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BOOK REVIEWS

Introduction to Mineral Exploration. Edited by Anthony M. Evans. Blackwell Science Ltd., 238 Main Street, Cambridge, Massachusetts 02142, U.S.A., 1995, 396 pages. CDN$74.95; softbound (ISBN 0–632–02427–5).

This book is an up-to-date introductory text on mineral exploration. It grew out of a course taught by the editor at Leicester University, although the book is a joint venture with several other experts. The authors do not assume extensive geological training on the part of the readers, but newcomers to the subject will need to consult some supplementary texts to keep pace.

The book consists of two parts. The first part focuses on the principles of mineral exploration, the second on case histories of selected types of deposit. The first section describes various programs of exploration and evaluation, including techniques employed in prospecting, target evaluations and predevelopment studies. The first three chapters review some basic information on mineral deposits and mineral exploration, including aspects of mineral economics, the choice of exploration areas, the mineralogy and nature of mineral deposits, and the relation of plate tectonics to the distribution of ore deposits. The remaining seven chapters of the first part deal with actual methods of exploration for evaluation of ore deposits. Chapters 4 and 5 contain concise and informative reviews of reconnaissance exploration and follow-up after the discovery of a mineral prospect. The emphasis is on how to find a drilling target, when to drill and when to stop. Chapters 6 to 8 discuss exploration methods, including remote sensing, photogeology, geophysics and geochemistry. The next chapter deals with evaluation techniques, and highlights geostatistical methods, various drilling techniques, pitting and trenching, estimation of ore reserves and calculations of grade. Chapter 10, on feasibility studies, focuses on assessing the economic viability of orebodies and financing of mineral projects. Each chapter contains useful summaries and recommendation for further reading.

The second part of the book includes six in-depth studies of various types of deposit. Chapter 11 is on the development of aggregate reserves, with an example of the exploration for and development of a hard-rock resource. Chapter 12 describes the case of a lignite deposit in Turkey. It is followed by detailed discussions of the classic deposits at Witwatersrand and Kidd Creek. The last two chapters focus on disseminated precious metal (Trinity silver mine, Nevada) and narrow vein (Wheal Jane tin, Cornwall) deposits. Case studies are the strength of the book, although Witwatersrand was perhaps not the best choice for a gold deposit because of its uniqueness.

The book is well produced and well organized; the 10 pages of index and 19 pages of references are very useful and enhance the value of the book. The writing style is smooth and readable. The book is particularly well suited as a textbook for a senior undergraduate course in mineral exploration. It would also be a good reference book for a mineral deposits course that touches on mineral exploration, and could be useful to professionals working in the field. Compared to some older books on mineral exploration and prospecting, this book is better as a textbook because of its detailed explanations and clear organization. The softbound edition keeps the price in an affordable range for students.

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Minerals of South Africa. By Bruce Cairncross and Roger Dixon. Geological Society of South Africa, P.O. Box 44283, Linden 2104, Republic of South Africa (Fax 27–11–8881632; e-mail <elenar@avmin.co.za>). 1995, 290 p. Hardbound, Standard Edition: US$115.00, ISBN 0–620–19324–7; Collector's Edition: US$300.00, ISBN 0–620–19325–5.

Minerals of South Africa began to take form in 1989, when the authors agreed to pool their resources on the subject. An offer followed from the Geological Society of South Africa to publish the book as part of its Centennial Congress festivities in 1995. This resulted in the first in-depth publication dealing specifically with minerals found in South Africa. For a country so prolifically endowed with mineral resources, yet weak in the tradition of mineral collecting and preservation, it has been long overdue.

