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Book Reviews

The Abyss of Time: Changing Concepts of the Earth's Antiquity after the Sixteenth Century

By Claude C. Albritton, Jr.
Freeman, Cooper and Co., 251 p., 1980
\$12.75

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From the marginalia in his bible, an eighteenth century Christian would know that Creation had occurred in the year 4004 B.C.; for so James Ussher, Archbishop of Armagh, had calculated. Moreover, thanks to the even more refined scholarship of Dr. John Lightfoot of Cambridge University, such a Christian would know Creation Week to have been October 18th to 24th of that year, the ultimate birthday of mankind beginning with the creation of Adam on October 23rd at approximately 9 a.m., forty-fifth meridian time. What could be more precise and satisfactory?

Unfortunately, that date could not nowadays be maintained even on the basis of biblical scholarship, for the Masoretic text on which Ussher and Lightfoot based their calculations is, we now know, both late and corrupt. The Samaritan targum would make the year of Creation 4710 B.C., the Septuagint 5872 B.C., and other texts furnish other dates.

Not even the addition of almost 2,000 years to this scriptural computation would satisfy the geologist of today however; for as we now recognise, the age of this Earth is incomparably vaster than 8,000 years. In four centuries, knowledge of the planet on which we live has necessitated almost a million-fold inflation of the time framework necessary to accommodate its formation and shaping.

It is the story of the growth in geological knowledge during these centuries that this book tells.

Appropriately enough, it begins with the work of Niels Stensen of Denmark, self-styled 'Nicolaus Stenonis', whose brilliant interpretations of the rocks of Tuscany and subsequent austere conformist religious life place him very precisely on what Arthur Koestler has called "the watershed" between mediaeval and modern thought. In subsequent chapters, the progressive evolution in comprehension of the processes of rock and sediment formation and the progressive development of the basic techniques in stratigraphy are lucidly outlined. It is shown how a growing understanding of those processes forced geologists to recognize that they could not be accommodated within the constraints of the Ussher/Lightfoot chronology. To be within set bounds is, for most people, comfortable; the biblical time frame, though long, had been within the grasp of most men. Instead, they found themselves on the brink of what seemed an unplumbable abyss of time - a 17th-century image which gives this book its title.

The earlier part of this book recounts the investigations that led to the recognition of that abyss and the later tells the story of the finding and testing of the scientific tools that have enabled it to be plumbed. The pace of the story mounts as the book progresses. Its first 174 pages show how concepts widened up to the time of Kelvin; 26 pages explain how Kelvin's discoveries seemed to force a considerable closure of that abyss of time; and, 21 more pages, developments from the beginning of this century to the present are summarised. Some readers may consider this acceleration in the telling of the story to be appropriate, for indeed the pace of new discoveries has correspondingly accelerated. Personally, I regret it, for the charm and clarity of the earlier text has been forfeited in the process and the last two chapters are no more readable or memorable than similar

accounts in any average text book on geology. Furthermore, the development of stratigraphic techniques and concepts after 1852 is barely hinted at: yet this development has enabled the making of those correlations and summations of strata that provide the framework for radiometric dating.

It is thus the earlier part of the book from which readers will derive most pleasure and imbibe most information. The story of the work of Steno, Hooke, Burnet, de Maillet, Buffon, Hutton and Smith has been told often, but rarely with such stylistic grace and lucidity. Scrope and Kelvin will be less familiar names to most readers; the summarizing of their work is thus especially welcome. I found the spirited defence of Hooke refreshing and the epitome of Darwin's evolution concepts, as expressed in *The Origin of Species*, admirable. I noted only three errors - the French pioneer of stratigraphy was Giraud, not Gerald, de Soulavie (p. 104); Charles Lapworth was an Englishman, not a Scot (p. 125); and Darwin's residence is correctly called Down House, not "Down Cottage" (p. 166) - but this is a low number indeed in a work of such broad compass. ("Quaternary", on p. 123, is presumably merely an undetected misprint). I found disappointing the fact that John Joly's work in estimating the age of the earth gained only two passing mentions (his results, though incorrect, were extremely influential and merited fuller analysis) and I would have liked a fuller treatment of the way in which radiometric dating techniques have been refined in recent decades.

Yet these criticisms are minor. Here is a book which is enjoyable as well as being informative. This is a rare combination indeed in the present age, when both authors and editors seem mutually to strive to render most geological works turgid and tedious by overloading them with facts and firmly deleting any graceful passages or felicitous images. It deserves to be on the shelves of all geological libraries - or, rather, to be taken

often from those shelves and read. Maybe you won't agree with all of Dr. Albritton's conclusions: maybe it is not a work of definitive historic scholarship; but after all, histories necessarily reflect a viewpoint - otherwise, they are valueless - and no history is ever definitive.

