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Book Reviews

Principles of Geology, being an attempt to explain the former changes of the Earth's surface, by references to causes now in operation.

Vol. 1, By Charles Lyell
Facsimile reprint of the first edition of 1830, with a new introduction by Martin J.S. Rudwick; University of Chicago Press, Chicago and London
511 p., 1991; US $20.75, £14.25

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In 1972, the venerable Buffalo Society of Natural Sciences mounted an exhibition of 198 books considered to constitute "Milestones of Science". The books that were featured were described in a handsomely produced catalogue of 305 pages, featuring a colour frontispiece, 207 monochrome plates and decorated endpapers. This catalogue is, by now, a collector's piece in itself for we historians of science, since we cannot hope to possess more than a few of the works illustrated therein, if any at all.

For the historian of the earth sciences, however, that catalogue is a little depressing. Although a few other works that are cited lie close to the frontiers of our discipline, only four of those 198 "milestones" are geological writings. The earliest is Steno's *Prodrome* of 1669; the next, William Smith's *Delineation of the strata of England and Wales...* of 1815; and the latest is Louis Agassiz's *Untersuchungen über die Gletscher* of 1840-1841. The fact that the work here reviewed is placed into so distinguished a literary company attests to the recognition of its immense scientific significance by historians at large.

Although a much briefer volume entitled *The Student's Lyell* was long to be used as an elementary text by geology students, the three stout volumes constituting the *Principles* proper passed out of print almost at the time of Charles Lyell's death in 1875. In his "Introduction", Martin Rudwick comments cogently (p. vii-viii):

> "Among comparable classics the *Principles* must be one of the least widely read. There are two simple reasons. The first edition, which is by far the most significant historically, has long been a rarity, and in recent years an increasingly expensive one at that. And the book is very long, and lacks clear internal signposts to the structure of its argument. With this inexpensive reprint edition, the first reason for the neglect of the work will at last disappear; potential readers will no longer have to resort to a rare-book room to read Lyell for themselves. The purpose of this introduction is to alleviate the second problem, by providing an outline of the continuous thread of argument that underlies the 400-odd pages of the first edition. This is particularly important, because the existence of such an argument has often been overlooked and the work as a whole misinterpreted as a mere textbook or compilation of contemporary knowledge of the science. Furthermore, attention has often been focused on one part of one of the three volumes, a part which was unquestionably of great importance in Charles Darwin's formulation of his theory of evolution. But this exclusive focus has tended to obscure the significance of Lyell's views on species for his own, more strictly geological purposes."

Rudwick's contribution is, in fact, an introduction not only to volume I but also volumes II and III, whose reprinting will be undertaken imminently by the University of Chicago Press. It is prefaced by a brief account of "The Making of the Principles" (p. viii-xv) and followed by a bibliography of the principal secondary works on Lyell and his writings.

The printing and paper are good, the cover design quite attractive, and the price (by modern standards) indeed quite moderate. By making this fundamental text on the geological philosophy of Uniformitarianism so freely available, the University of Chicago has indeed served earth scientists well.

Yes, nowadays we know there are limitations to our interpretation of ancient rocks by the observation of processes still in operation; for example, it is hard to comprehend how erosion must have proceeded in pre-Devonian times, when there were no land plants to inhibit its actions, even in parts of the World where there was both heat and heavy rainfall. And yes, even today there are believers in "astrogeological" catastrophes, just as there were in Lyell's time (and in even more flagrant disregard of the evidence from fossils!). Yet Uniformitarianism remains the proper, basic mental discipline for earth scientists: and this was the work that gave the first really strong dose of good scientific sense, to control or cure the aery flatulences of apocalyptic speculation. Read it, and learn anew!

The Highlands Controversy. Constructing Geological Knowledge through Fieldwork in Nineteenth-Century Britain

By David R. Oldroyd
University of Chicago Press, Chicago and London
438 p., 1990; price not available

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The image of the history of geology, derived from the historical works that were standard texts even up to twenty years or so ago, was profoundly gratifying to any reader with high scientific ideals. The "giants of geology", it was evident from these writings, were truly Olympian figures, calmly and devotedly engaged in expanding the frontiers of knowledge. If ever they disagreed, this came about simply through their clash of concepts, for they were above the meaner motivations of common humanity. Those were golden days, in comparison with which we lesser lights of contemporary geology are mere sordid, squabbling and self-centred midgets.

