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Aller au sommaire du numéro

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Book Reviews / Critique

Book Reviews

Paleoclimate, Paleomagnetism and Continental Drift

By J. K. A. Habicht
American Association of Petroleum Geologists
Studies in Geology No. 9, 31 pages
11 fold out maps, 1979
$15.00;
AAPG and SEPM members $12.00

Reviewed by E. Irving
Earth Physics Branch
Energy, Mines and Resources
Ottawa, Ontario K1A 0Y3

This is a soft-back ring-binder book. The text gives a useful account of paleoclimatic indicators - evaporites, tillites, paleotemperature determinations, etc. Mention of paleomagnetism is brief, and the quantitative aspects of determining paleolatitudes from paleomagnetic results are not covered. Continental drift is hardly mentioned in the text.

The fold-outs are beautifully produced in colour - one for each major geological interval. Each in two parts. On one side is a world map showing the distribution of paleoclimatic indicators. These are excellent and very useful compilations. On the other side is the same map showing paleolatitudes of the major continental blocks. Both maps have the continents in their present positions. The reader is not told about their relative positions (that is continental drift) only their relation to the paleogeographic pole.

The paleolatitude compilations are 10 years out of date. This is not too serious because it is one of the minor miracles of modern science that the 10 or 20 year old determinations of paleolatitude for the major continental blocks are repeatedly confirmed, with second-order adjustments, by new paleomagnetic results. More serious is the absence of indications of statistical accuracy. The reader is not told whether Permian values are more accurate than Cambrian - which they are by several times. More serious still is the indiscriminate way in which paleolatitude lines are in some instances extended over terrain to which they do not apply. From Carboniferous time onwards the paleolatitudes determined from northern Europe and northern Asia are extended from Gibraltar to Chukotsk, from North Cape to the Straits of Malacca, as if this enormous tract had been inviolate for the last 300 million years. This is wrong. Permian paleomagnetic evidence from eastern Siberia, China and Japan is grossly inconsistent with that from Europe. The evidence of warm Permian weather in China and Japan flatly contradicts the high paleolatitudes deduced from European paleomagnetic data. Also tectonic evidence favours a mobilistic interpretation of Late Paleozoic and Mesozoic evolution of eastern and central Asia.

All in all this book is a rather unquestioning review of reviews. No new arguments or insights are presented, no new questions posed or speculative solutions offered. Why, for instance, were Carboniferous coals accumulated preferentially in low paleolatitudes and later coals in intermediate or high paleolatitudes? Was the Carboniferous world poor in heat-loving plant-rotting organisms, and did these suddenly evolve in the Permian and proceed to remove subsequent low-latitude plant debris? Or has this odd time-space distribution something to do with the evolution of the peculiarities of the woody tissues of coal-forming plants? Furthermore how can faunas (including crocodiles unable to endure frost) and floras in evident abundance have existed within 15° of the north pole during the Eocene? Whatever the total climatic regime of the Earth, unless the obliquity has changed, it is difficult to see how heavy frosts would not have occurred so far within the paleoarctic circle. Can the obliquity have changed? If it has, the consequences for paleoclimates are very great. A sentence here and there is all that would have been needed to alert the reader to the existence of outstanding puzzles.

As a compilation of paleoclimatic evidence this book is a welcome reference for teacher, student and research worker. Potential buyers should note however that it is not about continental drift as the title says it is. It is a book about paleoclimates and paleolatitudes. For the student of ideas *Die Klimate der geolischen Vorzeit* (W. Koppen and A. Wegener, Borntrager, 1924) remains the best work on paleoclimate and continental drift. Alas it is unavailable in English.

MS received May 12, 1980

Invertebrate Paleontology and Evolution

By E. N. K. Clarkson
George Allen and Unwin,
Winchester, Mass., 323p., 1979
Hard cover $35.00, soft cover $17.95

Reviewed by Alan Logan
Department of Geology
University of New Brunswick
Saint John, New Brunswick E2L 4L5

To those of us given the dubious privilege of teaching introductory systematic invertebrate paleontology courses to geology majors with a limited background in biology, the choice of a suitable textbook is somewhat of a problem. Traditionally the texts by Shrock and Twenhofel or Beerbower have been used or, more recently, the monumental tome by Tasch or the succinct work by Rhona Black, but there is presently a need for a concise well-illustrated textbook, with no geographical bias, which incorporates recent developments in invertebrate paleontology as well as covering the more traditional aspects, such as basic description, classification and stratigraphic use of fossils. Clarkson's book goes a long way toward filling this need and turns out to be a splendid basic text

for invertebrate paleontology courses.

The book is divided into two parts. Part I begins by introducing basic principles and terminology of paleontology, then considers the theory of evolution including a discussion of the relative merits of phyletic gradualism versus allopatric speciation. The section on basic genetic theory related to variation and mutation is particularly useful for non-biologists. Part I concludes with a brief section on the origin and early diversification of metazoans, plus a discussion on extinctions in the fossil record.

