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Book Reviews / Critique

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Book Reviews

Submarine fans and related turbidite systems

Edited by A.H. Bouma, W.R. Normark and N.E. Barnes
Springer-Verlag Inc., New York
351 p., 1985; $59.00 US, cloth

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This book is the first in a new series to be published by Springer-Verlag Inc., entitled *Frontiers in Sedimentary Geology*. The series editor, A.H. Bouma, explains in a preface that the series will aim to provide monographic treatment of three types of subject matter: topical studies in areas of active research, regional studies, and interdisciplinary investigations involving the application of many lines of evidence to examine selected research problems. These three areas are not clearly separable and, in fact, this first book in the series could be said to combine all three.

The book developed from an important initiative of Bouma's to establish an informal research committee with the military-sounding name "COMFAN", the COMmittee on FANs. This group of international specialists was first brought together at an informal symposium in September 1982. From the proceedings of the meeting a special issue of the new journal *Geomarine Letters* was put together. At the same time planning was in progress for DSDP Leg 96, a cruise designed to carry out geophysical surveys and drilling on the Mississippi Fan. The activities of COMFAN seem to have been of considerable value in planning this leg. Two-thirds of this book represent an expanded and updated version of the initial COMFAN report, and the other third of the book is devoted to a presentation of many of the detailed results of this highly successful cruise.

It must be said at the outset that this is by far the most significant publication to deal with submarine fans that has yet been published. Sedimentologists, petroleum geologists and others will be digesting its contents for years to come. The strength of the book lies in its presentation of vast amounts of detailed information about numerous modern fans. The amount of this kind of information now available has mushroomed in recent years because of the rapid development of geophysical surveying techniques, better marine navigation, and the application of DSDP drilling technology. Foremost amongst the new geophysical techniques is sonar, which can now provide us with detailed pictures of submarine surface form much like the aerial photographs of subaerial landforms that have been so useful to students of non-marine environments.

The book opens with seven introductory chapters, which review various aspects of the COMFAN work, discuss sedimentary controls on fans, and examine the various problems with existing facies models. I personally found the most useful of these chapters to be the one by G. Shanmugam and R.J. Moiola, entitled "Submarine fan models: problems and solutions". Here they tackle some of the prevailing myths about submarine fans, such as the idea that particular facies assemblages are always associated with certain physiographic components of the fan, and *vice versa*. The pioneering work of E. Mutti and F. Ricci Lucchi on the Italian Cenozoic fan sequences has been frequently employed in this kind of over-simplification. The Italian workers themselves come under some much needed criticism in this chapter, for their invention of highly confusing terminology for two contrasting styles of fan sedimentation. I refer to the concept of the "highly efficient" and "poorly efficient" fan. Shanmugam and Moiola clearly illustrate the contradictions and confusions that have arisen from the introduction of these terms. The preceeding chapter, written by the same two authors, together with J.E. Damuth, examines the eustatic control of fan development. There is increasing evidence that fans grow most actively during times of low sea level, and these authors document this by plotting the occurrence of major fan deposits and associated facies against the familiar "Vail curve" of coastal onlap (which purports to be a record of eustatic sea level change). The coincidence of fan deposits with indicated episodes of low global sea level seems almost too good to be true. Avid readers of book reviews in *Geoscience Canada* will be aware of my suspicions about the Vail curves, and the ease with which everything can be made to fit them.

Sixteen modern fans, of various sizes, and in various tectonic settings, are described in the next two sections of the book. The descriptions are all illustrated with detailed maps showing surface form, constructional features (such as channels and levées), sediment grain size, channel dimensions, fan gradient and, in a separate map, bathymetry. The maps are all drawn at different scales, because the fans themselves vary enormously in size, but the use of a standard mapping style facilitates comparisons (all the maps were drafted from the authors' originals at Gulf Research and Development Company). Thumbing through these maps one is impressed by the great variety in shape, as well as the huge variations in size, of these fans. The latter point is well made by N.E. Barnes and W.R. Normark who state "the area of the Indus Fan is about one-third greater than the state of Texas, while the Navy Fan would easily fit inside the submarine canyon feeding the Bengal Fan". The Navy Fan is about 15 km long, whereas the Bengal Fan is 3000 km in length! Very few of the fans are actually fan-shaped. Most are elongate, or some more complex shape, as a result of basin configuration and the constraining effects of local tectonic features. These data are themselves an enormously important advance on existing concepts about submarine fans, such as the simplified (and stultifying) fan facies models used to teach undergraduate students. They should provide a considerable stimulus to research. However, actual lithofacies data for most of these fans are still sparse, so that their use in interpreting the ancient record remains limited. This is where the section of the book dealing with the Leg 96 results is so important. More on this later.

The next two sections of the book describe a total of twelve ancient turbidite successions. I found this part of the book much less satisfying to read, because in most cases the authors had not been able to make any really substantial contributions to the development of ideas about fan sedimentation. Some of

the examples are strongly folded, or are dislocated by strike-slip faulting, making even the most elementary paleogeographic reconstructions difficult.

The final section of the book consists of twelve chapters devoted to a detailed description of the Mississippi Fan. Most of the data were collected during DSDP Leg 96, and most, but not all, of the twelve chapters are written by the Leg 96 scientific party. Nine holes were drilled on the fan. Core recovery was variable, being best for the upper 80-90 m of the sediment column. Most holes were logged using standard petroleum exploration geophysical methods. The drilling data are supplemented by shallow seismic records and by sonar records. This three-dimensional, multi-faceted study qualifies the Mississippi Fan as the best known modern submarine fan in the world. We are likely to see history repeat itself, in that for many years the Mississippi Delta was the best known and best studied *delta* in the world so that, as a result, it became a standard for sedimentologic study. In recent years authors of reviews on deltaic sedimentation have had to point out that the Mississippi analogue is a very inappropriate one to use for many ancient deltaic sequences, because marine conditions and basin setting are commonly very different from those of the Gulf of Mexico. One wonders how long it will be before the same warning is voiced with regard to the Mississippi *fan*.

In the meantime sedimentologists, petroleum geologists, and others concerned with sedimentation in the deep oceans should read this section very carefully. The records confirm in some detail a surprising feature about submarine fans that has become increasingly clear in recent years — their similarity to fluvial systems. Maps of fans produced from sonar records (including several in this section showing the Mississippi fan) show meandering channels, ridge and swale topography, point bars, crevasse splays and overbank areas. Detailed vertical profiles showing lithofacies characteristics, now available for the first time from a modern fan, reveal fining- and coarsening-upward cycles very similar to those occurring in fluvial systems. Such cycles have long been a part of our mythology about fans and many have, in fact, been documented in ancient fan sequences; but there has been considerable doubt about their true origins, because it has rarely been possible to locate the cycles accurately in their correct physiographic context. The combination of seismic, sonar and drilling records from the Mississippi fan now permits such an analysis, and the results are fascinating. The cycles are shown to result from a combination of channel aggradation and migration processes, and from the processes of gradual channel and fanlobe abandonment. As with their fluvial counterparts, there are few, if any, diagnostic criteria with which to separate these various mechanisms, except a combination of careful regional studies and detailed local analyses. Data for the Mississippi fan are now beginning to approach this point. The major puzzle remaining is *why* submarine fans should show such fluvial characteristics, if their major sediment transport mechanism is not traction currents, as in rivers, but sediment gravity flows?

The book closes with a brief chapter written by the editors summarizing some of their concerns about the terminology used for submarine fans, and warning against the erection of any new "unifying" fan models until we have a much better data base. A fold-out chart in a back pocket in the book provides a repeat of the physiographic maps for thirteen of the modern fans. On the other side of this chart is a diagram comparing the sizes of these fans, and a table listing the basin setting, physical dimensions, and sediment types of 31 modern and ancient fans.