However, during the last two decades, an investigation of private correspondence, notebooks and other documents from the 19th century has given us quite a different picture. It is one that is much less elevating, even if much more in accord with present human behaviour. Instead of these calm, altruistic Olympians, we see men of ability and, yes, with a genuine interest in their science, who were also swayed strongly by their desire for fame — the transient fame of approval and admiration by their contemporaries, the more lasting fame of the acceptance into geological literature of the terms they invented and the notions they originated (or claimed to have originated!). Jealousies and jockeyings for social and scientific position were the rule, not the exception. A leading executive position in the Geological Society of London, or the Directorship — no lesser appointment would serve — of Her Majesty's Geological Survey, were trump cards in these scientific games: consequently these were striven for by much backstairs intriguing or discreet letter-writing. London was the place to be; the further from London, the further from that particular God, the God of satisfied personal ambition.

At the heart of these intrigues, and much the most skilled player of all the court or other cards at his disposal, was the formidable Scottish baronet Sir Roderick Impey Murchison. Martin Rudwick's *The Great Devonian Controversy* (1985) and James Secord's *Controversy in Victorian Geology: The Cambrian-Silurian Dispute* (1986) are admirable probings into the hitherto unopened closets of Victorian scientific discord, both books making evident Murchison's massive ego and ruthless self-seeking. Such other scientists as were tactful enough to remain in Murchison's favour might certainly expect to be used by him, but might anticipate also the favours of his patronage; and, in fairness to Murchison, it was a prerequisite that they should have adequate geological talents. In contrast, to question Sir Roderick's stratigraphical judgement was a risky business, however tactfully it be done; and one controverted his ideas at one's peril!

In this latest, searching analysis of a controversy in which Sir Roderick involved himself, the author's judgement is balanced enough (p. 169):

> "... we now know much more about how the patronage system operated in Victorian science: and how Murchison, perhaps above all other scientists of his day, was adept at using it to his advantage and for the advancement of his views. Nevertheless, despite the scrutiny that has been given to Murchison's work in recent years, the picture of him as a man of distinction, full of reckless energy and enjoying life to the utmost ... has rightly survived".

In the early stages of the geological battle here recounted, the concepts of Murchison — straightforward, simplistic and permitting a vast acquisition of new territory for his beloved Silurian system — had he not been called the "King of Siluria", and revelled in that title? — were pitted against those of James Nicol. Most geologists are aware that Murchison and Sedgwick began as friends and undertook fieldwork together, but were caused by differing views, to become enemies. However, that at least was a reasonably equal contest. Murchison and Nicol began also as friends, Nicol touring the northwest Highlands in the baronet's company; but, when their concepts diverged, Murchison the London-based heavyweight was readily able to rout a mere featherweight opponent in faraway Aberdeen. It was really no contest, even before Murchison added to his armament the massive scientific fighting power of the Geological Survey Directorship. Poor Nicol faded away into obscurity and virtual oblivion.

Archibald Geikie, Murchison's principal scientific protegé and eventual successor, was a useful second in these contests, even if sometimes discreetly disassociating himself from his principal's methods and toning down his aggression. The Murchison-Geikie partnership carried all before it. Only after Murchison's death were geologists at large permitted to express doubts about the correctness of their simplistic interpretation of a particularly complex area.

The mice that began nibbling away at the base of their edifice of theory were Henry Hicks, Thomas G. Bonney, Matthew F. Heddle and, in particular, Charles Callaway, who, as Oldroyd reports (p. 214), solved in its essentials the mystery of the Northwest Highlands. The edifice was finally toppled by Charles Lapworth, whereupon Benjamin Peach and John Horne erected a new and better construction upon the tumbled foundations of Survey concepts. Not that we can claim, even yet, fully to understand this geologically complex area; this newer structure is still being added to and altered in detail, even a century later.

In his preparation and writing of this meticulous study, David Oldroyd was greatly aided by his personal knowledge of the terrain. His study may properly be styled definitive and it is elegantly and lucidly written. (Though I winced at "The rock outcropped," p. 181. I am perhaps one of the few still to prefer "cropped out"!) The proofchecking and indexing are close to faultless; the illustration, and in particular the eight colour plates, mostly of maps, are well chosen, well placed and sensibly analysed.

All in all, then, this is a major contribution to our understanding of how geology evolved. It is most relevant to Canada since the problems encountered were mirrored, and the lessons learned were applied, in the study of our own more extensive — yet, in some senses, less frustratingly complex — Precambrian terrains.

