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Book Reviews / Critique

Book Reviews

Carbonate Depositional Environments: Modern and Ancient
Part I: Reefs - Zonation, Depositional Facies and Diagenesis

By Noel P. James and Ian G. Macintyre
Edited by J.E. Warme and K.W. Shanley
Colorado School of Mines Quarterly
(v. 80, #3), Boulder, Colorado
70 p., 1985; $15.00 US, paper

Reviewed By Gordon E. Tebbutt
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This is the first in a series of publications on carbonate depositional environments, arising from public lectures and Continuing Education short courses given at the Colorado School of Mines in 1985. Fourteen carbonate experts were invited to present a series of lectures in their areas of specialization, covering observations and interpretations of modern and ancient carbonate rocks.

In addition to the School of Mines, the subsequent publication of the series in the CSM Quarterly Journal is supported by SOHIO Petroleum and indirectly by Tenneco Oil.

This first segment is a compendium of current knowledge of reefs — their recognition, geological and economic importance, evolution and spectrum of variability and diagenetic mutability. It outlines many of the observations and problems pertinent to reef analyses conducted by and synthesized by two leading specialists in carbonate studies, Noel James and Ian Macintyre. The authors draw upon their own experiences and carefully selected references from the vast array of papers and volumes devoted to the subject of reefs, presenting an easily readable account of highlights from their geological history.

A brief introductory chapter sets the scene by emphasizing the uniqueness and importance of reefs and presenting a classification scheme for reef limestones (after Embry and Klovan). Later chapters review reef terminology and reef-offreef relationships, and James' four-stage reef model (stabilization, colonization, diversification and climax phases). Parts of two chapters examine reef mounds, mud mounds, algal (microbial) buildups, (modern) algal reefs, carbonate banks and mud banks.

A ternary diagram is introduced with the three intergrading components: (1) skeletal metazoan reefs, (2) microbial buildups (calcified algae, laminated stromatolites and thrombolites) and (3) mud mounds.

The remainder of the first half of the publication consists dominantly of examples of reef zonations in Holocene Indo-Pacific and Caribbean reefs and in their Pleistocene counterparts.

The second half emphasizes application of the previously illustrated observations and principles to the study of ancient reefs. One chapter chronicles the changes in dominant reef builders throughout geological time, briefly examining cyclicity and geometry of major buildups from Precambrian to Holocene. The final chapter cites examples of detailed facies and reservoir studies of three oil-bearing Devonian limestone reefs in Alberta's subsurface (Swan Hills, Judy Creek and Golden Spike), and Pennsylvanian algal reef mounds in the Paradox and Midland and Basins of Utah and West Texas.

This publication is in a format appropriate for its intended use — lecture notes for a succinct, broad-ranging synthesis of our current understanding of reef in time and space. Its comprehensive bibliographies at the end of each chapter are particularly useful. In many respects, it is a brief reiteration of earlier outstanding documents, including Geoscience Canada's *Facies Models* and the magnificently well-illustrated AAPG Memoir 33 (mainly by James), supplemented by Indo-Pacific and additional Caribbean examples contributed by Macintyre and by several published studies of ancient reefs. Serious students of reefs would be well-advised to refer to at least these two major references, particularly, for the quality of diagrams and (many coloured) photographic plates. The CSM issue, unfortunately, could only print black and white plates (2 photos, 63 drawings) and copies from earlier works are reduced and reproduced in Xerox-like fashion which renders lettering and textural patterns illegible in some cases.

Several additional small criticisms are:

(1) A more explicit definition of exactly what constitutes a "reef" would have been preferable at the beginning rather than on page 22;
(2) Chapters on modern reefs should have been grouped together, before proceeding to ancient examples;
(3) A few spelling and numerical errors eluded the editors (*e.g.* fossil names, dates and page numbers of references);
(4) Credit for illustrations on page 57 should have gone to Wendte and Stoakes, 1982;
(5) The soft cover binding in the copy reviewed is already disintegrating;
(6) The price of more than $20 Canadian seems rather high, even by today's standards.