The book treats in turn, minerals found in Archean, Proterozoic, and Phanerozoic terranes, including, in the last mentioned, a 12-page section on cave minerals of South Africa. The final important section of the book is a 75-page illustrated alphabetical compilation of South African mineral species. This constitutes the most complete list available anywhere in a single publication. It includes all type-locality specimens, as well as species classified as rare, aesthetic, unusual, microscopic, enormous, common, and famous. Descriptions are

presented in an engaging style reminiscent of the best articles in *The Mineralogical Record*. Mineral formulae follow the *Glossary of Mineral Species*, by Fleischer and Mandarino (1995) and the *Encyclopedia of Minerals*, second edition, by Roberts *et al.* (1990). Doubtless the list of mineral species of South Africa will grow; for example, there are over 150 unnamed or inadequately characterized platinum-group phases catalogued from the Bushveld complex alone!

Unlike many other books with which it might be compared, *Minerals of South Africa* directs considerable attention to an explanation of the geological relationship of the enclosing rock to the formation and distribution of the associated minerals. Several decades ago, this approach improved our understanding of ore deposits; woven into the fabric of *Minerals of South Africa*, it is likely to increase the understanding of minerals by layman and professional alike.

For the main mineral localities of South Africa, this volume artfully combines interesting historical information, high-quality photographs (most of them in color), lucid descriptions, information on geological settings, and tidy locality maps. Because of the vast amount of literature available elsewhere on major mineral sites such as the Witwatersrand gold field, and the diamond fields, the coverage of these sites is confined to only the most important details. Yet in all this, and despite the difference of scale among large and small localities, an excellent balance has been achieved. Appended are: a comprehensive bibliography, a glossary of definitions, a list of museums and institutional collections in South Africa, and a subject index.

The Kalahari manganese field, the largest land-based manganese deposits in the world, merits special mention, because it is probably the most famous region for mineral specimens in South Africa. It is renowned for a great number of rare mineral species, most of them Ca–Mn silicates. Incidentally, some of the world's finest rhodochrosite specimens hail from Hotazel, a Kalahari manganese mine that closed in 1991. In *Minerals of South Africa*, Cairncross and Dixon relate how the first specimens of rhodochrosite from the Kalahari manganese field were found at the opencast working of the Hotazel mine. During the first 10 years of production, only a small fraction of these specimens were preserved. Reportedly, one mine captain was asked by a miner to examine a complete working face covered with exquisite crystals of rhodochrosite. As no one could imagine any possible use for them, everything was blasted into fragments in order to obtain the remaining 2 meters of manganese ore left in the face. Now, contrast this story with that of a Hotazel competitor in Alma, Colorado. The Home Sweet Home mine in Alma was re-opened several years ago by entrepreneur Brian Lee. Totally distinct in habit and mode of occurrence from Kalahari rhodochrosite, specimens from the Home Sweet Home mine are formed of fantastic clusters of glowing cherry-red rhombs to 10 cm, on edge. Outstanding individual museum-quality specimens of this material are fetching prices from US$250,000 to US$500,000! How times change! But I digress.

Historical highlights in *Minerals of South Africa* include flashbacks to activities in mining camps 100 years ago. For example, in the Murchison Greenstone Belt, prospector Harry Pike complained: "There has been the devil to pay at our camp these last few days. A large troop of lions paid us a visit, broke into the donkeys' kraal within a few yards of the tent of one of my mates named Stewart and scoffed five donkeys. You never saw anything more determined in your life. All this was done despite three white men throwing dynamite and a large gang of kafirs (sic) making large fires. We had no guns and if we had, we would not have seen them for it was dark as pitch." So much for the old (South) Africa. Yet Herodotus had it right nearly 2500 years ago when he wrote "*Ex Africa semper aliquid novi*". Cairncross and Dixon note that in 1992, shortly before they visited the immense opencast Palabora mine, two elephants in the bottom of the pit had to be herded out before the day's mining could begin!

This splendid volume tells tantalizing mineralogical tales aplenty. In some instances the caption to a figure says it all. Take diamonds, for instance: "The *616*, the largest uncut octahedral diamond in the world. It was picked up in rubble spillage between the skip and surface crusher in 1974 at the Dutoitspan mine. The stone weighs 616 carats, which is the PO Box number of DeBeers in Kimberley. During a burglary of the Mining Museum in 1993, many diamonds were stolen, but this one was left." It is enough to strengthen the resolve of any mineral collector, professional or otherwise, to renew an assault on the nearest mine dump.