George William Featherstonhaugh, the first U.S. Government geologist

By E. Berkeley and D.S. Berkeley
University of Alabama Press, Tuscaloosa, AL, and London
357 p., 1988; US $39.95

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The names of most of the "giants of geology" — the geologists who constructed, upon very insubstantial earlier foundations, the framework for the present edifice of geology during the late 18th and 19th century — are known to most practising geologists of today. Yet there are a few who, though well known and influential in their time, have slipped mysteriously out through the meshes of scientific memory. Yes, we remember William Smith, Sedgwick, Murchison and Lyell; yet it is somehow harder to obtain any clear picture of that intriguing polymath William Buckland; and, though Henry de la Beche and George Bellas Greenough ranked among the leaders in their day, it is even harder to recall anything specific about them. On this side of the Atlantic — yes, one remembers at least something about William Maclure and James Dwight Dana, rather more about Clarence King and William Edmond Logan maybe, and a great deal about John Wesley Powell and those battling mammoths of paleontology, Cope and Marsh: but Ferdinand Vandiveer Hayden, Joseph Leidy, Henry Youle Hind now — why do they so elude memory, when they were equally prominent in the development of our science on this Continent? As for George William Featherstonhaugh — who was he?

In recent years, fortunately, historians of geology have been extending their researches beyond the handful of figures placed at centre stage by Archibald Geikie, in his *Founders of Geology*, and by the Fentons in *The Story of the Great Geologists* (later *Giants of Geology*), to consider the attainments of those other geologists allowed hitherto to lurk almost unnoticed in the wings. Among these studies have been Paul McCartney's *Henry de la Beche: observations on an observer* (National Museum of Wales, 1977), Lester Stephens' *Joseph Le Conte, gentle prophet of evolution* (Louisiana State University Press, 1982) and several other works noted at length by me in these columns. A new biography of Hayden has appeared, though it is not yet to hand; and Dennis Dean's study of Gideon Mantell is reportedly in the last stages of preparation. And here, at last, we have a properly thorough, balanced and well-researched study

of Featherstonhaugh, to bring that fascinating person back from the verges of oblivion.

For indeed, Featherstonhaugh was an influential and intriguing figure. He was perhaps the only English geologist ever to be employed successively by the US and the British Governments; moreover, he was a major pioneer of research on the geology of both the southern and the northeastern United States. Over many years, he was a close personal friend not only of the amiable Buckland but also of that difficult gentleman Sir Roderick Murchison; he advised Lyell on an itinerary for the latter's North American visits and discussed US geology with Edouard de Verneuil; he entered vigorously into the dispute between Wernerians and Huttonians on the side of Hutton (and thus, of the angels!); and he inveighed effectively against the geological absurdities being propagated by Amos Eaton.

His career was indeed a long and remarkable one. Born in London in 1780, he grew up and became a fossil-hunter in Scarborough, Yorkshire, in which town his mother spent the rest of a long life. (She lived to be 96 and was often visited by her son, who was with her at her death). Following earlier travels in Spain and Italy, young George voyaged to Boston in 1806; made a visit to eastern Canada in 1807; and in 1808, after marrying a Schenectady lady, settled in New York State to farm his new wife's property.

He proved an innovative and successful farmer, writing about agricultural matters as well as geology; yet he found time also for an involvement in politics and, in particular, in the controversy over the wool tariff. For the planning and construction of the Albany and Hudson Railroad — one of the first in North America — Featherstonhaugh deserved primary credit. In the leisure between these activities, he wrote on linguistics and published innovative translations of Dante's *Inferno* and Cicero's *Republic*. He also wrote some plays which, though published, were much less enthusiastically received. Though seriously embarrassed by his loyalty to his King during the American Revolution (or, as it is styled south of the border, the War of Independence), he survived that episode in a prosperous condition and bade fair to become one of the new Republic's most prominent citizens.

However, that was not to be. After bearing two sons and two daughters, his wife Sally died in 1828. Her death generated a series of financial problems for George; and, as a culminating blow, the house they had shared and most of their possessions were destroyed by a fire the following year. The ensuing period of difficulty and uncertainty caused Featherstonhaugh to move away from New York State to Philadelphia, where he scraped a living by writing geological articles, lecturing and other scientific activities. In 1831, he embarked upon a second marriage, this time with a woman more than 30 years his junior. It proved successful and brought further children, but he and his family had no financial security. Consequently it was with great relief that, in 1834, he accepted the appointment as Geologist to the US Government, even though it meant being prolongedly away from home.

His task was to examine the elevated country between the Missouri and Red Rivers; it proved difficult, often exhausting, but also, at times, exhilarating. He established good relations with the Indians he encountered and came to be known to them as "the Stone Doctor"; in contrast, he was horrified by what he saw of the slave trade. Featherstonhaugh's accounts of the travels that ensued were published in two works that are classics both of geology and travel-writing, *Excursion through the Slave States* (1844) and *A Canoe Voyage up the Minnay Sotor* (1847). His report of his geological reconnaissance to the US Government was published earlier, in 1835; it was careful and detailed, receiving many respectful notices in European journals. However, in part as a consequence of a malicious attack by a US soldier who had resentfully accompanied Featherstonhaugh in his explorations, his Government appointment was not renewed.