Bones for Barnum Brown. Adventures of a Dinosaur Hunter

By Roland T. Bird
Edited by V. Theodore Schreiber. With a foreword by Edwin H. Colbert and with introduction and annotations by James O. Farlow
Texas Christian University Press, Fort Worth
225 p., 1985; $29.95 US, cloth

Reviewed by William A.S. Sarjeant
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Roland Thaxter Bird (1899-1978) was the eldest son of a New York businessman and, one might have predicted, an unlikely entrant into the field of paleontology. His embarking upon such a career was the consequence of three chances. First of all, his frail physique caused his anxious parents to send him away from the city to the healthier countryside environment of the Catskills. Becoming interested in animal husbandry, he became an expert on dairy cattle, working principally in Florida and travelling widely to exhibitions. The second event that steered his lifetime course was the economic collapse of the 1920's, in which he lost both money and job; so he built himself a motorcycle-camper and began wandering about the country, finding jobs wherever he might.

Then came chance number three: his happening in northern Arizona upon a fossilized amphibian skull (misstated in Colbert's "Introduction" to have been a crocodile skull). In great excitement, Bird collected this and shipped it home. His father had it identified by the great vertebrate paleontologist, Barnum Brown, at the American Museum of Natural History; and, after an initial meeting between the distinguished scientist and the enthusiastic novice, young Bird was hired to work for Brown in the field and the laboratory. It was all as simple and satisfactory as that; a fossil-fascinated youth's dream come true.

The great charm of this volume is that it conveys so vividly Bird's delight in seeing that dream come true. The book was put together lovingly by his friend and literary executor Theodore Schreiber, under scientific advice from James Farlow. They have managed to distill, from Bird's autobiographical manuscript, a heady draught that inspires the reader with all of Bird's excitement.

The attractive layout of the book, its unusually spacious and attractive two-column format — a format much more often pinched and abhorrent for the reader — and its generous illustration are further bonuses. The chapter heads are charming. Almost all the illustrations are quite well reproduced, though that on p. 12 lacks clarity of definition and a few, like that on p. 80, have slim textual relevance. In particular, Bird's historic photographs and his original or redrawn sketches and site plans are featured: but, in addition, photographs and illustrations are included from other many sources. There are excellent portraits of Bird and Brown and some spirited restorations of dinosaurs. Personally, I am not happy with Eleanor Kirk's restorations, finding them too often grotesque (*e.g.*, p. 16, top) or rendered in colours that would have made the dinosaur much too improbably conspicuous in its environment. (Her colours are not, of course, visible in these black and white renditions. Gregory Paul's balletic restorations, if equally improbable perhaps, in general have greater charm (*e.g.* p. 14-21); although, I am not enamoured with that on p. 13, which appears to show a group of dinosaurs urinating — surely an impossible feat for them?

In his thoughtful and percipient introduction, James Farlow places Bird's achievements into their proper historical perspective and gives a first-rate summary of modern concepts of dinosaurs. His reflections on dinosaur taxonomy (p. 10), in particular, deserve the attention of all grappling with this problem. It is intriguing to be reminded (p. 22) that it was Richard Owen's initial mistake in reconstructing dinosaurs as quadrupeds that caused Edward Hitchcock reasonably to assume that his Late Triassic to Early Jurassic footprints from the Connecticut Valley must be those of birds.

That Roland Bird was a major contributor to the development of terrestrial paleo-ichnology, there can be no doubt. His research on Texas sauropod tracks first called into serious question the classical image of those long-necked dinosaurs as gigantic, submersible swans, perpetually confined by their bulk, like whales, to the waters. Of course, since the skeletal morphology of sauropods is designed for the conveyance of a great weight upon four stout limbs, this idea was always absurd; yet only the footprints provided a convincing demonstration that these dinosaurs were amphibians. Indeed, despite the growing bulk of evidence for their essential terestriality — from tracks so abundant, sometimes, as to suggest sauropod superhighways — many paleontologists still cling to the image of sauropods as essentially aquatic dinosaurs, only rarely and reluctantly straying ashore.