Part II is a systematic account of the most important invertebrate fossil groups, beginning with sponges, archaeocyathids and stromatoporoids and proceeding through chidarians, bryozoans, brachiopods, molluscs, echinoderms, graptolites and arthropods. The concluding chapter is entitled "Exceptional Faunas" and describes the fossils and paleoecology of the Burgess Shale, Hünsrückschiefer and Mazon Creek faunas. Each chapter in Part II deals with a separate invertebrate group in a similar manner; that is, the basic morphology is described, usually with reference to living examples, then the taxonomy of the group is given. Commonly-occurring fossil species are described and illustrated, ontogeny, evolutionary trends, global distribution and biostratigraphic usefulness are discussed, and aspects of paleoecology and functional morphology are reviewed. Each chapter is well illustrated with line drawings, which take preference over photographs. There is a short bibliography of selected monographic works and research papers at the end of each chapter and a systematic and general index at the end of the book.

It is difficult to find any major faults with this textbook. Some may deplore the absence of a chapter on microfossils, particularly biostratigraphers and systematists interested in protozoans or conodonts, but inclusion of these groups, as Clarkson points out, would have increased the book size (and presumably its price) considerably. The author has resisted the temptation to favour his own particular research interests (the arthropods) and the book is therefore very well balanced. One cannot fail to be impressed with Clarkson's breadth of knowledge on each group and the general impression is given that the author is totally familiar with all aspects of the subject. Altogether a most welcome addition to current textbooks on paleontology and one that most geology students will, I think, retain rather than sell at the end of the year.

MS received May 16, 1980

Geophysics and Geochemistry in the Search for Metallic Ores

Edited by P. J. Hood
Geological Survey of Canada, Economic Geology Report 31, 811 p., 1979
$35.00 Canada: $42.50 Other countries

Reviewed by J. M. Allen
COMINCO Ltd.
855-409 Granville St.
Vancouver, B.C. V6C 1T2

This book is a collection of the papers presented at the Exploration 77 Symposium in Ottawa in 1977. Considering the magnitude of the topic, the editor has done an excellent job of arranging the papers in a logical orderly way. There are a total of 44 papers starting with three overviews of geology, geophysics and geochemistry, followed by 11 papers on geophysical methods, 11 papers on geochemical methods, one on remote sensing, 2 on computer applications and 16 case histories from around the world. All of the papers are in English and all have abstracts in French.

The quality of the typescript is good. The distribution of the illustrations within the text is somewhat erratic and in some sections a good deal of page turning is required to correlate text and diagrams. The illustrations themselves are generally clear but quite variable and this no doubt relates to the number of authors involved. There are exceptions where authors try to include too much data in a single illustration, or where black and white copies of coloured maps are used. Extensive bibliographies are cited with many of the papers enhancing the value of the volume as a reference.

One of the principal virtues of a volume of this kind is that it provides short, state-of-the-art (as of 1977) summaries of a spectrum of exploration methods. This it does very well and the case histories complement these summaries. Inevitably there are omissions or less than desired coverage of a particular topic but this is unavoidable in a collection of papers covering such a range of topics, many of which could merit a similar sized volume on their own.

The trend indicated in the various papers is toward increasing sophistication and to the collection of more and more data. It is thus most appropriate that papers on the use of computers to store and manipulate data are included. We are becoming increasingly dependent on computers to manage and process information. As an example, consider a single Landsat image which within its four bands contains 21,000,000 bits of spectral information. Computers routinely handle and manipulate this volume of information and if current satellite plans are put into effect computing capacity will have to be increased by a factor of 50 to cope with the increased flow of satellite data. This will apply to geophysical and geochemical data as well, however, the volumes will be much smaller.

The volume is not cheap but compared to other recent scientific publications it is not out of line. It seems the age of low priced books is over. Considered on the basis of the information it contains, the price becomes more reasonable.

I recommend the volume as a good review of geophysical and geochemical methods complemented by a good selection of case histories.

MS received May 20, 1980

The Geochemistry of Gold and its Deposits

By R. W. Boyle
Geological Survey of Canada, Bulletin 280, 584 pages, 1979
$45.00 Canada: $54.00 Other countries

Reviewed by J. H. Crocket
Department of Geology
McMaster University
Hamilton, Ontario L8S 4M1

Bulletin 280 is a comprehensive and thorough account of the geochemistry of gold and the geology of gold deposits. It covers the literature to 1977 and is one of the most complete English language compilations of the vast Russian literature on gold. The work draws heavily on the author's experience of over 25 years in the field of gold metallogeny, particularly his work in the Yellowknife camp, and in addition, presents new previously unpublished analytical data on gold in rocks and ore deposits.