Partly for altruistic reasons, partly because he needed a new position so urgently, Featherstonhaugh began studying the then-vexed question of the Maine-New Brunswick boundary, proposing that a geological and topographic survey might help determine the proper placement for the US-Canadian frontier. President Andrew Jackson's cabinet responded positively and promised to engage him to undertake this task. However, something went wrong. Instead, after a visit to Quebec to sound out alternative prospects, he travelled to London and was appointed to undertake the survey by Lord Palmerston, thus serving the British, not the US Government.

Because of the difficult terrain to be traversed and unfavourable weather, this survey proved arduous; yet the 59-year-old Featherstonhaugh withstood its rigours much better than did his much younger English colleague, an officer of the Royal Engineers; and the resultant report, the basis for the Webster-Ashburton Treaty of 1842, was almost entirely his work. Thus it was that Featherstonhaugh helped to delimit the Canada of today.

Yet his activities had made him too unpopular in the United States for a renewal of life there. Consequently, Featherstonhaugh was grateful to accept instead appointment as British consul in Le Havre, France, even though the salary was not generous and the expenses were manifold. He held that appointment for the rest of his long life. Its most dramatic episode was Featherstonhaugh's involvement in the escape from France of the elderly King Louis-Philippe and his Queen, after the 1848 Revolution, for which service he received from the King a gold snuff-box encrusted with diamonds! He died in 1866, at the venerable age of 86.

This account of the life of George William Featherstonhaugh is thus a contribution, not only to the history of the earth sciences, but also to the general history of North America and Europe. It is lucidly written, well printed and meticulously proof-read (I noticed only a single error, on p. 83), and has good illustrations. Yet it leaves one question unresolved; how *should* his surname be pronounced? As written, with a terminal "haw", as "Festonhow"; or, in standard English fashion, as "Fanshaw"? That is something we may never know!

Clarence King. A Biography

By Thurman Wilkins, assisted by Caroline L. Hinkley; Revised and enlarged edition.
University of New Mexico Press, Albuquerque 524 p., 1988; price not available

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The history of the earth sciences has been always a matter of concern to some among the practitioners of these disciplines, but within the last fifteen years, the growth of interest in this topic has been remarkable. At a time of dwindling geological employment opportunities, a diminished government commitment in most countries (witness the slaughter of some 40% of British university Geology Departments and the imminent elimination of much meaningful research at the British Museum [Natural History]) and an increasingly tight control of geological exploration and fossil-collecting by conservation-minded governmental and private explorations, it is indeed tempting to escape into nostalgia. Only a few short years ago, for we geologists, the world was our oyster, to be prised open in the quest for solid scientific nutrition and the occasional pearls of economic riches, with no-one likely to complain about where the shell was thrown away. Not so nowadays, alas!

One beneficial consequence of this growth of interest is that more studies of the lives of geologists, and of the controversies in which they were involved, are being published than ever before. Another, equally beneficial, is that classic works, long out of print and unavailable, are being republished — and often by publishers quite different from those who issued the original editions.

Many of these are facsimile reprints, prefaced either with rather perfunctory introductions[1] or by thorough and scholarly studies that either enlarge the reader's knowledge of the author[2] or facilitate his comprehension of the reprinted work[3]. New editions such as that here reviewed, where the original author has revised or enlarged his text (in this instance, with the help of a collaborator), remain unusual and afford a particular interest to the reader.

Clarence Rivers King (1842-1901) was one of the most gifted scientists to engage himself in the early geological exploration of the vast, still almost unexplored regions of the American mid-west. He was a mountaineer of considerable accomplishments and a lucid writer: his *Mountaineering in the Sierra Nevada* (1871) has been repeatedly republished and has great freshness and charm. He was wealthy, handsome and charming, able and ambitious. He served as Director of the U.S. Geological Survey of the Fortieth Parallel (1867-1877), making pioneer investigations under difficult conditions of the geology of Nevada, Utah and Colorado; and, in competition with the leaders of two other contemporary surveys, he was appointed first Director of the U.S. Geological Survey, resigning after a year because of his desire to enlarge his already considerable mining interests. He seemed set fair to become a millionaire and one of the United States' most notable citizens; certainly he had political ambitions, conceivably he might have attained the Presidency.