Bird's other demonstrations of the paleoecological relevance of footprints passed almost unperceived. Though he showed that herbivorous dinosaurs were herd-dwellers and normally carried their tails high, only very rarely dragging them along the ground, both these observations were ignored. Even when, in his last years, Bird had reassembled for the American Museum of Natural History the Paluxy River tracks from Texas that had so long languished in storage, the sauropod skeleton reconstructed above them has its tail set so low that the lack of drag-marks is positively unnatural!

The imprint of the posterior of a squatting dinosaur that Bird discovered (p. 78-80) remains, so far as I know, unparalleled; maybe such traces are commoner than we suppose, but usually ignored or misunderstood?

Bird's career as Barnum Brown's assistant was not long, for the temptation of a higher salary lured him away all too soon into the search for economic minerals, especially vanadium and uranium. However, it was singularly eventful. He recounts his involvement in the discovery of two fossil crocodiles, one perhaps the earliest (*Protosuchus*) and one perhaps the largest known (*Phobosuchus*). He describes his adventures in working, but partially flooded Pennsylvania coal-mines, while recovering amphibian tracks, and in abandoned and perilous Colorado coal-mines, while recovering dinosaur footprints and fossil palm fronds. He tells of the problems in dealing with the intricate complex of sauropod bones — surely the remains of a herd, decimated in some cataclysm? — at the Howe Quarry in Wyoming; his meticulous map of the tangle (p. 55) is positively awesome. He tells of adventures in the Museum — of new discoveries made when dinosaur bones were uncovered from the encasing plaster and rock and of the hazards in moving their reconstructed skeletons. He recounts the problems of extracting dinosaur tracks from the beds of Texas rivers that might be almost dry at the start of a day and in full, turbulent flood before its end. All these descriptions pulse with the excitement of discovery.

Moreover, one finds oneself charmed by Bird himself, as he is mirrored in these autobiographical writings; his humility, his dedication, his surprised sense of privilege in finding himself at the focal point of such major scientific discoveries.

At one level, one regrets that Bird chose to transfer so early to another discipline of geology and, certainly, one mourns that illness brought so premature an end to his life as a field geologist. Had he continued in Barnum Brown's service, what other great discoveries might Bird have made? Yet maybe a longer involvement in paleontology might have dimmed his bright enthusiasm, might have dulled the excitement through the boredom of repetition.

All in all, we must be profoundly grateful that Roland Bird found time to set down these reminiscences and was so wise in entrusting Theodore Schreiber with the task of seeing them published. This book is destined to become a classic in the history of paleontology. Buy it; you will not regret the purchase.

Petroleum Geology

By F.K. North
Allen & Unwin, Winchester, Massachusetts
607 p., 1985; $60 US, cloth; $34.95 US, paper

Reviewed by Glynn Wright
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Petroleum Geology is a good text book. F.K. North's experience and colleagues with Chevron in Canada and the United States, as well as his university career, have provided the basis for his objective review of geology and exploration techniques. The presentation of his material reflects this in the clarity of the many diagrams and maps and the occasional warnings of the pitfalls of current and past exploration methods.

Naturally one compares this text with A.I. Levorsen's classic *Geology of Petroleum*, written in 1954. The last twenty years have, of course, seen an explosion in our understanding of petroleum geochemistry and utilization of geophysics and petrophysics. A new text was certainly warranted.

The introduction is followed by four parts entitled "The Nature and Origin of Petroleum", "Where and How Oil and Gas Accumulate" (possibly too long), "Exploration, Exploitation, Forecasting", and "Distribution of Oil and Gas".