The book is attractively produced and, as far as I could tell, free of error. It should be required reading for all petroleum geologists, advanced sedimentology students and other basin analysts.

Inside the Earth: Evidence from Earthquakes

By Bruce A. Bolt
W.H. Freeman and Company, San Francisco
191 p., 1982; $24.95 US, cl.; $12.95 US, pap.

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This is the third of an informal series of books produced by Bruce Bolt and W.H. Freeman and Company. The first, *Nuclear Explosions and Earthquakes* (1976) dealt with the use of seismology to detect and monitor nuclear explosions. The second, *Earthquakes: A Primer* (1978) was an introductory text to the study of earthquakes, their causes, and their effect on humankind. Both of these books were written for the educated layperson or the student at a junior undergraduate level. This book follows similar lines, but possibly because of its subject matter, is not quite as successful as the two earlier books.

According to the preface, this is a book for those who are curious about the nature of the Earth's interior. As the subtitle suggests, the book concerns itself with the interior of the Earth as deduced through seismology, and to a large extent ignores other geophysical and petrological clues to the nature of the Earth's interior. This is a blessing and a flaw. If you are teaching seismology, it makes a strong presentation of that science. If you are looking for a complete picture of what we know about the Earth's interior, then you will be disappointed.

The concept of the book is good, for not only does it outline our present state of knowledge, it explains, to a certain extent at least, the logic and methodology by which this state of knowledge has been attained. The material in the book is current, and the book is still up-to-date four years after publication. The book is shorter than it seems, as the last 30 pages consist of a section on problems and exercises, an appendix, a follow-up reading list, and an extensive index. Mathematics have been kept to a minimum, and the book is well illustrated. Detailed explanations are outlined in several "boxes" scattered throughout the book, improving the flow of the book. The book was intended by the author for use by students and non-specialists.

There are a few negative points to the book, however. For one, the author seems to be too close to the subject at times, and often loses the reader in small digressions or detailed explanations which are out of place. Much of the material on the history of the subject and the types and measurement of earthquake waves (Chapters 1-3) would be better placed in an appendix, or condensed. Although some of this material is needed to understand the main chapters of the book on the interior of the Earth (Chapters 4-7), it most likely will cause all but the dedicated reader to give up before reaching the heart of the book. As a minor point, the text does not flow well. It seems that each chapter at one time constituted a one- or two-hour lecture on the topic, and this lecture style persists in the book version. Finally, it is not clear to whom this book was intended. There is too much jargon and science in this book for the educated public. By non-specialist, the author apparently means scientists in other disciplines; by student, a first- or second-year undergraduate in Earth Sciences or Physics. This is unfortunate, as I think with some minor changes and editing, the author could have written a book more easily read by a larger audience; as he did in the first two books.

Alone, this book could serve as a supplementary text in an introductory course on seismology, particularly if the teacher wishes to show methodology and approaches as well as facts. The book could also be combined effectively with a laboratory course; for example, Chapter 3 could be used to introduce students to seismograph records, followed by a hands-on approach in the remainder of the lab. Other chapters could be used similarly. The reasonable cost of the book enhances its use as a supplementary text in introductory courses in seismology or the structure of the earth. Although not of interest to most *Geoscience Canada* readers, it is a useful addition to any earth science laboratory.

1985 Geoscience Software Directory

By Computers for Professionals
IHRDC Press, Boston
125 p., 1985; $45.00 US, paper

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If one has decided that a computer would be a useful tool for solving some problem, there are two basic approaches which may be considered. If the problem is a fairly common one, it should be possible to find an existing program which provides a solution. Unusual problems will require custom programs. In general it will prove much more efficient to use the first approach; coding programs can take a great deal of time, and if one considers the dollar value of that time, most commercially available programs appear quite reasonably priced. Even the solution to an esoteric problem may often be broken down into subproblems, many of which can be dealt with using available tools, and only a few of which require special coding.

In order to use existing tools it is necessary to know what is available for the machine one wishes to use; if a machine has not yet been selected, one criterion for making a choice should be the set of useful programs available for each of the candidates. Most major computer vendors, or their associated user groups, have directories of software of general interest for users of their equipment. Retailers and local user clubs may also be good sources of information for users of microcomputers. While these sources may not have a lot of information on specialized applications, they should certainly be consulted. Generally useful software is exactly that.

Although such sources will be extremely useful, it is encouraging to see the publication of more specialized listings, such as the present volume, which describes approximately five hundred programs of particular interest to people working in the geosciences. Unfortunately, both the content and the presentation leave a great deal to be desired.

There is a primary listing of programs, in alphabetical order by application, each entry in which generally includes the price of the program, the name, address, and telephone number of the publisher, a brief description of the program function, and an indication of hardware and support software requirements. An addendum, in the same format, gives information on programs which supposedly were published after the bulk of the book had gone to press, although one of these was found to be an exact copy of the entry in the first list.

A second list gives, for each application, all the programs and publishers, as well as the corresponding page numbers in the first listing. Since the order of the applications, and for each of them the order of the programs, is the same as in the first list, this amounts to nothing but a condensation. It adds no real value to the book, despite the fact that it accounts for a quarter of the content. It doesn't help that the page number cross references are two less than they ought to be.

The usefulness of both sections is limited by the choice of application categories, or more accurately, the complete lack of choice. It appears as if the selections were made by the program publishers individually, with no attempt by the editors to rationalize the results. Therefore the 483 programs in the first section appear in 208 categories in the second. Twenty-three of these categories begin with the word accounting, or some contraction thereof, for example:

"accntg. for oil & gas"
"accounting - oil & gas"
"accounting oil & gas"
"accounting oil/gas"
"accounting systm.oil/gs"
"accounting-oil/gas"
"accounting/oil & gas"
"accounting/oil/gas"
"accounting:oil/gas"
"acctng. for oil & gas"

The program descriptions are also not well done. This is partly due to the fact that they are limited to about thirty words, with the result that they contain little useful information, or are very difficult to read, e.g.:
"EXPL.DTA.MGMT.SYSTM. DESIGNED TO HANDLE BASEMAP DATA, SEIS. SURVEYS, WELL LOCATIONS, FORMATION TOP FILES, CHECK SHOT DTA SEIS.INTERPRETNS., STACKING VELOCITY,MDLS, SURFACE GRIDS,ETC."
Also the descriptions are in a column with no white space on either side, so that the descriptions are frequently run together with publication data on one side, and hardware/software requirements on the other, which makes them more difficult to read. In many cases, these problems are neatly avoided by giving no description at all. Also frequently missing are addresses or telephone numbers, although never both. The frequent omission of prices makes comparisons more difficult. Considering all of these omissions, a blank in the requirements column begins to look rather suspicious: one is probably not justified in assuming that this means that one need nothing but a basic machine with no special features, which is not a well-defined entity to begin with.

Other shortcomings include duplicate listings, typographical errors, and a lack of evaluations. Furthermore, the entire text was printed by computer, on a dot matrix printer, using condensed block capitals for everything except the column headings, which do include lower case letters. All of this makes what information there is even less accessible than it might be.

There are a number of anomalies in the choice of programs: a number of database packages, but none of the better-known ones; spreadsheet templates, but no spreadsheets or commonly available templates; one programming language, muLISP-83, but none of the more common ones, such as FORTRAN or Pascal, which are actually required in order to use many of the listed programs. While many of the programs are reasonably priced, some costs seem outrageous. The worst example found was a package for dealing with geophysical data, for which which the publishers were asking US$100,000, ten to twenty times the cost of the machine which would probably be required to run it.

This book was put together by a company of geoscience computing consultants. It appears that these so-called editors felt they could augment their income by taking whatever information they had on hand, having a computer format it for them, sending it out for printing and binding without looking at it, and charging fifty times what the final product is worth.