Yet, in true romantic fashion, all this was brought to an end by a love affair. To fall in love with a negress was, at the time, wildly outside the realm of social acceptability; but that is what Clarence did. Moreover, he married his Ada and remained, in his fashion, faithful to her and their children. However, the fear of social consequences caused him to marry her under an assumed name; only when he was at the point of death did she learn his true name. During all the years after his marriage, Clarence lived a double life, in part in secrecy with his wife, in part as a prominent figure in the social and intellectual life of New York and Washington, D.C.

Yet his life passed progressively from the sunshine of success into the shadow of eclipse. Clarence plunged ever deeper into a morass of financial problems, the consequences of unwise speculations in mining and pearl-fishing. The after-effects of an injury, and a series of painful illnesses, eroded his robust physique. Their effects were exacerbated by his dogged conviction that his mining investigations — often undertaken under harsh conditions — must, if persisted with, ultimately restore his fortunes. They did not. Clarence died on Chistmas Eve, 1901. His funeral in Manhattan was attended by many notable persons, including fifty members of the Century Club; but not by his wife.

Yes, it is a romantic story — the stuff more of Victorian and Edwardian novels than of real life, one might feel. It was well told in the first edition; and, according to the principal author's preface to this second edition, the changes are not extensive (p. xi):

> "My revisions have required no major surgery on the text. I have corrected some minor errors of fact and polished the style in a number of places. I have eliminated certain excess details, rearranged the sequence of a few passages, and reconsidered several points in the development of the narrative. No doubt the most significant difference lies in the addition of numerous details, amounting to nearly thirty-five thousand words, for whatever enhancement they may provide the text. The fresh materials I have drawn you include nearly two hundred letters by Clarence King ... which were not available to me during my original researches."

If you are fortunate enough to own the original edition, then, you may not deem it necessary to obtain this new edition. However, if you are not so blessed, you should buy and read it; for this is a fascinating story and very well told.

Notes:

[1] Rudolf Raff's introduction to the 1990 reprint by the University of Indiana Press of Charles H. Sternberg's *Life of a Fossil Hunter* serves as example.

[2] David Spalding's extended and erudite introduction to the 1985 reprint by NeWest Press, Edmonton, of Sternberg's *Hunting Dinosaurs in the Bad Lands of the Red Deer River* is a model of this kind.

[3] Martin Rudwick's guide to the understanding of Charles Lyell's *Principles of Geology*, prefacing the 1991 reprint of that work by the University of Chicago Press, exemplifies such an approach.

In the Footsteps of John Wesley Powell

By Hal G. Stephens and
Eugene M. Shoemaker
Johnson Books and the Powell Society, Boulder and Denver, Colorado
286 p., 223 unnumb. pls., 8 tabs., 7 maps, 1987; US $34.95 cloth, US $19.95 paper

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The explorations of the Green and Colorado Rivers, and in particular of the Grand Canyon, under the leadership of the one-armed Civil War veteran, geologist and soon-to-be ethnologist John Wesley Powell, rank among the foremost of scientific adventure stories. The first boat journey down the then-unexplored rivers, in 1869, was perhaps the greater adventure; it took 100 days and the surviving members — three had left the boats and been slain by Shivwits Indians — were weak from scurvy and near-starvation when they emerged from the canyon.

However, in scientific terms, it was the later (1871-1872) expedition that yielded the more important results. During this second expedition and immediately before it, three different photographers — E.O. Beaman, James Fennemore and John K. Hillers — took a long series of excellent photographs of the spectacular topography of that region. However, since the half-tone reproductive process was not then in use in publishing, Powell's accounts of the expeditions were illustrated instead by line-drawings made from the photographs by artists. In consequence, though some photographs were marketed commercially as stereophotographs for use in the then-popular stereopticon viewers, the work of the expedition photographers has been scarcely remembered.

In 1968, three organizations — the United States Geological Survey, the Smithsonian Institution and the National Geographic Society — jointly celebrated the centennial of Powell's canyon voyage. As one of the commemorative activities, the authors of this work spent three months in traversing the Green and Colorado Rivers along Powell's route, identifying insofar as possible the stations from which the earlier photographs were taken and taking new photographs from those positions. There were problems (p. 7):

> "At a few places on the river banks, Stephens could not occupy the exact station because it had been changed by the river, a tributary stream, or a rock fall. In the Canyon of Lodore, for example, a ten-ton boulder from the high canyon wall now reposes on the station where Beaman had set up his camera to obtain photograph 504. The 1968 photographs, in such cases, were taken

from an offset position, the extent of which is noted in their captions. At other places, we encountered heavy growths of tamarisk (introduced into the region some time around the turn of the century), box elder, or cactus that obscured the view from a formerly barren camera site. At one station on Kanab Creek, that cactus was not to be argued with! It was impossible, of course, to reoccupy sites now flooded by Flaming Gorge Reservoir and Lake Powell. We were able to duplicate roughly some of the gorge scenes, but the lake has drowned the Glen Canyon of Powell's day so completely that we omitted the 162 river miles between Hite, Utah, and Less Ferry, Arizona."