The usefulness of this book is increased by the fact that each section may be read on its own. References are usually given for the illustrations, but not in the text: this improves the readability of the book, regrettably there is only one page of bibliography in the book. The eight pages of black and white plates contain twenty-five excellent SEMs, unfortunately the photomicrographs and core photographs do not have the same clarity. The publications of the AAPG are the stock references.

With such a broad subject it would be impossible not to disagree with some generalizations, but North will often elucidate such comments in later chapters illustrating the rationale behind those generalizations. One attractive feature of the book is the geographic breadth of the examples ... it is obviously written with a global perspective (and for world distribution).

Chapter 4 on the history of petroleum geology provides an insight into attitudes shown by early exploration personnel. North writes with a lively interest of the history of exploration, putting into perspective the arrival of new approaches to seismology, electric well logs, and theories on petroleum genesis.

Quite properly, North shows that advances in seismic acquisition and processing have allowed advances in the detailed understanding of the distribution of some subsurface formations. He also shows how the integration of geology and geophysics in the eighties has lead to the popularity of "seismic stratigraphy".

In the chapter on basic petroleum chemistry, which also contains a good section on sulphur, gas:oil ratios are discussed in cubic feet per barrel of oil. I think there could have been a comment in the practice in Canada of the recent use of the ratio m^3 gas:m^3 oil ... Canada seems to have been ignored in terms of our use of SI units. The discussion of the origin of hydrocarbons includes a welcome review of theories of non-organic origins: this is one chapter for which a concise selected bibliography would have been very useful.

Chapter 7, on the conversion of organic matter to petroleum, provides an examination of time and temperature effects on that conversion, with proper reservations about the dangers of using present geothermal gradients while calculating ancient burial history.

I feel uncomfortable with Chapters 11 and 12; they include statements such as "The interval transit time is easily measured from density or sonic logs", and "Very high permeabilities ... in carbonate reservoirs are more commonly from limestones than from dolomites ... " which are either wrong or misleading. I wonder how familiar the author is with modern log suites. His preferences for SP/resistivity logs in clastic correlations extends into carbonates, where I would much prefer the gamma ray/sonic or gamma ray/density combination. He does not comment on the order of magnitude of improvement of the modern (*i.e.* 1960s and 1970s) sidewall and compensated neutron logs over the obsolete, qualitative, neutron log. For the geologist working on logs used in the last ten to twenty years, in Canada at least, accurate porosity determinations are best made from combinations of compensated neutron, density and compensated sonic logs, and therefore a graph relating density and neutron readings to determine lithology and porosity would also have been appropriate. One of my concerns is that if I were more knowledgeable about geochemistry, I might find similar omissions in those sections too.

The chapter on reservoir rocks greatly emphasizes sandstone reservoirs, although North himself says that carbonates amount to 40% of all reservoir types; it also includes a very good summary of fractured reservoirs.

In the chapters on the migration and trapping of oil and natural gas, the dangers of strict classification are well illustrated, and he demonstrates the ubiquitous nature of the combination trap. One oversimplification here is the comment that dip in the Western Canada Basin has a constant gradient to the south west. His accompanying illustration shows an increasing gradient and in more detail I am sure some "hinge lines" could be isolated. Fault traps are given more emphasis than I would have expected.

Part IV collates the earlier discussions of stratigraphy, structural geology, geochemistry and fluid movement and delves into exploration and forecasting.

Chapter 19 should be read by all new or prospective petroleum geologists in order to accelerate their development, and understanding of their role in industry. It includes a check-list of items to be verified before presentation to management (I presume this is modelled on Chevron). However, North could have put more emphasis on well logs; instead, he says " ... cores are eventually studied by more individuals than any other item derived from the well".

The short chapter on exploration seismology provides useful comments and quite good reproductions of a variety of seismic sections. This chapter is followed by a description of several mapping techniques used in exploration and exploitation geology, along with comments on the hazards of their interpretation. Occam's razor is quoted, but I question the usefulness of presenting it in Latin. The section on resource assessment is useful and properly includes warnings of the limits of error on this topic.