The Outcrop Quiz

By John Wright
Allen and Unwin Ltd., Winchester
62 p., 1986; $7.95 US, paper

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This book is a collection of black-and-white photographs of rock outcrops. Each photograph is accompanied by a series of questions about the outcrop, which serves as the "quiz" for the reader. Answers are provided in the back of the book for those who want to score themselves, or the baffled. The book is suitable for student and classroom use, but it can also be used to challenge even the most skilled geologist. And, at a price of $7.95 US, it is even affordable.

I have only two minor complaints about the book. First, the author does not indicate where the photographs were taken. I spent a lot of time trying to guess where some of these classic outcrops were. This is as much of a quiz as identifying the geological features. The second complaint is that, as usual in geology, not all features shown in the outcrops are unequivocal. For instance, outcrop photograph 36 is described in purely sedimentological terms. However, the photograph looks like the Uwekahuna Laccolith from Hawaii which is of igneous origin. Here, a location would aid in resolving this confusion. Fortunately, equivocal examples such as this are few.

Overall, this book is a very worthwhile buy, whether for personal use or classroom instruction. Give it to your favourite geologist for Christmas or other special occasion.

Down to Earth. One hundred and fifty years of the British Geological Survey

By H.E. Wilson
Scottish Academic Press
189 p., 1985, £9.50

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The British Geological Survey, formerly the Institute of Geological Sciences and for much longer Her (or, at times, His) Majesty's Geological Survey, has had the longest continuing existence of any national geological survey, for it is now in its 151st year. The Survey came into being in 1835 as a one-man unit within the Ordnance Survey, founded by the Board of Ordnance to produce reliable maps of the British Isles for military purposes. Moveover, it had still earlier precursors, for John MacCulloch had served as first Geologist to the Ordnance Trigonometrical Survey from 1814 till his death in 1826; Capt. John Watson Pringle had served as Superintendent of the Geological Survey in Ireland from 1825 to 1828; and Captain Joseph E. Portlock had been appointed to inaugurate a Geological Survey Branch in Ireland in 1830. Thus the history of the Survey truly spans 172 years, with an interruption of only a single year — an impressive record indeed.

There have been two earlier histories: a massively official account, *The First Hundred Years of the Geological Survey of Great Britain* by Sir John S. Flett (H.M. Stationery Office, London, 1937) and what Mr. Wilson, in his "Introduction", styles "the more idiosyncratic account" by Sir Edward B. Bailey, *Geological Survey of Great Britain* (Thomas Murby, London, 1952). Both those authors served as Directors of the Survey; this is the first history by a more junior officer — and, speaking frankly, quite as idiosyncratic as Sir Edward's!

Mr. Wilson's two greatest assets are, first of all, his sense of humour and, second, his ability to write with candour and understanding of the attitudes of the "junior ranks" of what was, in origin, a military establishment — yes, the early Survey officers were given a distinctive uniform to wear! — and long retained many military characteristics. His sense of humour is delightfully made manifest, not only in his accounts of the adventures of the Survey's statue of Hercules in Portland stone and the changing attitude to Hercules' rather-too-apparent genitalia (p. 55, 64, 79-82) but also in his selections from the versifications of the "Royal Hammerers" (see especially the Appendix, p. 183-188).

The first Director, Sir Henry De la Beche, is given a short chapter to himself. Mr. Wilson's assessment of him, as his choice of chapter title indicates, echoes that of Sir Roderick Murchison, who called De la Beche "a thorough jobber and a great intriguer". Yet, as M.J.S. Rudwick's *The Great Devonian Controversy* (University of Chicago Press, Chicago, 1985) has so recently and so thoroughly demonstrated, De la Beche's political manipulations and other scientific machinations were begun only to counter those of that greater master of those questionable arts, Sir Roderick himself. It is intriguing to remember that Murchison, having opposed vigorously the establishment of the Survey, was not only delighted to succeed Sir Henry as Director but also the most vigorous and unprincipled of all the Directors in the wielding of the power of his position!

The succeeding fourteen Directors receive short shrift from Mr. Wilson, for their doings are summarized in a single chapter of twenty pages. Maybe the author felt that the "top brass" had received attention enough already — and maybe he is right. Yet that chapter has its points of interest. If one contrasts the accounts of Sir Archibald Geikie's arrogance and extreme unpopularity (p. 15-17, 120), of the rule of the unbeloved "Black John" Flett (p. 20-22) and of the tiresome eccentricities of Sir Edward "Cyclops" Bailey with the reigns of more popular Directors like Sir Jethro Justinian Teall (p. 16-17) and Sir Aubrey Strahan (p. 20), it becomes sadly evident that it is the tyrannical and unloved Directors who achieved most in research and even in mapping, whether personally or through the work of their minions. This chapter loses interest in its latter pages since Mr. Wilson was quite evidently unprepared to discuss the recent Directors (from Pugh onward) with anything like the same frankness of the earlier ones. (Did he learn that lesson in precaution from reading Charles Dickens' differential treatment of England's monarchs in *A Child's History of England*, one wonders?). One feels that much of value has been lost through this reticence.

The middle chapters present an intriguing picture of many aspects of the changing life of the Survey geologists through its history — and a most depressing one of the swamp of bureaucracy through which its officials must nowadays wade (see especially p. 42, 46-47). The history of the changing methods of reproduction of geological maps (p. 83-89) is fascinating but leaves one a little sad that, in this area as in so many others, artistic skills have dwindled away as computational and other mechanical devices have acquired an overvaunting sophistication.

A clear picture is presented of the development of hydrogeology in Britain, both within and outside the Survey (p. 124-134), and several other recent developments are fairly summarized — the chequered career of the Overseas Geological Survey (p. 139-151), the emergence of geochemistry and geophysics (p. 152-167) and the beginning of submarine studies on the Continental Shelf (p. 171-176).

In contrast, it is sad that another major development of recent years — research on microfossils as a means for the dating of subsurface samples — is given no mention whatsoever. Work on microfossils in the Survey was effectively inaugurated by F.W. Anderson but, as he told me himself, was treated at best with unenthusiastic condescension and at worst with actual discouragement by successive Directors who, it seems, still believed that all fossils had to be recognizable in the field if they were to be of the least interest. Only under Sir Kingsley Dunham did micropaleontology and its sister discipline, palynology, come to be valued. The story is a salutary one, but it may be that Mr. Wilson is not among those geological mappers who have yet learned lessons from it.

In general, indeed, Mr. Wilson himself seems singularly unenthusiastic about stratigraphical paleontology and gives the discipline minimal mention — a sad distortion of the balance of his history of the Survey.

The text is plagued by eccentricities of presentation. Sometimes there are two spaces between sentences, sometimes only one, making some paragraphs crowded and hard to read whereas others are more attractive. Individual geologists are sometimes named in full (e.g. "William Francis Porter McLintock", p. 25), sometimes only by initials; and those initials are sometimes separated by periods (e.g. "G.W. Lamplugh", p. 19) and sometimes not (e.g. "F M Trotter", p. 27). This arbitrariness is tiresome, to say the least!

Mr. Wilson is unhappy with foreign names, whether French ("Geological Societie du Nord", p. 123) or Portuguese ("Companhie Portuguesa", p. 16). Nor has the relatively short text been checked for misprints as carefully as it might have been: I noted them on p. 64, 81, 111, 114, 117, 125 (twice), 126, and 137. However, I like best that on p. 149 — "Geolosits" would be an admirable word to apply to those officials without scientific education, the "Oxbridge classicists" at whom Wilson so justifiably rails for so severely impeding the Survey's scientific progress!