Following an intriguing introductory chapter on gold mining, metallurgy and exploration from antiquity to the modern era, the geochemistry, chemistry and mineralogy of the element is discussed in chapter II. Gold abundances in a large number of media, including rocks, minerals, soils, waters, biological and cosmic materials are presented. The tables, which include some silver data as well, are compilations of individually referenced literature or averages compiled by the author from the literature and unpublished data. The average gold abund-

ances for common rock types are generally in reasonable agreement with previous estimates based on smaller sample sizes although some differences, such as a 20ppb average for gold in basic rocks, are apparent. Chapter II includes a very thorough discussion of gold content and speciation in natural waters and their precipitates.

The majority of the book, some 70%, is contained in chapter III - Gold Deposits. The topic is dealt with from both a descriptive and interpretative viewpoint. A descriptive classification of gold deposits is presented followed by a lengthy discussion of elements and minerals associated with various types of deposits. Descriptions of typical deposits, wallrock alteration, Au/Ag ratios and metallogenic epochs of gold mineralizations provide a broad and detailed description of auriferous mineral deposits. Much of the discussion is concerned with epigenetic gold-quartz vein deposits, but an excellent discussion of modern and paleoplacer deposits is also included. Much less attention is focussed on by-product gold from sources such as base metal sulphide deposits, a probable reflection of the limited data base available but unfortunate in view of the steadily increasing contribution of by-product gold to Canadian output. Various theories on the origin of epigenetic gold deposits are critically discussed with specific reference to numerous contributions from the literature. Estimates of the pressure-temperature conditions applicable to epigenetic gold deposition as derived from fluid inclusion, isotopic and other physical methods are reviewed although the impact of isotopic studies, particularly oxygen and hydrogen received minimal attention. The author's metamorphic secretion-dilation theory of the formation of epigenetic gold deposits is elaborated in some detail.

The remainder of the book covering oxidation and secondary enrichment of gold deposits and prospecting for gold deposits is similarly detailed and comprehensive. Prospecting is covered from both the geological and geochemical viewpoint with excellent discussion of both epigenetic and placer occurrences.

As a source book of information on gold and its ores, Bulletin 280 is probably the most comprehensive single source available. It should be of much value to both industry and academics new to the field of gold metallogeny.

MS received May 22, 1980

Economic Mineral Deposits

By Mead L. Jensen
and the late Alan M. Bateman
John Wiley and Sons, 593p., 1979
$23.95

Reviewed by Terence J. Bottrill
Senior Research Geologist
Rio Tinto Canadian Exploration Limited
2400 - 120 Adelaide Street West,
Toronto, Ontario M5H 1W5

This is a new edition (third) of a textbook, last updated some 30 years ago by the original author, and now revised by one of his students, who is a well-known economic geologist of the American school. It is intended for the undergraduate student and is an attempt to fill the obvious need for a new text in economic geology. It is organized into four sections of principles, processes of formation of mineral deposits, metallic mineral deposits, and non-metallic minerals.

When the original book was written in the 1940s the science of economic geology was young, basically descriptive, and in North America the theories were biased by experience in the western United States. Available information on many deposits was rather limited, especially outside of North America, the subject could reasonably be covered in a single textbook, and as a result the first (1942) and second (1950) editions of this book became the standard reference for most English-speaking economic geologists. It continued to have influence long after the facts and the theory in it became badly dated by new research and the discovery of many new mines.

The standard theory prevalent in the North American school throughout most of the early twentieth century was that the majority of metallic mineral deposits had been introduced into much older host rocks by hydrothermal fluids derived from the crystallization of plutonic magmas. The classification of deposits was therefore organized according to the supposed mechanism of introduction such as replacement and void filling, and by individual metals whose distribution was thought to be controlled by the specific temperature, and therefore depth, of deposition from an otherwise similar, magmatic-hydrothermal fluid. This new edition has retained this basic theory and approach, and in fact has retained much of the original text. Newer concepts of economic geology - such as the importance of meteoric waters as the source of most hydrothermal solutions -have been added towards the end of each of the many subsections. As these often contradict the older theories, the student is likely to become very confused as to what exactly is the current understanding of ore-forming mechanisms.

The author rejects the more current "ore petrology" concepts whereby most deposits are considered an integral part of their host rocks and are a normal result of their tectonic, lithological and chemical environment. These newer concepts are not merely academic, for they have become the basis of most modern mineral resource exploration.

The one major addition to the earlier editions is the recognition of deposits formed on the sea floor by bacterial sulphate reduction and from precipitation of base and precious metals leached from hot volcanics by seawater (volcanogenic exhalative). However, the author seems to be only partially convinced of the merit of these alternatives, and more recent explanations for many of the world's most important metallic mineral deposits and throughout the book many of them, such as Noranda, are still frequently ascribed to replacement. This is particularly unfortunate because volcanogenic exhalative sulphides have now been seen forming on the sea floor of the East Pacific Rise, and are perhaps the first mineral deposit type whose formation can be removed from the realm of theory to actual observation.

