the problems created by resource usage has been added.

Resources are used in the broad sense to include any material garnered by man from the solid earth, the atmosphere, or the hydrosphere. The first two chapters deal with definitions of resources and reserves and where they are found; subsequent chapters deal with fuels and other energy sources, metals, fertilizer and minerals, building materials, and water. Brief descriptions of the origin and geological setting of each resource are provided, along with estimates of current consumption and reserves, and prediction or speculation about future usage. A useful distinction is made between possible problems associated with continuing use of abundant and scarce metals.

The book is well written and well illustrated, and can easily be digested in an evening. The geological descriptions are clearly written at a level that should be understandable to any reasonably intelligent person. I found very few typographical or other errors. At $14.95, in today's book market, it is a good buy.

I am not sure what market this book, like others in the Foundation of Earth Science series, is aimed at. It is too brief to be used as an assigned text in a main-line geology course. Perhaps it could be used in a 2nd or 3rd year course on resources for general Arts and Science and Education students. It might also be used as supplementary reading for some Geology courses. At any rate, the fact that the book is into its 3rd edition indicates that there has been, and should continue to be, a sizeable audience for it.

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