However, these carpings are all minor. This book is usually entertaining and always informative. It deserves to be read alongside the more "official" histories, so that one's picture of the development of the British Geological Survey is viewed, not just from above, but also from ground level. I trust that, even if he does not yet dare publish them now, Mr. Wilson will put on record his uncensored recollections of the more recent Directors and lodge them in some archive, for they will surely be of great value to future historians of science!

The Chronology of the Geological Record

Edited by N.J. Snelling
Blackwell Scientific Publishers
Geological Society Memoir Number 10
340 p., 1985; $60.00 US, cloth

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"I measure time but know not what it is."
St. Augustine, 600 A.D.

Nearly 1400 years later, we still have to agree with St. Augustine but we can work with the concept of time as a set of closely spaced measurable physical events. For geologists, application of this concept began with appreciation of the progressive nature of organic evolution and the rates of geologic processes and became the quantitative science it is today with the application of isotopic dating techniques. Important challenges now are integration of the paleontological, paleomagnetic and isotopic time scales and refinement of isotopic dating systems.

This memoir describes much of the state of the art at the time of the symposium on Geochronology and the Geological Record held in May 1982. The emphasis is on results; although problems with analytical techniques and interpretation are mentioned, no paper focusses on this vital facet. The first part of this volume deals mainly with calibration of the time scale, the second contains papers that apply geochronology to the understanding of crustal processes.

The first part opens with a succinct introduction and history by Snelling. Two tables illustrate the development of the Phanerozoic and Precambrian time scales. Although papers were accepted up to April 1984, neither Harland *et al.*'s (1982), Stockwell's (1982), nor Palmer's (1983) scales are included (although they are referred to elsewhere in the volume). Snelling gives considerable emphasis to the Precambrian scale proposed by Preston Cloud ten years ago, rather than giving the various scales a balanced summary. This is later seen to be an introduction to his own proposals. He concludes with a summary of the main topics of the memoir.

Both an overview and many valuable details are in this volume and both browsing and focussing on the parts of the time scale important to a particular reader are rewarded. A brief review of a volume rich in ideas, controversy and data cannot do more than touch upon a few points.

Moorbath and Taylor discuss a variety of problems in Precambrian rocks from the perspective of those working with the Rb-Sr and Pb-Pb systems. The limited utility of methods that commonly yield ages with uncertainties of ±50 to ±100 Ma is well recognized in Canada and the future must certainly lie with high-resolution zircon analyses pioneered in Ontario. Some of these analyses are discussed here but are given faint praise: "It is also questionable just how useful such precise ages would be, since it is not yet known exactly what stage or event in an extended magmatic and/or metamorphic evolutionary history a measured zircon age would actually represent". This is convoluted logic indeed! Precise ages describe a history well while imprecise ages can only sketch its broad outlines. It strikes me as a very British sentiment: "If we are not doing it, it is not worth doing". The valuable part of this paper deals with problems of interpreting Rb-Sr isochrons in the face of total or partial resetting during one or more thermal episodes.

In his discussion of Precambrian time scales, Wright takes as given that geologic time can only be defined in terms of geologic events, thus rejecting the use of an "absolute" numerical scale based on isotopic ages. However, he then concludes that no worldwide events preserved in the rock record are known that could form the basis for an international scale. He views recent proposals such as that for DNAG as: "...simply a stage in the process of trying to discover major changes ... sufficiently distinctive to enable correlation to be made world wide". If that process is important, the definitions of "local" scales (eg. Stockwell, 1982) must, in their detailed considerations of numerous significant geological events, contribute even more to it.

Succeeding papers deal with calibration of paleontological and isotopic scales. Odin outlines the key rules for such work. The intractable Proterozoic-Cambrian boundary position is discussed by Cowie and Johnson and Odin *et al.* with the only conclusion attained being that the age is between 600 and 530 Ma. Both extremes seem less likely than the presently chosen median value of 570 Ma. Substantial controversy continues about ages of Ordovician to Devonian epochs. Odin, McKerrow *et al.*, Gale and Kunk *et al.* contribute to this debate. Differences arise from the use of various dating methods and considerable discounting of other authors' methods goes on. Is this a problem of calibrating the methods or one of greater sensitivity to perturbation of one method *versus* another? The differences lie just beyond the limits of error (5-20 Ma). Fission track and ^{40}Ar-^{39}Ar give older ages than assemblages of K-Ar, Rb-Sr and (a few) Pb-U ages.

In contrast, Forster and Warrington and Odin are in nearly complete agreement for the Carboniferous to Triassic part of the scale. Hallam *et al.* and Berggren *et al.* present a thorough assessment of magnetostratigraphic, paleontologic and isotopic scales for Jurassic to Paleogene time. Here, the database is larger and more precise than for older rocks; differences among various scales are small. A similarly complete assessment of the Neogene and Quaternary, including oxygen and carbon isotope and organic geochemical stratigraphy, is given by Jenkins *et al.*

Snelling summarizes preceding papers, treading a precarious path between opposing views to create an interim Phanerozoic scale, and introduces his favorite Precambrian scale. He rejects Proterozoic and promotes the Proterophytic and Paleophytic eons, separated by the appearance of the Gunflint microbiota, the virtual end of banded iron formations and the appearance of red beds at *circa* 2000 Ma. The latter eon is divided into the Guianian, Riphean and Vendian eras but the criteria for their boundaries are not given.

After the cut and thrust debates about time scales, the eight papers in the second part of this volume are a bit anticlimactic. However, they take one away from intellectual arguments and provide a sampling of the exciting practical applications of geochronology to the understanding of crustal processes. Curry discusses the relationships between magnetic lineaments and the Mesozoic-Cenozoic time scale. He shows that different oceanic spreading rates create discrepancies among time scales based solely on lineaments, hence these cannot be used unless their isotopic ages are known.

House illustrates the high resolving power of the ammonoid-based time scale — as good as 0.25 Ma for parts of the late Paleozoic-Mesozoic interval — and the significance of ammonoid evolution to the theory of evolution itself. Gregor discusses the preservation of Phanerozoic sediments — the balance between deposition and erosion rates in various environments. Clauer and Hoffert, in their study of deep sea red clays conclude that sedimentation rates vary widely and thicknesses cannot provide independent estimates of time.

Raynolds and Johnson report on a well-integrated study of molasse sedimentation in the Himalayan foredeep using magnetostratigraphy and fission track dating to supplement field mapping. They document the variation of accumulation rates in space and time, rates of facies changes and of uplift and deformation. Jäger reviews her classic work on metamorphism, cooling and erosion of the Central Alps; an inspiration to anyone wishing to understand orogeny in the original sense.

Dodson and McClelland-Brown describe an innovative combination of isotopic and magnetic blocking temperatures to infer cooling histories and hence, uplift rates. Studies of mid-Proterozoic rocks from west Greenland, late Proterozoic ones in the Grenville Province and Tertiary dykes in Scotland are discussed. The last paper by Brown delves into the implications of geochronology on

models of evolution of the continental lithosphere. Continental growth was apparently rapid in the Archean but has slowed and has continued to decrease since then.

I recommend this memoir for its wealth of ideas and data, presented, for the most part, clearly and concisely. With nearly 350 large-format pages for $99 US it offers good value and, despite continuing changes in the time scale and refinements to methods of isotopic analysis, will be a useful reference for some years to come. For those concerned with older parts of the time scale it may be a bit too expensive, given the rapidly changing data base on which the conclusions presented are based. The libraries of all major geological research institutions should definitely have a copy.