However, the reader is posed with a problem that might disturb him. Over four centuries of geological discovery, we have gained greatly in our understanding of the world in which we live; yet we have also, at an accelerating pace, despoiled it. How well we are *using* the understanding we have gained? There was much comfort in that 7,000-year time frame: have we such comfort now?

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A Concise World Atlas of Geology and Mineral Deposits

By Duncan R. Derry
Mining Journal Books Limited,
London, England, 1980
(Available in Canada from
P.D. Meany Co., P.O.B. 534,
Port Credit, Ontario L5G 1J8
 \$65.00

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This long-awaited Atlas, compiled by the dean of Canadian mineral deposit geologists, describes and depicts the distribution of the world's metallic, non-metallic and energy minerals in their geological settings. It seeks to serve the needs of interested lay people, students and professional earth scientists. Although it may fall a little short in conveying its important messages to the first of these groups, it is a handsome book that will find a useful place in many personal libraries, particularly those of professionals. As Sir Kingsley Dunham points out in his preface, it is a timely Atlas, the first to take account of the impact of two recent, major trends of thought: the breakthrough in global tectonics and the widespread realization of the finite nature of our non-renewable resources. And, as author Derry points out in his introduction, it will give many professional geoscientists an opportunity to augment their knowledge of regions outside of their areas of specialization.

The first part of the Atlas is an introduction to geology which is designed to make the second and major part, the maps and descriptive text, intelligible to readers with little background in geology. Condensed as it is to 20 pages, it is unlikely to enlighten the novice - especially the sections on plate tectonics and volcanism. The introduction will prove most useful to those with some background in geology, especially those who have allowed their reading to lapse in one or other of the basic aspects of geoscience.

The second, principal part of the Atlas consists of seven double and three single page map sheets that, together, cover all the land area of the world. The author has chosen not to break major geological features by artificial boundaries. This has necessitated use of different scales, thus North and South America are shown together on a double page sheet, at 1:27,300,000, to preserve the integrity of the Cordillera. Other scales vary from 1:7,500,000 for Northern Europe to 1:30,000,000 for Antarctica. Projections also vary to achieve the truest outlines for the land areas of each sheet.

The maps are attractively drawn, simple and informative. Seven bold colours effect the division of supracrustal rocks into eight principal time units which stress the isotopic age ranges that conform to Early, Middle and Late Precambrian, Early and Late Paleozoic, Mesozoic, Tertiary and Quaternary. These units are unfortunately referred to as "periods" and the legitimate periods of the Paleozoic and Mesozoic, shown in smaller print, are labelled as 'subdivisions'. Three or four intrusive units are also depicted: pre- and post- 700 m.y. granites, basic intrusions and, on some sheets, ophiolites. Major mineral deposits, denoted by chemical symbols of the important elements, are shown in red lettering. Brief notes, also in red, describe their past or present importance. Producing gas, oil and coal basins are outlined by red boundaries, some offshore prospects (but not Canada's east coast) are also shown. Large lakes and rivers are shown in blue, political boundaries and cities in a subdued but easily readable grey. Many more cities could have been shown, particularly on the large scale maps (e.g. of Europe) and would have been helpful in relating geology and resource features to known points. This could have been a boon to travellers who might take the briefcase-sized Atlas with them on their wanderings in foreign parts. Despite such minor criticisms, the maps are pleasingly uncluttered and present a clear picture of the relationships of mineral and energy

deposits to age and types of rocks and to plate boundaries.

The text accompanying each map sheet follows a pattern - beginning with an introduction which summarizes the tectonic history of the region and points out similarities, differences and former links with regions depicted on other sheets. Then follows a brief history, approximately following the legend units, starting with the pre-2500 m.y. old rocks and working through to the Present. Major stratigraphic, structural and igneous events are described briefly and the settings of important energy and mineral deposits well-covered. Dr. Derry varies his pattern to suit the circumstances. Thus, in discussing the Southern Asia sheet where two major components were widely separated for most of their histories, he treats each separately as "Original India" and "Original Asia" up until the 65 m.y. age section when the beginning of the collision process that formed the Himalayas permits him to treat them together as a single unit.

Geological data and interpretations are remarkably up to date. For example, there is a short but precise discussion of the Messinian Event, some 6 m.y. ago, when the Mediterranean basin received its enormous content of evaporites as it occupied a Dead Sea type of environment on an immense scale. Fascinating little historical notes also enliven the text. The reader learns that copper deposits were first worked in Anatolia in 4500 B.C., the Hittites who later occupied this area were leaders in copper metallogeny and produced the first iron artifacts - some of which later ended up in King Tut's tomb.