Because the book is still organized by individual metals it is necessary to search through many sections in order to extract the data and ideas of any one particular deposit type. Volcanogenic deposits for example, are discussed in the copper, lead-zinc, nickel, bacteriogenic and replacement sections as well as in the new volcanogenic chapter. Moreover, within that new chapter there is information on the Zambian sedimentary copper deposits and on manganese nodules, neither of which are submarine exhalative or volcanogenic, for both are probably produced by sedimentary, bacterial and diagenetic processes.

Despite the antiquity of much of the text, and the ideas which it contains, the book has a modern appearance and contains many recent diagrams copied from the journal literature. However, both the additions to the original text and the figures have been very poorly edited, and there are hundreds of errors of spelling and language throughout the book. The figure editing is particularly poor with numerous misplaced captions; frequently the wrong figure number is referred to in the text; many figures are

unnecessarily duplicated or irrelevant to the chapter in which they are found; many contain line-style errors. The bibliographies at the end of each chapter are sparse, with only a few recent references added to a selection of those in the earlier editions. Authors referred to in the text, and particularly on the figure captions, are frequently not included in the bibliographies. It is also very hard to locate individual references because the older bibliographical style of title first has been retained from the earlier editions, but without the use of a heavier print for the title.

In all fairness to the author the task of updating this historically important book is one which probably no one could have achieved without considerable difficulty because of the substantial advances in the subject in the intervening years. Perhaps the task of writing a textbook on this very complex and diverse subject is now beyond the capacity of any one author. However, the frequent factual and editing errors in the book are far less forgivable. Professors of economic geology would be well advised to try some alternative rather than use this text as the basis for any courses, and the practicing economic geologist will find little in it that he needs.

MS received April 29, 1980

Effects of Taxation on Base Metal Mining in Canada

By Brian W. Mackenzie
and Michel L. Bilodeau
Centre for Resource Studies, Queen's University, 190p., 1979.
$5.00

Reviewed by J. A. Johnson
Department of Economics
McMaster University
Hamilton, Ontario L8S 4M4

Different policies have been employed in the taxation of various industries. The authors develop a procedure for evaluating current tax schemes and provide suggestions for designing an improved taxation policy. The procedure is applied to the Base Metal Mining Industry in Canada and the authors estimate the impact of four actual and three hypothetical tax measures on the net present value of the industry's output, tax yield, and rate of return on investment. These empirical results are the basis of recommendations for future tax policies.

The study encompasses nine chapters and 16 appendices. The first two chapters give an overview and present the major findings of the study and the remaining material provides a description of the mining industry, a more thorough discussion of the procedures employed in making empirical estimates and the results of employing alternative assumptions.

Before taxation issues are analyzed, the authors examine all of the base metal deposits (copper, zinc, lead and molybdenum) discovered in Canada during the 1951-1974 period and compute the net present value of the economic deposits (a discovery which realizes a total revenue of at least $20 million and a rate of return of at least 8%). Under their "base case" assumptions regarding metal prices, current cost estimates and an annual exploration budget of $2 million, they found that 86 out of 124 deposits are economic and that the net present value of the deposits is $2.8 billion, with a return of 16 per cent. Mackenzie and Bilodeau also found that: 1) the highest yield is in the Shield region and lowest in the Cordilleran region, 2) the rate of return is highest for the discoveries made in the 1951-58 period and lowest for the discoveries in the 1967-1974 period, 3) yields rise with metal prices which are assumed to be higher than the base case and fall when the cost of capital is assumed to be greater than 8 per cent (rate of return remains constant, however, because deposits which become uneconomic are excluded from the analysis), 4) an exploration budget of $2 million per year is optimal in that budgets of greater or lesser amounts reduce the net present value of total discoveries.

The impact of four actual taxation policies on the number of economic deposits and total yield are then estimated. These four policies are the federal corporation, provincial corporation, and provincial mining taxes in effect in: 1) 1969, reflecting a traditional system of mining taxation, 2) 1972, reflecting federal tax reform but without provincial changes which followed the reform, 3A) 1976 - reflecting recent mining taxation including royalty provisions in British Columbia (heavy taxes) and 3B) reflecting recent mining taxation after withdrawal of B.C. provisions. Taxation reduces the number of economic deposits, the total present value of the deposits and the rate of return to investors. This is most pronounced for 3A where the number of economic deposits is reduced (as compared to the "no tax" situation) from 86 to 72, the yield is reduced from $2.8 billion to $2.4 billion and the rate falls from 16% to 13.5%. Under 3A the Government receives 62% of the net present value and investors, 38%. Inflation further reduces the return from the deposits and increases the share of the yield secured by Governments.

The authors also estimate the relative impact of three types of taxes on the yield from the deposits. The three taxes considered are a revenue tax (royalty), profits tax, and tax on rate of return above a certain level. The net present value is reduced most for a revenue tax, considerably less for a profits tax and is not affected by the specific type of rate of return tax described here.