Preferred Orientation in Deformed Metals and Rocks: An Introduction to Modern Texture Analysis

Edited by Hans-Rudolf Wenk
Academic Press, Inc., Toronto
640 p., 1985; $83.50, Cloth

Reviewed by Don H. Rousell
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"It is obviously hardly possible for an editor, even when fully conversant with the subject, to secure among the essays of the various gifted contributors the degree of uniformity of treatment which he might desire." (A. Geikie in Preface to *Geological Structure of the Northwest Highlands of Scotland*, 1907). H.-R. Wenke, the editor of the volume under review, appears to have achieved a remarkable "uniformity of treatment" in the 26 chapters written by no less than 27 authors from 7 countries (USA, FRG, France, Australia, UK, Belgium, and GDR) and representing several disciplines (Metallurgy, Mathematics, Geology, Geomechanics, Geophysics, Physics, and Material Sciences).

The volume stemmed from a workshop on Deformation Mechanisms and Texture Development in Rocks held during the 23rd US Symposium on Rock Mechanics at Berkeley in 1982. Metallurgists and geologists have co-operated in the past (eg. Nicolas and Poirier, 1976); the present volume must represent the most comprehensive example of co-operation between the two disciplines. Metallurgists and geologists proceed, in a sense, in opposite directions. The aim of the metallurgists is to manufacture a product, with specific properties, by controlling the production process. The geologist begins with the product and tries to determine the process — a formidable task indeed, particularly when many of the "products" have been re-worked. Most of the methods we apply to the study of tectonites, including techniques of data analysis, flow mechanisms, mechanical models and so on are borrowed directly from physical metallurgy. Consequently, it behooves geologists to acquaint themselves with metallurgical research.

The book may be divided into three parts. The first part (Chapters 2-7) considers techniques, procedures, and the theoretical aspects of the collection and analysis of orientation data. Chapter 2, curiously titled "Measurement of Pole Figures", is a review of topics familiar to all geologists including plotting and contouring of Lambert nets, optics, U-stage techniques, reflected light and diffraction methods. Chapter 3 ("Symmetry of Pole Figures and Textures") is quite readable to those familiar with crystallography. Chapter 4 ("Representation of Preferred Orientations") requires a specialized background to comprehend such topics as orientation distribution function (ODF), Euler angles, Euler space and co-ordinate systems. The next three chapters are entitled "The Harmonic Method", "Vector Method", and "ODF Reproduction with Conditional Ghost Correction". Most geologists will find the mathematics in these 3 chapters very heavy going. Part 1 is probably of the least interest to geologists.

Part 2 (Chapters 8-12), on the other hand, is of considerable interest to geologists as it provides an introduction and summary of crystal flow processes and the formation of preferred orientations. Chapter 8 ("Dislocations and Microstructures") sets out a good introduction to topics including: origin of dislocation concept, nature of dislocations, point defects, grain boundaries, plastic deformation, and techniques for the study of dislocations. Chapter 9 ("Recrystallization") treats nucleation, grain-boundary migration, dynamic recrystallization and so forth; all of the examples are of metals. In a brief chapter (10) entitled "Regimes of Plastic Deformation", flow mechanisms are succinctly summarized and deformation maps are explained and nicely illustrated. In Chapter 11 ("Development of Textures by Slip and Twinning"), the topic is developed from a theoretical point of view. Chapter 12, "Reorientation Due to Grain Shape", is mainly concerned with rigid-body rotation.

Part 3 (Chapters 13-26) sets out textural data for certain metals, minerals, and rocks; it also contains several "odd-and-ends" topics. In Chapter 13 some simple examples elucidate the development of textures in metals. The orientation distribution function is used to gain an understanding of the copper-brass texture transition (Chapter 14). Microstructures and textures in evaporites are covered in Chapter 15. The behaviour of ore minerals are discussed in Chapter 16. Most ore minerals are weaker and more ductile than host rocks. Ores commonly occur in planar veins or layers; during deformation these are often the locus of high strain. This chapter would be of interest to economic geologists working with deformed ore deposits. Chapters 17, 18, and 19 deal with preferred orientations in carbonates, quartzites, and olivine-pyroxenes, respectively. Chapters 20 and 21 discuss textures in slates and schists, respectively; more comprehensive treatments can be found in modern structural geology textbooks. Much of the material in Chapter 22, "The Geological Significance of Microfabric Analysis", is also treated elsewhere in the volume. Chapter 23 summarizes "Experimental Determination of Mechanical Properties". The topic of Chapter 24 ("Physical Properties of Polycrysts") is discussed from a mathematical-metallurgical viewpoint. Chapter 25 is titled "Texture and Magnetic Properties of Metals". The final chapter (26) deals with "Anisotropy in Rocks and the Geological Significance". Anisotropy includes elastic properties, strength, and thermal conductivity. Some of the earth's fundamental processes are due to anisotropy.

Researchers in the material sciences, with an interest in the relationships between the flow and textures of metals and silicate phases, would presumably find the volume useful. Structural geologists and crystallographers, who are familiar with the topics, might use the book for review purposes. The book is not entirely suitable as an introduction to the topics as the coverage is rather terse. However, the good reference list will lead interested readers to the pertinent literature.

The Geological Evolution of the Eastern Mediterranean

J.E. Dixon and A.H.F. Robertson
Blackwell Scientific Publishers, Palo Alto
848 p., 1985; $120.00 US, cloth

Reviewed by Georgia Pe-Piper
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This book includes sixty-one of the contributions presented at a conference of the same name in Edinburgh in September 1982, and was published some two years later in December 1984. The volume is principally concerned with the complex geology of the Mesozoic-Cenozoic mountain belts of Greece and Turkey, with some contributions in adjacent areas. Greece has been intensively investigated over the last thirty years, principally by Greek, French, German, British and Dutch geologists; the geological framework is reasonably well understood; and there is consensus on many of the features of its geological evolution. The larger area of Turkey is less well known, where much of the work remains of a reconnaissance nature.

The editors have written a 75-page review of the tectonic evolution of the eastern Mediterranean, placing particular emphasis on the nature of unresolved problems and the way in which solutions might be tested. They have also prepared brief summaries of the papers presented in each of the five sections of the book, which helps the reader place these papers in perspective and indicates the areas of disagreement. This effort by the editors has turned what might have been just a collection of papers into a very useable review of the geologic problems of the area.

Paleomagnetic reconstructions of the continents and the magnetic anomaly patterns in the Atlantic Ocean have for the last fifteen years provided a general framework for examining the tectonic history of the Mediterranean area between the stable African and Eurasian continents. This external kinetic framework provides constraints that are largely lacking in the reconstruction of say the Appalachian and Cordilleran orogens. Least constrained is the configuration of the Paleotethys ocean in Permo-Triassic time, which is dependent on the magnitude of Permo-Triassic transcurrent motion between Laurasia and Gondwana.

There is general agreement that oceanic crust of Neotethys developed in Jurassic time in a series of basins as modern Greece and Turkey rifted away from Gondwanaland, and these oceans were closed in the Cretaceous and Cenozoic, with the emplacement of ophiolites. Many of the key disagreements in the Eastern Mediterranean relate to the source areas and emplacement directions of the allochthonous ophiolites, and the distribution and extent of both Paleotethys and Neotethys oceanic crust.

The non-specialist reader will find useful reviews of the possible tectonic evolution of this area in the synthesis by the editors, and in a number of regional papers. Sengör *et al.* (in a paper further developed in a GSA Special Paper) suggest that rifting of a Cimmeride microcontinent from Gondwana resulted in closure of Paleotethys to the north (resulting in the Balkan/Carpathian, north Anatolian and Caucacus Triassic-Early Jurassic orogeny) and concomitant opening of Neotethys to the south. The editors, in contrast, summarize evidence suggesting that a large part of Paleotethys persisted throughout the Mesozoic. Ricou *et al.* present evidence that all the ophiolites of Turkey are derived from a single ocean basin, whereas Robertson and Woodcock argue for several Neotethyan basins with modern Turkey.