In all, about 150 camera stations were identified to be shown on the accompanying maps; and, at all these positions, new photographs were taken. From these, 110 were selected for reproduction alongside the originals taken from the same positions. In each case, a commentary is given on the two photographs, discussing the circumstances and the changes over 100 years. Yes, the construction of the Flaming Gorge Reservoir and Lake Powell has indeed flooded some areas, causing a modification to the whole water-flow regime of the region, and yes, there are some visible differences in the vegetation. Nevertheless, one is struck much more more by the close similarities between the photographs than by the changes.

This was an intriguing project, handsomely carried through to publication. The result is a book that can be equally well displayed on coffee-tables, consulted by historians of geology, or utilized by geomorphologists to exemplify the slowness or erosive processes in arid regions. In particular, though, this volume is of value because it makes available, for the first time, so many excellent reproductions of those historic photographs from the expedition 120 years ago.

The Western Photographs of John K. Hillers. Myself in the Water.

By Don D. Fowler
Smithsonian Institution Press, Washington
166 p., 1989; US $24.95

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To geologists, the name of John K. "Jack" Hillers (1843-1925) is likely to be quite unknown. The more erudite western historians may remember Hillers as one of the boatmen in John Wesley Powell's epic journey of 1871 through the Grand Canyon — one, moreover, whose diary of that memorable journey has been published (see Fowler, 1972). However, it is only those persons interested in the visual history of the American West, as represented by photographs, who are likely to be familiar with Hillers' name and to honour it.

Yet, Hillers was long in the service of geologists — not only on the Grand Canyon journey, but also as an employee of the Geographical and Geological Survey of the Rocky Mountain Region (the Powell Survey) and subsequently of the United States Geological Survey, as well as of the Bureau of American Ethnology. One reason why he has been forgotten is explained by author Fowler:

> "... Hillers, unlike many other government employees, left but a scant "paper trail". Apparently because of his close friendship with John Wesley Powell, who was Hillers' boss from 1871 to 1894, Hillers worked for the most part under verbal rather than written orders. The files [of the Surveys and Bureau] contain very few documents on, by or about Hillers." (p. 11)

However, I believe there is another and better reason. A good photographer tends to be a quiet man, an observer rather than a doer — a man who can, by avoiding obtruding himself unduly upon the notice of his subjects, record their character and moods more accurately. That Hillers possessed these traits is evident from his success with native Indian subjects, the Indian men and women whose portraits figure so prominently in this volume (Plates 63 and 85 to 92 well exemplify this success). Such a person does not impose upon memory, as do his or her more forceful — and, very often, less pleasant — contemporaries.

Yet it is not with Hillers' portraits of Indians, but with his visual record of the American West as seen during pioneer geological explorations, that scientific historians will be concerned. Many of these photographs have appeared already in published accounts of the Powell expedition, while others have adorned US Government reports and other publications; but even of these, the quality of reproduction in this volume enforces a refreshing reconsideration and causes the seeing of much new detail. The remainder of the photographs — notably those taken by Hillers in Indian Territory (now Oklahoma) in 1875 — are published here for the first time.

Mr. Fowler's text likewise deserves praise. His prolonged and meticulous probings through the veil that has hitherto concealed Hillers' life gives us the fullest biography that can ever be written, from Hillers' birth in Germany to the deterioration in health that preceded his death. Yet, it is hard to gain any clear sense of the "personality behind the pictures"; and, quite probably, that is what Hillers would have wished. It is through his photographs, with their "great sense of composition and balance and the use of light and shadow", the photographs which helped raise "photography in America from mere recording to high art" (p. 157) that Hillers deserves to be, and will be, remembered.

REFERENCE

Fowler, D.D., 1972, ed., "Photographed All the Best Scenery": Jack Hillers's Diary of the Powell Expedition: University of Utah Press, Salt Lake City, 225 p.