Part V on the distribution of oil and gas examines the stratigraphic distribution of hydrocarbons; in this, more weight could have been given to the Mesozoic of the east coast of Canada.

The final chapter analyzes case histories of five pairs of giant fields from all over the world, including Pembina and West Pembina, and offers enlightening conclusions. This "learning opportunity" is the central theme to the book as far as the practising and future geologist is concerns: no matter how experienced one is, there's much to be learned here. The question arises — how could a petroleum geologist practise his or her profession without reading North ... or Arville Levorsen, for that matter! ...

Geology and Society

By Donald R. Coates
"A Dowden and Culver Book"
Chapman and Hall, New York
406 p., 1985; $40.50 US, paper

Reviewed by W.O. Kupsch
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Once upon a time, the happy and contented people of the world believed that Mother Nature would look after them by providing boundless crops from the fields, free and clean water, inexhaustible energy, and metals in unlimited quantity.

No more. Now every farmer knows about soil depletion and erosion. A walk to the nearest brook for a drink is now replaced by a few steps toward the fridge for the Perrier Water. Thanks to OPEC and Ken North, we know about oil crises and the ultimate depletion of that resource in our life-time. The supply of metals is a non-issue, because who knows where *they* come from

Donald Coates has written a "disastrous" book as a look at 5 titles of 7 appendices will show: Volcanic disasters; Major earthquake disasters throughout the world; Landslide disasters; Severe flood disasters in the United States; Coastal area disasters from tropical storms and tsunamis.

Yet, not all is doom and gloom. The author's central message in his own words is: "A careful orchestration of geological studies can help soften the deleterious aspects of nature and minimize the harmful byproducts of civilization."

A book of this scope, dealing as it does with mineral, energy, and water resources, volcanoes, earthquakes, landslides, floods, coastal environments, soil destruction including salinization, overgrazing, and desertification, as well as with geoengineering, environmental contamination, environmental management, and environmental law, can not be else but introductory. This in turn has its own advantages and disadvantages. At the same time, the text has to be concise yet explicit. It has to avoid unfamiliar technical terms but not be condescending. The spectacular (the Frank Landslide) has to be balanced by the inconspicuous (wide-spread destructive soil creep).

Overall, Don Coates has succeeded in calling attention to the many things that can go wrong with our physical environment. But surely, the title *Geology and Society* leads one to expect more than a discourse on negative impacts. Society has benefited greatly from geological studies on the origin of petroleum and ore deposits which have resulted in a wider availability of these resources to all mankind. Economic Geology by its very definition is linked to society.

At the same, asking the author to live up to his title is asking too much. What we have here is a book particularly suitable as a text for engineering and science students who have had one introductory geology course and perhaps one in soil mechanics, and are going to take a course in environmental engineering, air photo interpretation, or terrain analysis. For them, this book will be most helpful to provide a much needed wider perspective.

Principles of Physical Sedimentology

By J.R.L. Allen
George Allen and Unwin, Winchester, MA
272 p., 1984; $40.00 US, cloth; $28.95 US, paper

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J.R.L. Allen's *Principles of Physical Sedimentology* is a major rewrite of his earlier book *Physical Processes of Sedimentation* written in 1970. The new book contains thirteen chapters describing essentially all depositional processes except glacial with only minimal coverage of aeolian. The objective is to provide a general understanding of physical processes of sedimentology. Throughout the text, rather than being simply descriptive sedimentology, we see the whys of sedimentology being answered. Allen attempts to relate processes responsible for modern and ancient sediment to simple laboratory experiments. Most chapters begin with a brief introduction followed by a description of 1 or 2 experiments to demonstrate the appropriate principles. The figures are well drawn and uncluttered. Photos are clear and illustrate the principles being discussed.