There are several valuable reviews of specific topics, for example radiometric data on ophiolites (Spray *et al.*), Neogene paleogeography (Steininger and Rogl), Neogene volcanicity in the Aegean area (Fytikas *et al.*), and the geological evolution of the northeast African margin (Sestini). In addition, there are a large number of papers of regional interest; some provide welcome high quality data in critical areas, whereas the impact of others is less substantial.

The concept of geological evolution developed in this volume centres around plate dynamics and tectonic evolution. Those seeking a descriptive review of the geology, structure, stratigraphy and igneous activity of the eastern Mediterranean will in general have to go elsewhere. This is (as the editors note) particularly true for Greece, for which there are several important syntheses by both the French and German schools in the last ten years that are cited but not emphasized sufficiently in this volume.

The book is attractively produced, although not always thoroughly copy edited. The editors' introduction shows signs of haste in the figures, although the text is excellent. Authors will have a terrible time knowing how to reference this book: there is no guidance in the book itself, and although the dust cover says "Geological Society Special Publication No 17", this information is not present anywhere in the bound volume. The Geological Society (of London) and Blackwell should get their act together on this problem.

Seabed Mechanics

Edited by Prof. Bruce Denness
Graham and Trotman Limited
Distributed by IHRDC, Boston
281 p., 1984; $69.00 US, cloth

Reviewed by J.I. Clark
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This volume contains the Edited Proceedings of a Symposium, sponsored jointly by the International Union of Theoretical and Applied Mechanics (IUTAM) and the International Union of Geodesy and Geophysics (IUGG). The Symposium was held at the University of Newcastle Upon Tyne in September of 1983. Prof. Bruce Denness organized the Symposium and is the Editor of the proceedings volume.

In the Foreword to the volume, Prof. Denness describes for our enlightenment how he was ever so reluctantly manoeuvred into organizing the Symposium. He then informs us that the proceedings volume, follows the same order as the programme, designed to lead us, the reader, logically(?) upward from the sediment 10 metres below the seabed to the waters 10 m above. He then goes on to titillate us with amusing incidents from the Symposium, one of which involved Armand Silva appearing at the registration desk in his underpants. Clearly, you would have to have been there to appreciate it.

Prof. Denness has done an excellent job of editing and the publishers have put out a very presentable piece of work. Both are limited by the content which is a mixed bag. Like Armand Silva in his underpants, the proceedings volume doesn't quite make it.

The Symposium peaked in Section 1 of Part 1 dealing with sub-seabed characteristics. This part of the program was divided into two sections: (1) strength and consolidation and (2) submarine slopes and sediment testing. Adrian Richards opened Section 1 with a thoughtful essay on some problems of laboratory and *in situ* testing. He proposes a paradigm that excess pore pressures will always be found *in situ* in cohesive marine soils. He then goes on to restate a hypothesis that he devised some years ago to the effect that the high water contents of deep marine soils is due (at least in part) to the influence of invertebrate mucus on the permeability. Even today there is little evidence to support or deny either the hypothesis or paradigm but both are very interesting. The four papers that follow Richards' introduction are all well worth reading. Nukase and Kamei present some very interesting data on seabed clay anomalies and Yasuhara *et al.* present results for undrained shear behaviour of clay that has been overconsolidated by cyclic

loading. Sills and Thomas have a carefully crafted presentation on settlement and consolidation in a laboratory setting and Silva and Jordan do a nice job on consolidation properties and stress history of some deep sea sediments. Section 1 is all good stuff and may in itself be worth the $69 US price of the book. Section 2 is a mixed bag of submarine slope papers and sediment testing with one very good paper emerging when Silva and Jordan link up with Booth to deal with several cases of slope stability and susceptibility of Quaternary sediments on the northeastern continental slope of the USA.

Part II deals with "Sub-seabed Site Investigation and Design" and by now you are probably wondering what happened to the promise in the Foreword where we were to be lead "logically" upward from the sediment 10 metres below the seabed to the water 10 metres above. Section 2 had us bobbing up and down and Section 3 does the same. Worth reading here is the contribution by Shiffman and Pane on "Non Linear Finite Strain Consolidation of Marine Sediments". Section 4 deals mostly with wave induced liquefaction and is not very exciting.

Part III, entitled "Sediment Transport", tells us we are now up out of the mud and at the seabed. Better we had stayed 10 m below. Section 5 contains 4 papers on "Wave and Current-induced Transport" and Section 6 has two papers on "Storm Impact and Forecasting". The presentation by Farmer and Kelly on "Climatic Variation in the North Sea Region", in Section 6, is well done.

Continuing our rise into the water column and drop in relevance, Part IV promises us something on sediment — structure interaction but fails to deliver. Worthwhile reading is the paper by Hovland and Gudmestad dealing with gas-induced erosion of the seabed.

In summary, it is a nice looking book and is well edited. The List of Delegates indicates that some 65 people were in attendance and the Foreword by Bruce Denness assures us that they all had a rollicking good time. The $69 US price is perhaps not so bad in today's terms and it will buy you a scattering of interesting papers that have to be sieved out from the majority of less interesting papers. It is by no means clear why the publishers chose to put it out as a book. Whatever happened to the days when proceedings of Symposia and Conferences were just that?

Geology for Civil Engineers, Second Edition

By A.C. McLean and C.D. Gribble
Allen and Unwin, Winchester
314 p., 1985; $35.00 US cl., $15.95 US pap.

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The carefully declared purpose of this book is to present a "scaled down" introduction to geology which is not to be perceived as a course or text on engineering geology. Considerable engineering application is presented, however, in an attempt to make it relevant and interesting to civil engineers. The result is a very brief, almost terse presentation (text) of enormous breadth that reads like a set of lecture notes and except for a few appendices is of little value as a post-course reference.

Chapter 2, "Minerals and rocks", is adequate except for the very weak discussion of clay mineralogy which is void of any discussion of charge deficiency, cation exchange capacity and cation type, all factors that control the engineering behaviour of clays.

Chapter 3,"Surficial deposits", discusses everything from soils and chemical weathering to wave action, littoral drift and glacial erosion/deposition. Extreme brevity creates ambiguity, especially the 4-page description of shoreline erosion and Figure 3.11 which erroneously correlates spreading wave orthogonals with increasing rather than decreasing energy striking the shore. The vast deposits of extrasensitive clays in Scandinavia and eastern Canada do not even merit a comment.

Chapter 4, "Distribution of rocks at and below the surface", is another "catch-all" chapter which includes the time scale, isotopic dating, maps, structural geology, plate tectonics, earthquake prediction and a 6-page section on the geology of Britain. Use of "rock head" for the more familiar "bedrock" and other unfamiliar terms do not detract from a reasonably good chapter.

Chapter 5, "Subsurface (ground) water" is a conceptual discussion of groundwater flow with serious errors where the authors try to be specific. For example, the hydraulic gradient is the drop in total head divided by the length of the flow path. Only in special cases is this equal to the changes in pressure head and in many geological situations flow occurs at constant pressure head and is caused by changes in elevation head only. Figure 5.1 requires a tail-water elevation and is incorrect with soil filling the constriction near the exit valve as shown. Finally, the phreatic surface is shown dropping below river surface in Figures 5.4 and 5.8 which is clearly impossible.

Chapter 6, "Geological exploration of an engineering site", is more than adequate for this type of book, especially the section on geophysical exploration which is quite long compared with a very brief section on drilling, boring, trenching and pitting.

Chapter 7, "Rocks and civil engineering", is crammed with data on index properties and several brief descriptions of testing procedures. Although generally adequate, the use of terms such as apparent specific gravity for bulk density used in geotechnical language is confusing. Several correlations in the form of useful figures and a test problem were quite interesting.

Chapter 8, "Principal geological factors affecting certain engineering projects", is a most interesting practical chapter on a variety of subjects. The only really weak section was a very confusing presentation of the interrelationships between cohesion and peak/residual/ultimate friction angles applied to slope stability problems.