The major conclusion of the study is that the taxation of mining in Canada is unsatisfactory. Recent policies have resulted from "superficial, uncoordinated government" actions and have damaged the incentive to make new discoveries. The authors argue that a tax system must be flexible enough to take account of the spatial variability, cyclicity of base metal markets and the diminishing economic viability of the industry. They also recommend that the tax system should be "simple, coordinated and integrated".

The study is a very useful case study of the taxation of base metals. The authors appeared to be painstaking in their research efforts. A great deal of effort was directed toward collecting data to estimate the present value of 124 discoveries, the calculations were undertaken with care and the sensitivity testing of several of the parameters adds to credibility of the results. My chief concern is with some of the interpretation of the results. Judgements about desirable tax policy are often made from the point of view of the mining industry and some of the conclusions are "motherhood" statements which do not follow from the analysis. An example of the latter point is the recommendation for a simple integrated tax system. This recommendation may be desirable but it does not take account of the conflicting goals which different levels of government attempt to fulfill.

The bias toward the mining industry is shown in many parts of the study. Efficiency is defined in terms of maximizing the yield from deposits, with the implicit assumption that taxation is undesirable because it reduces the yield from discoveries and reduces the share received by investors. No consideration is given to comparing the yield from mining with the return from other private investments (e.g., manufacturing) or public investments (e.g., health). This view is illustrated in the discussion of the rate of return basis of taxation recommended by

the authors. They do not take account of the effect on the government revenue and expenditure programs if the average tax yield is less under this system and the misallocation of resources which would result if tax burden in mining is vastly different than the tax burden on manufacturing.

Less important are some of the "base case" assumptions but these also show some bias in the direction of the mining industry. For example, the assumption of a 3% risk-free interest rate (as the base case) is greatly different than the 10% employed by the federal government in its benefit cost studies. The lower rate increases, of course, the apparent importance of the mining industry.

The study is of value to those interested in mining economics. It is well written and is a thorough study of the return on the discoveries of base metal deposits in Canada in a recent period. Those who are unfamiliar with the methodology employed in the study will find the analysis interesting and those concerned with the yields of the various Canadian deposits will find the results to be of value. The parts dealing with taxation are also of interest but some of the findings could be drawn from a qualitative analysis and some of the conclusions are open to dispute.

MS received May 28, 1980

Asbestos: Properties, Applications and Hazards - Volume I

Edited by L. Michaels and S. S. Chissick
John Wiley and Sons, 533p., 1979.
$62.50

Reviewed by Dr. David C. F. Muir
Director
Occupational Health Program
Faculty of Health Sciences
Health Sciences Centre
McMaster University
Hamilton, Ontario L8N 3Z5

In their preface to this book, the authors indicate that it began as a literature search by one of them who was required to provide information about asbestos. Being unable to locate a comprehensive source book, they decided to summarize the results of their literature survey and to invite individual authorities to contribute separate chapters. Care was taken not to involve individuals with industrial connections unless these were on non controversial issues. Persons thought to be actively engaged in a campaign to ban the use of asbestos were also avoided. The invited authors were given free reign to present their own ideas and there was no editing to avoid duplication.

The result is the production of a volume of very uneven quality indeed. Some chapters are outstandingly successful and deserve special mention. These are on the mineralogy of asbestos by Zussman, the chemistry and physics of asbestos by Hodgson, on the measurement and identification of asbestos by Beckett and Middleton, on the pathology of asbestos disease by Jones and on epidemiological aspects by Newhouse. These are all authoritative chapters contributed by workers who have published extensive original work and who provide fully documented references for the material presented.

Unfortunately, some other chapters of the book do not reach this high standard and a number of misleading and inaccurate statements are made. The non expert reader may not be able to identify those parts which are reliable and this is a severe drawback in a volume which attempts to be authoritative. For example, in the chapter by Derricott on asbestos in buildings, the wording on page 313 suggests that a dose response relationship in the causation of mesothelioma has been seriously challenged and that a single inhaled fiber may be adequate to cause a tumor. In the same page, the wording suggests that the author believes only crocidolite to be capable of causing mesothelioma. Readers are also likely to be confused by conflicting statements such as that on page 154 where it is implied that talc does not contain asbestos whereas on page 200 it is stated that talc may contain up to 14.5% asbestos.

A great deal of the book is repetitive and describes regulations and practices relevant only to Britain. Large sections of it are therefore unlikely to be of interest to readers in other countries. For these reasons and for the lack of critical editing noted above this volume cannot receive wholehearted endorsement. This is a pity because undoubtedly some of the contributions are of the very highest quality. The title of the book appears to indicate that a second volume will be forthcoming. There is no indication of the subjects that will be covered but hopefully a more uniform scientific standard will be required by the editors.