The chapter titles themselves, show Allen's attempt to simplify or ward off the mystique of sedimentological processes. For instance, Chapter 1, entitled "Concepts and rules of the game", provides the essential background to mechanics and fluid mechanics on which our understanding of the physical processes of sedimentology are based. In this chapter, most of the equations necessary for fluid mechanics are derived. Chapter 2 is called "Pressed down and running over" and describes the characteristics of sedimentary particles, their size, density, shape, packing, pore spaces and angles of repose. Chapter 3, "Sink or swim", discusses particle settling and fluidization. Sediment transport and the resulting bedforms are the subject of "Sliding, rolling, leaping and making sand waves" (Chapter 4). "Winding down to the sea" (Chapter 5) describes channelized flow by concentrating on fluvial processes. "Order in chaos" (Chapter 6) shows that there is a pattern to turbulence by covering boundary layer streaks, bursts, large eddies and the resulting sedimentary structures. Suspended sediment flow is described in "A matter of turbidity" (Chapter 7), "The banks of the Limpopo River" (Chapter 8) is a reference to a muddy river described by Rudyard Kipling and a suitable title for the chapter on very fine-grained sediment. In this chapter, Allen discusses the properties of clay minerals, their cohesiveness, how they are deposited, packed and eroded. An unexpected, but worthwhile, aspect of this chapter was the discussion on the drying out of muddy sediment and the resulting cracking. "Creeping, sliding and flowing" is Chapter 9 on mass movements. Chapter 10, called "Changes in state", covers fluidization, liquefaction and the resulting soft sediment deformation. "Twisting and turning" is an appropriate title for the effects of vortices on sedimentation. Chapter 10 covers topics such as turbulent jets and their application to sand volcanoes and the effects of horseshoe vortices at flute marks, current ripples and dunes. Density flows are discussed in "Sudden, strong and deep" (Chapter 12) which covers nuée ardentes, haboobs and turbidites. Wave motion, both tide and wind generated, is the subject of "To and fro" (Chapter 13).

Allen has also written a laboratory manual entitled "*Experiments in Physical Sedimentology*" to accompany the textbook. The manual describes 28 experiments ranging from Bernoulli's Principle to rheological properties of muddy sediments that can be run using relatively cheap and simple apparatus. They are simplistic but still serve to demonstrate the basic principles of sedimentology. Each experiment provides a follow-up analysis and discussion of its relevance. If the labs were to be applied to a senior undergraduate course, they should be more rigorous with descriptions on quantification. As it is, they demonstrate various sedimentological processes and their results, but at a level one commonly sees at a Science Centre or in a high school class.

Those who pursue the field of sedimentology must go beyond the strictly descriptive aspects and have at least a basic understanding of the physics involved. The book is recommended for any students of sedimentology at the undergraduate level or anyone not sure of the basic physics and needing a refresher. It would make a suitable accompanying text for any of the texts on facies models out on the market.

Wind as a Geological Process: on Earth, Mars, Venus and Titan

By R. Greeley and J.D. Iversen
Cambridge University Press, Cambridge
Cambridge Planetary science series 4
333 p., 1985; $59.50 US, cloth

Reviewed by Michael Brookfield
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In an earlier book co-authored by Greeley (*Earthlike planets: surfaces of Mercury, Earth, Moon, Mars*, 1981) basic concepts were illustrated with sufficient details from the various planets in a marvellous thought-provoking way. In that book "we see clearly how the simultaneous consideration of several planets illuminates the entire subject" (Carl Sagan). I thus looked forward to reading the present book. It could have been just as good.