Finally, should one buy this book? Perhaps, yes, for a one-term course in geology for civil engineers, and I may try it for my own course in spite of the book's errors and omissions. Since the book is designed to be an elementary treatise, it is obviously not recommended as a reference text.

Airphoto Interpretation and the Canadian Landscape

By J.D. Mollard and J.R. Janes
Energy, Mines and Resources Canada
415 p., 1984; spiral bound, sheets 28 x 43 cm, $60 ($72 orders outside Canada)

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The origin of this large and impressive volume can be traced back to the comprehensive collection of aerial photographs gathered some 40 years ago by the Surveys and Mapping Branch of Energy, Mines and Resources. At that time large tracts of Canada were mapped using aerial photography, and representative photographs were later selected portraying various aspects of the Canadian landmass. Over the years the collection has been extensively used by the clients of the National Air Photo Library in Ottawa. The growing demand for more detailed descriptions of the existing imagery culminated in the production of the present volume.

The volume collates an enormous wealth of local and regional information that has been organized into the following eight chapters: "Black and white airphotos and their interpretation", Bedrock terrains", "Glaciated landscapes", "Slope movements", "Running water and groundwater features", "Shorelines and wind effects", "Permafrost terrain and peatland features", and "Remote sensing and satellite imagery". Each chapter is divided into sections beginning with an explanatory introduction and followed by topical discussion. For example, "Bedrock terrains" are subdivided into volcanic, intrusive, metamorphic, sedimentary and meteorite crater terrains. Sections such as sedimentary terrains are then further subdivided into karst and badlands topography, jointing, faulting, and so forth.

The first chapter delves into the theory of airphoto interpretation and stereoscopy, while other chapters summarize the mechanics of geomorphic/geologic processes and their bearing on the origin of landscape features. The volume includes small-scale colour reproductions of the Geological Map of Canada, the Glacial Map of Canada, Permafrost in Canada, and many other maps, some taken from the *Geology and Economic Minerals of Canada*. The text is suffused with numerous geologic maps and cross-sections, many in colour, from selected areas of local and regional import, and the descriptions are accompanied by a bibliography and suggestions for further reading. A glossary of geologic-geomorphic terms is also included.

In addition to maps, cross-sections, explanatory diagrams and regional summaries, the first seven chapters are illustrated by 209 loose-leaf plates of black and white stereopairs. The final four plates include stereograms of normal colour and colour infrared photography to accompany the remote sensing and satellite imagery of Chapter 8. This final chapter features, amongst other things, LANDSAT and SEASAT imagery and it covers topics such as urban land use, land inventory, forest reserves, and iceberg tracking.

To summarize, this beautifully polished production presents a synoptic overview of the regional diversity of the Canadian landscape. It is a compendium of geomorphic-geologic information that should prove to be a bonanza for those professionals concerned in one way or another with the pure and applied aspects of earth science. Even certain aspects of the human landscape are given a cursory treatment. The volume represents an important and a welcome addition to the literature on photo interpretation.

Sedimentary Environments and Facies, Second Edition

Edited by H.G. Reading
Blackwell Scientific Publications, Oxford
615 p., 1986; $55.95, cloth

Reviewed by Andrew D. Miall
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The long-awaited Second Edition of this famous and very successful book has now arrived. If you liked the First Edition, you will like this one, as it is essentially the same book with some changes in chapter authorships, and updated to about 1984. The chapter headings are the same, and the treatment has undergone no substantial changes in philosophy.

The chapter headings are, in order, introduction, facies, alluvial sediments, lakes, deserts, deltas, siliciclastic shorelines, arid shorelines and evaporites, shallow siliciclastic seas, shallow-marine carbonates, pelagic environments, deep clastic seas, glacial environments, sedimentation and tectonics, problems and perspectives.

The most interesting chapters are, because of their novelty, those that have been rewritten from scratch by new authors. Those revised by the original authors are much less changed. The illustrations and ideas from the old edition have been used so often in undergraduate teaching and in other books and course notes that to see so many of them again (particularly in the chapters revised by the original authors) tends to make one's eyes begin to glaze over as one turns the pages. This is, perhaps, unfair, and is certainly a sign of the success of the book as the treatment was undoubtedly the most thorough and thoughtful of any text on the subject when it was first published. Some fashionable ideas, which have perhaps tended to receive undue emphasis in the GAC *Facies Models* book, are downplayed here. This seems to be a much more balanced book — but then it was written for a much more advanced audience, and attempts to be comprehensive.

The most substantially revised chapters are those on lakes (by P.A. Allen and J.D. Collinson), arid shorelines and evaporites (B.C. Schreiber), shallow siliciclastic seas (H.D. Johnson and C.T. Baldwin) and deep clastic seas (D.A.V. Stow). All include much expanded discussions of sedimentary processes, with numerous examples from the modern record.

Perhaps it is because I know the fluvial and glacial subject areas so well, I found these chapters the least interesting. The fluvial environment is described (by J.D. Collinson) in terms of the four or five long-established basic models, supported by descriptions of the same aging case studies. A few newer references have been included, mainly to papers given at the second international fluvial conference held in Keele in 1981, but no real attempt has been made to revise the critical framework of this chapter. The glacial chapter (by M. Edwards) also lacks a discussion of many of the newer papers on glacial models and on subaqueous glacial sedimentation, and continues to base facies descriptions on genetic "till" terminology that has not been extensively tested by sedimentological documentation. The section on ancient examples is particularly weak.

The chapter on sedimentation and tectonics (by A.H.G. Mitchell and H.G. Reading) has been extensively rewritten, with many new examples, but it still follows essentially the same format as before. There is very little discussion of the exciting new geophysical models of basin development, and no mention at all of the new ideas on accretionary terranes and of deep crustal seismic exploration, which have so changed our ideas about orogenic belts. Perhaps all this was omitted in the interests of saving space, and in order to focus on facies rather than on regional tectonics. The discussion tends to lean heavily on selected case studies, with only limited attempts to generate generalized ideas about the facies assemblages, stratigraphic geometries and associated structural geology that might typify each plate tectonic setting. Nor is there any discussion of how tectonic styles, and the resulting basins, may have been different in the Precambrian. Having said that, though, the examples are well chosen, the diagrams generally good,

and there is no doubt that the advanced student will learn a lot from reading this chapter.

A general criticism that can be levelled at this kind of book, including the somewhat similar GAC *Facies Models* volume, is the treatment of facies and environments in isolation from other elements of basin development. The Reading book includes the lengthy chapter on sedimentation and tectonics discussed above, but there is no equally systematic treatment of climate or of sea level change, and a highly variable approach to large scale depositional-systems concepts, including a very limited use of seismic facies data. The vertical profile reigns supreme, as in all sedimentology textbooks these days, and one would have liked to see more on three-dimensional facies architecture, to borrow John Allen's term. There is no doubt that the subject of facies and environments is quite enough to fill one book, but other topics, such as those listed above, are so inextricably a part of basin evolution that it seems inadequate, nowadays, to discuss sedimentology without them.

These are not really criticisms, but the carpings of a colleague who might have wanted to do it differently. The level of presentation remains at a substantially more advanced level than that of Walker's *Facies Models* book (this is not a criticism, the books were written for somewhat different audiences), and will be most useful for graduate students and professionals. I tried using the first edition in advanced undergraduate courses, but discovered that the students never read it, as shown by rather dismal performances on examinations, and I have used the more elementary Walker book ever since (they don't read that very thoroughly either, but at least it's a cheaper book). The First Edition of the Reading book was probably kept on a handy shelf by nearly every sedimentologist, and this new edition will certainly be treated with the same respect.