Here, we obviously have two enormously talented and diligent individuals. Cairncross and Dixon not only visited most of the important mineral-producing localities in the country, searched out old specimens in private and institutional collections, traced down relevant geological and mineralogical literature and archival sources, and wrote the book; they also took more than 250 of the nearly 400 superb color photographs! These range from landscape and mine site down to museum and micromount-scale mineral specimens. Hey, these guys do it all!

No question about it, this production deserves full marks. *Minerals of South Africa* is an absolute delight. In content and presentation, it's rather like a gigantic volume of *The Mineralogical Record*. Stated otherwise, it's a very sound investment. The Geological Society of South Africa can be justly proud of the results of their working relationship with Cairncross and Dixon. You, too, can be a proud owner of *Minerals of South Africa*. At the price, this is a steal!

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Aquifer Disposal of Carbon Dioxide. Hydrodynamic and Mineral Trapping – Proof of Concept. Edited by Brian Hitchon. Geoscience Publishing Ltd., Box 79088, 1020 Sherwood Drive, Sherwood Park, Alberta T8A 5S3. 1996, 165 p. $45 (CDN) (ISBN 0–9680844–0–0).

By artificially increasing the greenhouse gas (GHG) CO_2 into the atmosphere, mankind is currently indulging itself in the largest uncontrolled scientific experiment in its history. Though a large number of questions remain unanswered about the potential impacts of this increase, a significant number of scientists and governments feel that waiting for definite proof of impacts is not an intelligent strategy, considering the changes to climate that might occur. As a result, international treaties designed to curb GHG increases have been proposed and are currently being negotiated under a wide variety of umbrellas. As a major trading nation, a major producer of hydrocarbons, an inefficient user of its energy, as well as a nation that may be significantly affected by climate change, Canada is under pressure to stabilize its output of atmospheric GHGs.

Though Canada has been slow to implement significant measures to stabilize (much less reduce) its emissions of CO_2, some research has been undertaken to deal with the problem. This book addresses the use of sequestration of CO_2 generated by coal burning into deep aquifers as a way of reducing carbon additions to the atmosphere. This book can best be described as an extended case-study of the disposal of CO_2 produced by coal-burning electricity-generation plants in Alberta in deep aquifers. It contains a general introduction for an interested but non-specialist reader (read "decision maker") explaining the background of the CO_2 problem, the make-up of aquifers, their function, and the general concepts behind aquifer sequestration of anthropogenic GHGs. The second and major part of the book describes the site used for a conceptual test of the approach (the area around Lake Wabamun, west of Edmonton, Alberta), and addresses the two potential CO_2-trapping mechanisms, hydrodynamic and mineral.

The dissolution of CO_2 in aquifer waters under high pressure (hydrodynamic trapping), modeled for the Lake Wabamun area, emphasizes aquifer thickness, permeability and porosity. Sensitivity analyses identify variables that will have the greatest impact on the ability of the rock strata to absorb and transport CO_2 away from injection points. Mineral trapping involving the formation of carbonate rocks is modeled using three geochemistry packages. Model predictions are then compared to laboratory tests. These point to the reasonable conclusion that mineral trapping is most likely successful in calcium- and magnesium-rich sandstones and would be a relatively slow process.

The authors conclude that aquifer sequestration of waste CO_2 is viable. The results of their separate studies suggest that hydrodynamic trapping is the most likely significant mechanism (from the perspective of a human lifespan). Although the book contains a discussion chapter, the authors do not specifically indicate how the mineral and hydrodynamic mechanisms of CO_2 trapping might complement each other in an aquifer, nor do they explain the potential significance that aquifer trapping may have on global or Canadian carbon budgets. Despite sponsorship of research described by federal and provincial governments, and by utilities, this small book is expensive for what is basically a preliminary feasibility study.

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