MS received May 14, 1980

Metal Pollution in the Aquatic Environment

By U. Förstner and G. T. W. Wittman
with contributions by F. Prosi
and J. H. van Lierde
Springer-Verlag, 468p., 1979
$54.00 US

Reviewed by J. F. Barker
Department of Earth Sciences
University of Waterloo
Waterloo, Ontario N2L 3G1

The response of scientific and regulatory bodies to the recognized health hazard posed by trace metals in the environment has generated a considerable body of literature. *Metal Pollution in the Aquatic Environment* compiles and evaluates this growing body of knowledge. A geochemical approach is adopted by the authors with considerable emphasis on the sedimentological aspects of heavy metal behaviour, reflecting their broad research experience in this aspect. This approach is unique in books concerning metal pollution in aquatic systems and has particular appeal for geoscientists working in this dynamic, multidisciplinary field.

This book generally touches all the bases. A brief introduction is followed by a chapter describing the toxic metals, their toxic action, examples of metal poisoning events and the regulatory response. The discussion of metal toxicity and poisoning events is particularly useful. In the next two chapters, the sources, content and some aspects of speciation of metals in surface waters are presented together with an extensive treatment of sediment studies in the assessment of metal pollution. A comprehensive discussion of sampling and analytical considerations is given as well as many examples of the use of this sedimentological assessment method in lakes, rivers and the oceans. The next chapter deals with solid-solution transfer of metals, providing an evaluation of processes such as precipitation/dissolution and sorption/desorption which are critical for the acceptance of sediment analysis as a method of metal pollution assessment. This chapter also discusses organic-metal interaction including complex formation and precipitation and sorption of trace metals by organics. An interesting chapter by F. Prosi deals with the uptake of heavy metals by aquatic organisms. The last chapter deals with the removal of trace metals in water purification processes

and the problems of trace metal pollution by specific industrial and waste disposal processes.

The strength of this book is the extensive review of the literature. Over 2100 publications are referenced. Most are from the English literature, but a number of French and German papers are included and the most recent citations are 1979. Although four authors and colleagues contributed to this book, a coherent, if dry, style persists throughout. The text is essentially free of errors and clearly reproduced. Considerable use is made of reduced point size for paragraphs and even pages. This space-saving practice seems to have been applied rather arbitrarily and does not always identify less-significant passages.

Readers with an interest in specific aspects of trace metal pollution may have some criticism of the author's emphasis. For example, discussion of speciation of trace metals does not include the attempts to develop quantitative, predictive models based on thermodynamic calculations and experimental studies. Organo-metal complexing particularly suffers from an all too brief treatment. The work of soil scientists, such as that of Gamble and Schnitzer on humic complexing of metals is not mentioned. Only very brief mention is made of bacteria in the chapter on bio-accumulation of metals.

In reading this book, assimilating the voluminous information compiled is virtually impossible. This is not so much a criticism of writing style but an indication of the bulk of information introduced. As such, *Metal Pollution in the Aquatic Environment* must be considered as a reference text. The $54 US price probably takes this book beyond the means of many researchers. However, as an up-to-date, comprehensive compilation of the literature on trace metal pollution, this book should be acquired by most institutions involved in research or teaching in this increasingly important, multi-disciplinary field.

MS received March 24, 1980

The Musk-Ox

A journal of the north, Publications Nos. 23 (1978) and 24 (1979), Institute for Northern Studies, Univeristy of Saskatchewan, Saskatoon, Canada S7N 0W0
$5.00 per publication for individuals, $8.00 for institutions, companies, and libraries.

Reviewed by H. W. Little
Consulting Geologist
8111 Saunders Road, No. 61,
Richmond, B.C. V7A 4L9

From Erzgebirge to Cluff Lake - a scientific journey through time and *Report on the Cluff Lake Board of inquiry (special issue) Edited by Shirley Milligan.*

The two issues concentrate entirely upon uranium. The first, authored by W. O. Kupsch, although prepared for the non-specialist, is an absorbing, well illustrated review of uranium and its uses, from its discovery as an oxide in 1789 and as a metallic element in 1841 to the present. The discovery of radioactivity and development of instrumentation for its detection are similarly dealt with, and a lucid but simple explanation of nuclear fission and nuclear energy is given. Wartime and peaceful uses of atomic energy are discussed, together with radiation therapy and the hazards of radiation on the human body. This part of the review ends with comments on radioactive dating.

The latter part deals with the history of uranium mining (initially for radium) in Canada, with heavy emphasis on the Eldorado operation between 1933 and 1960 at Great Bear Lake, and subsequent developments in Saskatchewan from Ace-Verna-Fay mine in 1953, Gunnar in 1955, to Rabbit Lake in 1975. Among deposits that are not yet producing but being actively explored and developed are Cluff Lake, Key Lake, and Midwest Lake. A classification of uranium deposits is presented, with impartial discussion of the origin of "veins and fracture-fillings." Recently others have used the term "unconformity-related deposits" for this category, and many are undoubtedly so, but this forces one to include, on the basis of their mineralogy, deposits where there is no evidence of an unconformity, i.e. the presence of the latter must be postulated.