Alas, in *Wind as a geological process* we get fine detail without broad concepts. The book also lacks any unifying theme and is boring to read. The lack of unity comes from an inadequate view of atmospheric fluid dynamics (discussed in some detail below). The boring writing comes from lack of variety in sentence structure and length, lack of vivid language, and lengthy circumlocutions. For example, on page 7, "Although, we are a long way from carrying out this approach in the study of all aspects of aeolian processes for Earth, Mars, Venus and Titan, the results presented here draw upon this general approach as much as possible. As one might expect in defining the various problems, we commonly find that many aspects of aeolian processes are not well understood, even for Earth, let alone for other planetary environments. Consequently, a benefit of the approach outlined here is not only to provide a logical means for solving extraterrestrial problems, but to contribute towards solving problems dealing with aeolian processes on Earth as well." What the authors presumably mean is that: although we can't do all this for the planets, we have tried hard. Since, we still don't understand all aeolian aspects, even on Earth, this logical approach can help us solve terrestrial as well as extraterrestrial problems.

Well, it is obvious that I am very disappointed in this book. But to be fair, a reviewer should judge a book on what it tried to do, not on what he thought it ought to do.

In their preface the authors state their aims and intentions: "The book deals with aeolian processes in the planetary context."

They intend the book to be used as a reference and text for senior undergraduate and graduate courses in comparative planetology. And they have attempted to write the book in such a way that it can be understood by anyone with a science or engineering background.

How well have they succeeded? In some respects very well, in others abysmally. The book can be readily understood by students with a basic minimum of science. And some chapters, those on aeolian features and particularly the one on physics of particle motion, can serve as useful reference chapters.

But, they haven't dealt adequately with "aeolian processes in the planetary context".

The nemesis of this book is already apparent in the authors' preface. Here they state "In 1941, Bagnold published the first edition of his book, *The Physics of Blown Sand and Desert Dunes* ... The fact that nearly every subsequent paper dealing with aeolian processes refers to the Bagnold book bears testimony that the basic principles described by him are essentially correct and have withstood the test of time. ... It is not our intent to "replace" Bagnold's book *or the research it represents* (my emphasis) ... Instead, we have built upon the solid foundation laid by Bagnold, testing the relationships defined by him through different approaches, and extrapolating the results to other planetary environments ...". In this, the authors serve notice firstly, that the revolutionary advances in knowledge of planetary atmospheres since Bagnold are not going to get much attention and secondly, that other alternatives to Bagnold's views are similarly not going to get much consideration, or critical evaluation. They note, "... planetology requires a multidisciplinary approach to combine talents from the geological sciences, engineering, chemistry and physics". Notably absent is any reference to atmospheric sciences. Throughout the book, there is lack of any clear explanations of atmospheric structure and dynamics of planetary atmospheres. This is like trying to explain submarine current features without going into the structure and dynamics of the oceans. It is the reason for the fragmentary nature of the book.

Next, the lack of critical evaluation of various explanations occurs in many places. For example, in a discussion of ripples, the ballistic theory of ripple formation is preferred over the wave theory without any clear explanations of either (p. 147-153): though I must admit that I have *never* understood Bagnold's ballistic theory. Again, they come to no particular conclusions about ripple formation, give no possible ways of testing the various theories of ripple formation (or even observational criteria for and against), and make no comparisons with ripple formation in other fluids (*e.g.* water). The modelling of yardangs (streamlined, wind-abraded features) in terms of fluid drag until an "ideal" profile is reached could also have been applied to dunes — but it isn't. What we get is the statement from Bloom (p. 158) that "True dunes can best be considered as deformable obstructions to air flow". And so they are — but why do they have regular shapes and why do they often develop in patterns. Bedforms and their relationship to fluid flows are much more critically and thoughtfully explained in John Allen's 1982 books on *Sedimentary structures*: where various divergent explanations are treated seriously and with understanding.

This lack of questioning and critical evaluation and lack of cross-reference to analogous features in other fluids are the main reasons that I consider the book unsuitable for undergraduate and graduate courses. "Why does the wind pile up sand into heaps yet disperse smoke and dust" (from R.S. Scorer, 1978: *Atmospheric aerodynamics* — a great thoughtful book in which the author shows that complex mathematical modelling need not obscure the underlying simplicity of basic theory, nor need observations of clouds and gliders and flying insects be ignored). Such fundamental questions are essential, particularly after the basics of any science have been mastered. It is all too easy, once initial expertise has been gained, to slip into a rut of unquestioning conformity. Any textbook should strenuously attempt to stop this — even if it means putting the case for a theory that the author considers wrong.