The text is generally well written, carefully edited, and very readable for anyone with some geological background. I was annoyed by a few practices, e.g., except in the map legends, the adjective "intrusive" is used as a noun. Also, the discarded terms "acid and basic" are used instead of "salic and mafic" It must be jarring to non-geologists when these sins are compounded and the term "acid intrusives" is used to refer to the sodium- and potassium-rich aluminum silicate intrusions which laymen know as "granites". Also, for smooth reading it would have been worth adding a simple "ago" to phrases such as "... when the orogeny ended about 2700 m.y." or "... ophiolites thrust onto continent about 70 m.y."

I have tried the text out successfully on a senior draftsman, a mechanical engineer and a chemist, all of whom had some backgrounds in geology. Less successful attempts were made to interest a

nurse, a librarian, an accountant and an economist. They were initially attracted by the dramatic dust jacket design, the colourful maps and the appendix on mineral resources. The text did not hold their attention, however, with its discussions of "the spasmodic convergence of plates" and the relationship of hot spots to convection currents within the asthenosphere. Also, it is astounding how many otherwise informed lay people are unfamiliar with most of the chemical symbols for the elements which the author uses to denote mineral deposits. Those who will most appreciate and benefit from this Atlas are the professionals and those on the fringes of geoscience. Let us hope that there are enough of each in senior policy-making positions to appreciate the main messages of such a book - namely that world mineral and energy resources are very unevenly distributed and that geological factors control their genesis and location.

The cost is high for a 110 page Atlas but not outrageous in view of the high quality of production. It makes an ideal gift for a retirement, graduation, birthday or other signal of appreciation so, if you feel you can't afford it, drop hints in the right places. It will not only attract attention on your coffee table but you will find it a publication that you will refer to frequently both for pleasure and profit.

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Early Diagenesis: A Theoretical Approach

Robert A. Berner
Princeton Series in Geochemistry,
241 p., 1980
\$25.00 U.S. (hardcover),
\$9.50 U.S. (paperback)

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This second book by Berner is much more specialized than *Principles of Chemical Sedimentology* which was published in 1971. In the introductory chapter thermodynamics and observational methods are lumped together as "qualitative", while kinetic processes are described as "quantitative". I might disagree with this statement, but it does warn the reader that the kinetics of various diagenetic processes is the major topic in this book.

A general diagenetic equation is developed in the second chapter. The formulation is easily followed and provides insight to processes we take for granted. Physical (compaction) and biological (bioturbation) processes and porosity-depth relationships are covered in chapter three. Mathematical equations for the age of a layer, rate of compaction, water flow due to compaction and total water volume flow through a layer since deposition are developed.

In chapter four, equilibrium processes, homogeneous reactions and microbial reactions are covered. A very terse survey of thermodynamics and aqueous chemistry is followed by a discussion of absorption and ion exchange. Dissolution, precipitation, authigenic mineral growth and replacement are the subject matter of chapter five. The approach of George Fisher (*Rate Laws in Metamorphism*) is applied to the processes of cementation and replacement. Simple, elegant models explain the common observation that fossil fragments and grain contacts provide sites for nucleation of grains.

The second part of the book has three chapters in which the principles developed are applied to actual examples. Marine continental margins, pelagic deep-sea sediments and non-marine environments are studied both in the bioturbated and non-bioturbated zones. First order kinetic models which assume steady state diagenesis are applied to sulfate reduction, methane, phosphate,

ammonium and pyrite formation. The section on carbonate dissolution includes a useful explanation of the lysocline and compensation depth. Dissolution of biogenic silica, radio isotope diagenesis and volcanic-seawater interactions conclude the chapter on deep-sea sediments. Non-marine sediments are given only limited coverage.

On the negative side my opinion is that the book suffers a little from the way topics are organized, the restriction of discussion to a very specific approach to the problems of early diagenesis and some minor difficulties in keeping up with the nomenclature in the mathematical developments. These few negative points are compensated by the laudable practices of listing all the assumptions before each topic is covered and drawing heavily on other published work to develop topics to their fullest.

The book provides a useful framework for the planning of research programs and should help to avoid the "data for data's sake" problem. While the book would probably be too specialized for use as a textbook in most graduate courses, it would be a useful addition to any graduate student's or researcher's library, and for the price, is a real bargain.