The second issue (No. 24) contains five articles by experts on various aspects of the final report of the Cluff Lake Board of Inquiry. This is particularly appropriate in view of the Government of British Columbia's seven year ban on uranium mining *and exploration*. This ban was imposed while a commission appointed by the provincial government was actively studying the situation, and was made in response to the hysteria of some citizens, largely those living in rural areas. For example, a former colleague was warned he would be shot if he persisted in attempting to collect, on public land, a (non-radioactive) sample of lava for paleomagnetic study!

The first article, by D. V. Bates, reviewed health and environmental considerations. The Board concluded that regulations are adequate for protection of the workers and the public, but Bates had reservations, though he did not offer any solution.

Environmental issues were analysed by J. S. Rowe who took exception to what he regarded as unjustified optimism of the Board's conclusions regarding contamination and safety. He presented a lengthy and well referenced dissertation on "objective adjudication", and the conclusion that the Board was (without meaning to be) prejudiced. J. W. T. Spinks briefly summarized future requirements for uranium waste disposal from mining operations. He regarded the problem as controllable in the short term (25 to 50 years) but in the long term problems could arise that must be forestalled by more elaborate precautions.

Problems of nature and human nature were examined by F. F. Langford who made some interesting points with regard to nuclear proliferation, contamination, and suspicion of scientists by the public. R. M. Bone reviewed at some length, the socio-economic effects on northern people. It was argued that the greatest impact would be on native people who should be compensated by means of employment and a share of royalties.

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Lectures in Isotope Geology

Edited by E. Jäger and J. C. Hunziker
Springer Verlag, 329p. 1979
$27.00 (soft cover)

Reviewed by Christopher Brooks
C.R.E.P.
Département de Géologie
Université de Montréal
C.P. 6128
Montréal, Québec H3C 3J7

This book is based on a two-week lecture course (one week on geochronology, one week on stable isotopes) given at the Mineralogical Institute of the University of Berne in March 1977. The lectures are published in the form of 24 individual articles, the contents of which (4 out of 24 on stable isotopes) do not reflect the original division of lecture time.

The aim of the lecture series was to inform earth scientists, graduate and postgraduate students from Western Swiss Universities on the subject of Isotope Geology. The aim of the book is presumably to inform those of us who were not at the course! As Jäger states the book will appeal less to specialists than to geologists who desire information on the possibilities of isotope geology. Generally speaking she is probably right, but within the volume are some excellent contributions that are worthy references even for quasi-specialists. Unfortunately they are mixed in with some rather less appealing articles.

The 19 articles on geochronology and related topics cover in order: an outdated review of the Rb/Sr dating technique by Jäger; a short but informative account by Hofmann on the Rb-Sr dating of thin slabs; a detailed and interesting resumé of recent advances in the Rb-Sr dating of sediments by Clauer; a very enjoyable article by Hunziker on potassium-argon dating (in which the geochronology of lightly to strongly metamorphosed sediments in Europe is critically discussed); an informative but not very stimulating or critical article on $^{40}Ar/^{39}Ar$ dating in the southern Appalachians by Dallmeyer; two first class reviews of U-Th-Pb dating and isotope geochemistry of lead by Gebauer and Grünenfelder and Koppel and Grünenfelder respectively (these reviews are well illustrated, well organized, do not hide the inherant difficulties in interpretation and are accompanied by excellent lists of references); two articles on fission-track dating by Naeser (1) and Wagner (1), and one on Archaeometric dating (again by Wagner); a succinct and clear review of diffusion experiments in isotope geology by Hoffman; a discussion of cooling ages in terms of diffusion theory by Dodson; a surprisingly comprehensive article on the isotope and trace element geochemistry of the Earth's Mantle in three pages by Hofmann; a "bare-bones" discussion of some aspects of Archean geochronology by Dodson; an illuminating critical appraisal of the geochronology of the crystalline rocks of the Schwarzwald by Hofmann; a somewhat simplistic model for the evolution of the European continent by Jäger; an article on thermal models of the central Alps by Clark, Jr.; and finally a rather unappealing article on the geochronology of ophiolites by Delaloye (they cannot be dated!).

The remaining four papers concern stable isotopes. Commencing with a good comprehensive general review by O'Neil, we progress successively to the individual subjects outlined by O'Neil in three detailed contributions by Siegenthaler (hydrogen and oxygen isotopes in the water cycle), Stahl (carbon isotopes in petroleum geochemistry) and Nielsen (sulphur isotopes). These four papers form a good basis for the non-specialist to acquire information in this realm of isotope geology.