Individual chapters vary greatly in quality.

Chapter 1, *Wind as a geological process*, starts with their approach, with as an example the determination of the threshold curve, starting with Bagnold's studies. Later on in the chapter, they note the aeolian features on the planets. This is where the book's subtitle starts to become rather misleading. There is very little in the book on either Venus *(mentioned* on 25 pages — with one and a half pages summarizing its basic features here) or Titan *(mentioned* on 6 pages — with a one-page summary here).

The second chapter is the weakest in the book. It starts off with properties of atmospheres. This section is one of the worst examples of mindless number-crunching I have ever come across. Hydrostatic equilibrium, adiabatic lapse rates, unstable/neutral/stable boundary layers, Richardson number, Pressure gradient, Ekman spiral, Rossby number, appear like rabbits out of a hat, unrelated to each other and nowhere used to explain anything. And in some cases unrelated things are stuck together. The effect of non-neutral stability is related to the Richardson number which is a function of vertical change of temperature and horizontal velocity (along the x, normally along-wind axis). Yet what is plotted as an illustration on Fig. 2.10 is the dimensionless wind shear against the ratio of height above the surface to the Monin-Obhukov parameter (a different stability measurement) — based on similarity theory. Wind speed profiles for Venus, Earth and Mars stop at an arbitrary 100 metres despite their very different atmospheres.

Measured wind profiles of the Earth stop at 15 metres height, though aeolian bedforms can be much higher than this. The Ekman spiral is nicely displayed in two figures, but it is nowhere mentioned that the number of times it has actually been observed can be counted on the fingers of one hand. Observations on actual atmospheres are not given. This is all the more annoying in that models of terrestrial boundary layers are now reaching a stage when they can be useful in interpreting aeolian features. However, the authors cite no papers on terrestrial atmospheres later than 1971 in this section (later papers are all of extraterrestrial atmospheres).

The rest of Chapter 2 (on particle formation) and Chapter 3 (on physics of particle motion) are well done. Chapters 4 and 5 on aeolian abrasion and deposition and resulting features are also reasonable summaries of features. Wind streaks in Chapter 6 seem to get too much attention, occupying 50 pages, *i.e.* more than one-seventh of the book. In this chapter, mention is made of snow. There is not much elsewhere on aeolian snow and ice features which is a pity, as is the absence of mention of possible bedforms on Venus. Its dense atmosphere, low velocity and incredible thermal regime could have led to interesting logical speculations; on for example, grain size, density, sorting and their relation to bedform size, wavelength, anatomy, orientation, etc. But only a few asides on saltation paths, wind streaks and ventifacts occur. Though the low-level wind profiles of Mars, Venus and Earth are given, there is no explanation as to why they are so different, nor a comparison of their effects on the different planets. Chapter 7 is a reasonable summary of windblown dust, but I would have liked a bit more on the source of loss (wind-blown silt deposits) and its origin. There could have been much more cross-reference to Chapter 2 where the origin of particles is discussed.

The book ends abruptly with no summary or conclusions.

Though individual parts of this book are useful, I can recommend it neither as a text nor as a good summary of "wind as a geological process". Far too many books are being written and published, without sufficient preliminary planning or peer review. In *Wind as a geological process*, the authors were very poorly served by at least some of their critical reviewers (cited in the acknowledgements). If you agree to criticize a book draft, you ought to make a good thorough job of it. Lastly, given the authors' competence, they ought to be able to write a much better book than this one. I hope they can write either a revised edition of this book, or perhaps better, a book on aeolian processes on all planets: I look forward to reading it.