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Hypersaline Brines and Evaporitic Environments

Edited by A. Nissenbaum
*Elsevier Scientific Publishing Co.,
 Developments in Sedimentology 28,
 270 p., 1980
 \$48.75 U.S.*

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Brines are of increasing economic importance as sources of minerals and as potential solar-energy collectors. This was recognized in 1977 by holding an international seminar on "Saline Lakes and Natural Brines". Seventeen (just over half) of the papers presented are included in the present publication. Topics covered are varied and include brine geochemistry (4 papers), physics (1 paper), biology (2 papers), heliothermal lakes (2 papers) and 5 papers concerned with Recent evaporitic environments (North Sinai, Dead Sea, Lake Magadi (Kenya), Red Sea). There are also articles on the environmental effects and human consequences of variations in the level of saline lakes, the alteration of volcanic sediments in the saline environment, and Silurian evaporites of the Michigan Basin - the last being somewhat out of place in this collection. It is unfortunate, given the rationale for the meeting, that there is no paper that deals with economic aspects of saline lakes.

The foreward states that the volume is not intended as a treatise on saline lakes but is to present "to the initiate and uninitiate (sic) alike, a taste of this fascinating environment" - editor's pun probably intended!

There is no introductory overview paper and the scope of papers is varied and uneven. Some papers are reviews, some present new data upon specific topics, whereas others revamp and summarize earlier papers written by the authors without adding new information - hardly a laudable practice. Commonly research papers do not contain discussions of the wider relevance of their subject material and indeed most papers lack abstracts, some summaries also. The book therefore is exactly what it professes to be, a collection of papers given at a seminar with no attempt to be inclusive or, it seems, to make the contents relevant to sedimentologists other than those few who work upon saline lakes. It is questionable whether the 'need' to publish

seminar proceedings is a sufficient reason for this book. It is difficult to discern to what general audience the book is directed for most papers are repetitions of previously published material or are at too high a level to be introductions to their topics. For the sedimentologist who wishes to interpret ancient evaporites there is little that is immediately obvious. There are, however, four exceptions to this: the Silurian evaporite paper, two dealing with recent changes in the Dead Sea - changes that have destroyed the brine stratification and allowed precipitation and preservation of bottom gypsum and halite (important because some have used the stratified Dead Sea analog to argue that deep-water evaporites are impossible), and a useful summary paper by Eugster on the classic alkaline Lake Magadi that includes new data. In addition, Stern's paper on "Mixing in stratified fluids" should be required reading for all those constructing depositional models for subaqueous evaporites.

The editing and organisation of the book leave much to be desired. I can find no rhyme nor reason for the arrangement of papers and similar topics may be widely separated. With few exceptions there is no cross-referencing of papers and this is particularly noticeable where reviews fail to refer to research papers on the same subject located elsewhere in the volume. The text is replete with minor errors and some figures are poorly identified.

I conclude that, unless you are a specialist upon saline lakes, this book is probably not for you. Those interested in evaporites, however, might profitably browse through a copy at their university or company library.

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The Terrestrial Environment

Edited by A.P. Fritz and J.-Ch. Fontes
*Elsevier, Handbook of Environmental
 Isotope Geochemistry, Vol. 1,
 545 p., 1980.
 \$90.25 (Dfl. 185)*

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Introduced in the geological sciences about 30 years ago, isotopic geochemistry has contributed considerably to their

development, especially in the fields of hydrology, hydrogeology, magmatology and paleoclimatology. Several comprehensive introductory books have been published during the '70's. No effort has been done, however, to publish a book presenting with great thoroughness all the various applications of isotope geochemistry.

The Handbook of Environmental Isotope Geochemistry, which will later contain 5 volumes, comes at an appropriate moment to satisfy this need. The first two volumes will deal with the terrestrial environment, the following two with the marine environment and the last one with the high temperature environment.

In the first volume, P. Fritz and J.-Ch. Fontes have assembled 12 review articles written by 16 well-known geochemists. An introduction recalls the basic concepts, definitions (especially of the standards used in isotopic geochemistry) and key isotopic equilibria. The following chapters illustrate, with often very interesting examples, the possible applications in the fields of hydrology, hydrogeology and glaciology. The third chapter, especially, can be considered as the most complete review published up to date, on the subject of Environmental Isotopes in groundwater hydrology. One also notes, articles on geothermal systems, on sulfur and nitrogen isotopes in natural environments, on oxygen and hydrogen isotopes in low temperature mineral-water interactions and in paleo-lacustrine environments. Finally, a very complete chapter discusses organic carbon in plants, sediments and fuels. This book can be recommended as a basic reference for any geochemist (graduate student or specialist), in so far as it presents the state of the knowledge in the low temperature isotopic geochemistry of continental environments. One of its merits is to enable the researcher to cut through an ordinarily very fastidious bibliographic search through thirty years of publications in each field of application. The references at the end of each chapter offer a very helpful bibliographic selection on each topic even though some reiterations from one chapter to the other lengthens the work. This book is an excellent investment (despite its rather high cost).

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