The challenge of this type of book is that it has to start with a bracing introduction of excellent clarity in which not only is the subject matter introduced but also the organization of the book is advanced and the theme(s) delineated. Jäger's introduction does not achieve this. Out of the 19 contributions on geochronology and geochemistry, only 10 are mentioned in the introduction and there is very little liaison or continuity between articles (except for the stable isotope section). If these objectives had been achieved, then the review would have concerned a book. I felt that I had 24 review articles on my desk for examination. Still, this collection of papers has merit and could be useful in undergraduate teaching. However we are dealing with a $27.00 paperback that began to fall to pieces three weeks after I commenced reviewing it! This does not bode well for a student reference text of any type. Apart from that there is a multitude of typographic errors and some very unusual manipulations of the English language by our foreign colleagues.

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Variscan Geohistory of Northern Japan: The Abean Orogeny

Edited by M. Minato, M. Hunahashi, J. Watanabe and M. Kato
Tokai University Press, 1979, 427p.
$50.00 US

Reviewed by J. A. Roddick
Geological Survey of Canada
100 West Pender Street
Vancouver, B.C. V6B 1R8

Although identified only as editors of this large volume (8½ x 12 inches), it was written mainly by Masao Minato and Mitsuo Hunahashi who were responsible, as sole or senior authors, for 33 of the 44 sections. The four 'editors' are professors at the University of Hokkaido in Sapporo, although Minato and Hunahashi have now attained emeritus status. In 1965 these two remarkably productive geologists, along with Masao Gorai, brought forth an even larger volume, entitled 'The Geologic Development of the Japanese Islands', now a classic opus on Japanese geology.

The present volume is not a revised version of the older treatise, which although outdated remains the best generalized description of the geologic history of Japan, but is a much needed elaboration on the somewhat neglected Paleozoic geology of northern Honshu and Hokkaido. This is the region of greatest familiarity to the senior authors both through their own work and that of their numerous students.

The term Abean was proposed by Minato in 1960 for the orogenic movements in northern Japan during the interval spanning Devonian to Late Permian time. It is derived from the Abe tribe who, from strongholds in the Kitakami Mountains in northeastern Honshu, successfully defied the armies of the central government until the twelfth century. The timespan of the Abean Orogeny is similar to that of the Variscan in middle Europe except in Japan the region affected did not become stable at the beginning of the Triassic. Instead, the late Paleozoic orogeny was soon followed by geosynclinal development and further movements which culminated in the Honshu orogeny in Early Cretaceous time.

The book is divided into four parts; the first deals with the basement complexes. Early in the Meiji Era (1868-1912) Japanese geologists became aware that some of the gneisses may represent Precam-

brian terrane, but the matter remained in dispute until about 1967. Since then a few isotopic dates have been obtained ranging in value from 600 to 1200 Ma, mainly from the Hida Mountains of central Honshu. Most Precambrian dates, however, have been obtained from granitic and gneissic clasts in the Triassic Kamiaso conglomerate which crops out south of the Hida Complexes. The clasts yield dates from 1000 to 2000 m.y. and fall into groups which can be correlated with Precambrian terranes in China and Korea, but are not easily correlated with rocks of the Hida Complex. In northern Japan Precambrian ages have not been obtained, but some of the gneisses are thought to be mobilized Precambrian basement which now yield Paleozoic or younger ages.

Unmetamorphosed Paleozoic strata are described in considerable detail in Part II, mainly by Minato although Kato is responsible for the paleontological information. Excellent plates of the relevant fossils form a major part (92 pages) of this section. The Paleozoic strata are grouped into three sections: Silurian to Lower Mississippian eugeosynclinal deposits; Upper Mississippian and Pennsylvanian pelitic sediment and carbonate which form a kind of flysch; and Permian conglomerate, slate and sandstone which form the molasse.

The third part deals with Abean metamorphism and plutonism and is written almost entirely by Hunahashi. The metamorphic belt, which underlies the Abukuma Mountains, is divided into a low-grade section on the Pacific side and a high-grade section to the west which consists mainly of metasomatic rocks. The main disputes about these strata concern the significance of the glaucophane-bearing rocks, which are difficult to interpret because of their erratic distribution, and whether or not Miyashiro's concept of paired metamorphic belts is applicable to the Abukuma Mountains. Paleozoic plutonism is not significant; the only Abean plutons are very small granite bodies restricted to the high-grade metasomatic rocks.

Part IV deals briefly with post-Abean strata and orogenic movements in northern Honshu, as well as the Cretaceous granitic rocks which form large plutons in the area.

The many figures include page-size maps, correlation charts, rock specimen photographs, photomicrographs, and chemical variation diagrams, and most are well-done. This reviewer would have appreciated an index map of placenames used in the text.

This volume is more descriptive and less interpretative than the volume on the geologic development of the Japanese islands. It does not attempt the grand scale of the older work, yet for a number of years it will be probably the best available treatment of the geology of northern Japan. The writing throughout has a uniform style which indicates a thorough and generally good rewrite job by the person engaged to handle the translation. Considering the high-grade paper and the quality of the many plates the U.S. $50 price is not out of line with current publications.

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Positions Available