Igneous Petrogenesis: A Global Tectonic Approach

By M. Wilson
Unwin Hyman, London
466 p., 1989; US $39.95, paper; US $100.00, cloth

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As the title suggests, this book attempts to place igneous petrology in a plate tectonic context. It succeeds admirably. This is not a traditional petrology text. For example, phase diagrams, norms, plutonic rocks, and the Bushveld and Skaergaard intrusions are essentially ignored. The author leaves these topics to others. Instead, she has synthesized the enormous amount of petrologic, geochemical, isotopic, and geophysical data on volcanic rocks from different tectonic environments, through 1987, into a coherent and logical story. She presents chapters on mid-ocean ridges, island arcs, active continental margins, back-arc basins, oceanic islands, continental flood basalts, continental rift zones, and potassic magmatism, in that order. In each chapter, the author follows the same order of topics: (1) simplified tectonic model, (2) crustal structure, (3) petrography, (4) major element chemistry, (5) trace element chemistry, (6) isotopic data, (7) detailed petrogenetic model. This systematic approach is elegant because each topic builds upon the preceding in order to arrive at the synthesized model. There is a remarkably comprehensive compilation of data, particularly so for the trace element and radiogenic isotope data. The author uses the same general format throughout for the element and isotopic diagrams. It is, therefore, simple to compare the trace elements and isotopes among the different environments. She also includes the MORB and ocean island basalt fields as points of reference on almost all the isotopic diagrams, thus aiding comparison of the data. This excellent compilation makes the book useful as a reference as well as a tectonic petrology text.

The first part of the book is a review of the geochemical characteristics of igneous rocks and the petrogenetic processes that give rise to and modify magmas. The geochemistry presented in Chapter 2 is essentially an outline of the kind of data she uses throughout the book (major, trace elements and isotopes). If this material is being introduced to students for the first time, it is important to supplement the material offered here with a more detailed treatment. Chapter 3 is a nice synthesis of the current state of knowledge concerning the mantle. The author uses geophysical and experimental petrology studies, as well as the mineralogy and geochemistry of presumed mantle rocks, to illustrate the petrological nature of the mantle. She also provides a fairly detailed treatment of the different types of melting that may occur in the mantle. Chapter 4 discusses petrological processes that may modify a primary melt. This chapter is a good introduction to the literature of the 1980s concerning convection, mixing, convective fractionation, and AFC processes.

Some of her synthesis concerning the complexity of magma sources is very good indeed. For example, in Chapters 6 and 7, she discusses many different sources that contribute to island-arc and continental margin magmas and indicates that many questions still remain. There is also a section on the significance (or lack thereof) of negative Nb-Ta anomalies in subduction zone volcanic rocks. She also discusses the problems of distinguishing between source contamination and high-level crustal contamination.

My complaints are few. There are several minor errors in the text and diagrams. Chapter 4 is rather general and, in places, superficial. More detail is needed for someone unfamiliar with the plethora of new concepts since 1980. The chemical data that she presents does not follow a standard format, which makes comparison difficult at times. Different normalization procedures for trace elements are used in the diagrams, and it takes a bit of work by the reader to unravel them.

I highly recommend this book; it is excellent value for the money. It is best suited to three audiences; (1) as a text for an advanced undergraduate tectonic petrology course; (2) as a starting point in a graduate petrology-tectonics class; and (3) as a reference for workers in petrology, geochemistry, tectonics, and ore deposits. Because of its strong chemical emphasis on volcanic rocks, this book nicely complements volcanological treatments such as Fisher and Schmincke (1984) and Cas and Wright (1987).

References

Fisher, R.V. and Schmincke, H.-U., 1984, Pyroclastic Rocks: Springer-Verlag, Berlin, 472 p.

Cas, R.A.F. and Wright, J.V., 1987, Volcanic Successions: Modern and Ancient: Allen & Unwin, London, 528 p.

Lacustrine Petroleum Source Rocks

Edited by A.J. Fleet, K. Kelts and M.R. Talbot
Geological Society, Special Publication No. 40
Published for the Geological Society by Blackwell Scientific Publications, London and Boston
391 p., 1988; price not available

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Lacustrine Petroleum Source Rocks is a collection of the papers presented at a meeting held in London in 1985 by the Geological Society and organized by the International Geological Correlation Program (IGCP) Project 219. This volume is a companion publication to *Marine Petroleum Source Rocks* published by the Geological Society in 1987, which also is a compilation of papers of a meeting organized by IGCP 219.