Aspects of Fluvial Sedimentation in the Lower Triassic Buntsandstein of Europe

Edited by Detlef Mader
Lecture Notes in the Earth Sciences, #4, Springer-Verlag, New York
626 p., 1985; $58.00 US, paper

Reviewed by Andrew D. Miall
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Detlef Mader is an energetic young German researcher who first burst on the international scene at the second international conference on fluvial sedimentology at Keele, UK, in 1981. He is an extremely prolific writer, who has already produced two books and numerous lengthy articles dealing mainly with the Buntsandstein of Germany. This unit is a classic continental deposit, consisting mainly of fluvial deposits, with some intercalated eolian facies. In this book he presents a series of twenty two separate but linked papers on the Buntsandstein. Most deal with the western European basin, which extends from Poland to Britain, but also included are three articles on rocks of similar age in France and Spain.

I was not happy with the introduction of this new Lecture Notes Series by Springer-Verlag. The intent of the series is to report new developments quickly, in an "unfinished" or "tentative" form. However, the last thing the scientific readership needs is more lengthy, poorly written, unedited manuscripts, and this is exactly what the new series promises to be. The present book exemplifies the problem. Few have the time or the interest to read 626 pages on one sedimentary unit.

The plan of the book is quite a good one: to provide detailed local studies throughout the European area, and to combine these gradually into a larger and more regional scale of analysis, in order to build up an overview of the Buntsandstein depositional complex. Where Mader himself has not worked, he has invited contribution or co-authorship from local experts.

Eight of the papers in the book were written by various European contributors; these are the best in the book. The remainder were written by Mader himself, some of them with co-authors. Those by Mader consist mainly of unsupported assertions about facies interpretations, cycle characteristics, fluvial models and tectonic controls on sedimentation. Illustrations consist mainly of occasional photographic plates (good in themselves), occasional stylized stratigraphic sections, and numerous highly schematic block diagrams of interpreted depositional environments. Mader provides virtually no actual hard sedimentological data in the form of measured vertical profiles or stratigraphic crosssections. All this, plus geologic maps, paleocurrent data, and paleogeographic interpretations, are presumed to be available in other papers by Mader. These are referred to extensively. In fact I counted a total of 232 self-citations by Mader in his contributions to this book. This has to be some kind of record. In contrast to the extensive self-citation Mader does not attempt any kind of comparative analysis by referring to the analyses and results of other fluvial workers. This renders impossible the exercise of mental integration that one normally performs when reading research publications.

Mader's problem seems to be that he has never had a tough critical reader or editor. Most of the book is simply unreadable, because it is quite impossible to check his statements against any documentation of the actual field data. The same is true for those of his journal articles which I have attempted to read. I am sure that he has collected a great deal of data, but little of this appears in any of his English-language publications which have crossed my desk. A paper dealing extensively, but solely, with paleocurrent data, appeared recently, but as any experienced basin analyst knows, paleocurrent data on its own is virtually useless. Having skimmed the book, and tried to read some of the chapters carefully, I have come away without having learnt anything of real use, other than that there seems to be a lot of Triassic fluvial sediment in Europe.

The book is well put together. It was produced from camera-ready text prepared on a word processor, and the quality is excellent for this type of reproduction. Considerable credit is due Mader for producing such a tome with a minimum of error. The text is marred, however, by the curious device of printing about thirty percent of it in bold face type. I could discern no real pattern to this procedure; it becomes very irritating after a few minutes of reading, and seems to achieve nothing.

In conclusion I cannot recommend this book to anyone, and I strongly suggest Springer-Verlag discontinue this series. As I was writing this review the University of Toronto was debating the need to meet budget deficits by cancelling possibly as much as 30% of its journal subscriptions and book purchases. Perhaps if there were fewer marginal publications like this one libraries would not become over-extended in the need to keep up, and such deficits would not arise.

Introducing Groundwater

By Michael Price
Allen and Unwin Ltd., Winchester
195 p., 1985; $25.00 US, cl.; $11.95 US, pap.

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Michael Price's new book is more than just an introduction to groundwater. It is a lesson in expressive and informative writing that we would all do well to heed. From the very start, Price sets into a "user friendly" mode and proceeds patiently to explain the fundamental principles of hydrogeology in a clear, organized, and yet commendably concise manner. No aspect of groundwater is considered too difficult to tackle. Armed with an impressive array of analogue examples and sharp, uncluttered diagrams, the author manages to explain such conceptually complex subjects as unsaturated flow, aquifer storage, well hydraulics and delayed yield with remarkable clarity. Although this is largely achieved by the refreshingly honest and lucid style of the writer, it is considerably helped by the separation of the basic principles of each subject from their mathematical representation, the latter being kept to an absolute minimum and isolated for supplementary reading if required.

In content, the 195-page book is directed primarily toward groundwater as a resource, its 13 chapters encompassing all the traditional topics associated with the study and exploitation of aquifers. Its potentially universal utility is somewhat tempered by an exclusive reliance on examples and illustrations from the British hydrogeological scene. Also, in its balance of subject matter, a slightly greater emphasis on groundwater pollution and contaminant flow would have been desirable, particularly considering current concerns and common misconceptions in this field. Nevertheless, this non-specialist book provides a welcome addition to the growing family of hydrogeological texts and is highly recommended reading for the mystified well owner, the confused student and for a good many professionals, who in their cookery book approach to hydrogeological interpretation, often never did quite understand where all that water was coming from.

Rare Earth Element Geochemistry

Edited by P. Henderson
Elsevier Science Publishing, Amsterdam
510 p., 1983; $84.75 US, cloth

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This volume contains 13 chapters, written by a number of authorities, on all aspects of rare earth element (REE) geochemistry ranging from the "Mineralogy of the Rare Earth Elements" (Chapter 2) to "The Rare Earth Element Characteristics of Igneous Rocks from the Ocean Basins" (Chapter 6) to "The Economic Importance of the Rare Earth Elements" (Chapter 12). The volume is designed primarily as a source book for geologists, geochemists, and chemists who deal daily with various aspects of rare-earth element geochemistry. Some chapters such as Chapter 4 on "Petrogenetic Modelling — Use of Rare Earth Elements" and Chapter 11 "Radiogenic Isotopes — Some Geologic Applications" could also be used in upper-level geochemistry and igneous petrology courses. Most chapters, however, assume a basic knowledge of geochemistry and petrology, and deal with specific applications and use of rare-earth elements in these fields. All chapters provide a concise, but not exhaustive summary of their subject; they are designed to provide the basics on the subject. For instance, Chapter 9 on the "Mobility of the Rare Earth Elements in the Crust" highlights the factors to consider when dealing with REE mobility, and provides sources to more detailed and specific works on the subject. The value of the book lies in the fact that it provides information on many aspects of REE geochemistry, information that previously could not be found in a single source book.

Although the book is a collection of papers, it is logically organized, and the book reads as a tightly edited text on the subject of REE geochemistry rather than as a series of uneven contributions. The book is well illustrated, and contains lengthy reference lists after each chapter. Typographical errors are few.

The book has a few biases. Published in 1983, it deals mainly with the use of REE geochemistry in igneous petrology, reflecting the state of knowledge at that time. It has only been since the early 1980's that REE studies have begun to flourish in the study of sedimentary processes, mineralization, and metamorphism. Presumably any future editions of this book will incorporate chapters on these developing fields. Chapter 13 on "Analytical Chemistry" deals almost exclusively with Instrumental Neutron Activation Analysis for the rare-earths (a major analytical method for REE), and neglects (but does not ignore) other methods such as ICP-Mass Spectrometric methods, x-ray fluorescence, and spark-source mass spectrometry. However, these flaws are minor. As a source book, this volume belongs in most geological libraries and is a good first source for anyone wishing to know about REE geochemistry. In addition, many geologists and chemists will find the book useful enough to buy for their own personal libraries.