Lacustrine Petroleum Source Rocks is a collage of 29 papers and abstracts that is divided into three parts: (1) tectonic, geological, geochemical and biological framework; (2) palaeoenvironmental indicators; and (3) case studies. The first part comprises four papers and two abstracts. The first paper in the volume, by Kelts, provides a summary (overview) of the hydrology and chemistry of lacustrine systems. This paper compares and contrasts lacustrine and marine systems as well as different types of lakes with particular emphasis on such factors as aquatic organic productivity and preservation geochemistry. The three succeeding papers describe the factors controlling the formation of lacustrine source rocks as determined from examination of Quaternary lake deposits. Talbot describes organic-rich deposits from a number of lakes in tropical Africa and tests the playa lake, anoxic lake and ephemeral lake models for formation of lacustrine source rocks. De Deckker describes "deep lake, lake with ephemeral water and dry lake" models based on Australian examples with particular reference to organic and metal accumulations. In one of the most interesting papers in the volume, Oremland and some 12 co-authors present an extremely comprehensive and interdisciplinary overview of the microbial and biogeochemical processes in Big Soda Lake, Nevada.

Part two of the volume, "Palaeoenvironmental Indicators", includes eight papers on topics ranging from organic geochemistry to palynological techniques of interpreting the paleoenvironment of lacustrine systems. The organic geochemistry of recent (Tanganyika, Kivu and Edward) and ancient (Eocene lacustrine rocks of Colorado and Utah) lacustrine systems is described by

Katz. Behar summarizes the general organic chemistry of a variety of lacustrine and delta systems. The paper by Volkman and that by Ten Haven *et al.* describe the utility of biomarkers as paleoenvironmental indicators. The last four papers in this section cover a variety of topics: Davison provides an interesting overview of the role of iron, sulphur and carbon in lacustrine and marine sediments and De-Xin describes the use of palynomorphs extracted from oil as indicators of source rock and migration path. The paper by Bahrig on the formation of deep water siderite and that of Yuretich on stratigraphy and clay mineralogy, although interesting, are out of context in this volume.

Part three includes 15 papers under the heading "Case Studies". Of these, five papers discuss some aspect of the Devonian (Orcadian Basin) or Carboniferous (Dinantian oil shales) of Scotland and four papers deal with non-marine source rocks of China. The remaining six papers discuss a variety of basins. Papers in this section cover diverse topics on physical limnology to biogeochemistry and isotope analysis. The papers are interesting and well illustrated although uneven in their treatment. Notably absent from this section are some of the better known oil shale deposits and source rocks of North America and Europe.

Overall, *Lacustrine Petroleum Source Rocks* is an excellent compendium of recent advances in the field. The papers, with few exceptions, are well written, edited and illustrated. There are no substantial errors in the volume and the only shortcoming is that the case histories do not adequately represent important known lacustrine source rocks. The strength of the book is the review articles in Part 1, which provide both the background information necessary for the novice and an excellent comprehensive summary for the expert. No similar volume exists on lacustrine source rocks and anyone seriously interested in petroleum source rocks should consider purchasing not only this book, but also the companion volume *Marine Petroleum Source Rocks*.

The Encyclopedia of Igneous and Metamorphic Petrology

By D.R. Bowes
Van Nostrand Reinhold, distributed in Canada by Nelson Canada, 1120 Birchmount Road, Scarborough, Ontario M1K 5G4
666 p., 1989; $160.95, cloth

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For the post-graduate geoscientist, the concept of one book where one can quickly look up information in the fields of igneous and metamorphic petrology is very attractive. Most undergraduate texts deal with only one of the two subjects, and often several books are needed to provide adequate coverage of most important topics.

The Encyclopedia of Igneous and Metamorphic Petrology goes a long way to meeting this goal, particularly as it is well illustrated in many sections. For instance, the section on igneous textures is accompanied by 48 photographs illustrating most common rock textures, all in a compact 11-page summary. Similarly, the sections on metamorphic facies and metamorphic facies series provide a quick reference guide to these subjects which is extremely useful for the user who needs to refer to such information while writing geological reports. Coverage of the book as a whole is adequate, and there are not too many topics which are not addressed in some fashion within the book. Metamorphism, a subject that usually gets poor representation in overviews of this type, is well covered. Mineralization related to igneous and metamorphic processes is also noted in several instances.

The Encyclopedia of Igneous and Metamorphic Petrology does have a number of weaknesses, however, which weaken the potential market and utility of this book. Being an encyclopedia, it is a compendium of articles by different authors from around the world, and as such, coverage is uneven. For instance, the section on metamorphic rock textures is not illustrated, even though it immediately follows the well illustrated igneous rock texture section. The former was written by the editor, presumably to provide some coverage of the subject, but the use of the volume would be greatly enhanced if both sections were presented similarly. The section on lavas could also have more illustration. In general, many of the metamorphic sections are better illustrated than the igneous sections.

The section on oceanic basalts is inadequate in the extreme. A table of analyses consists mainly of pre-1960 compilations, and although MORB subtypes are noted very briefly in the text, they are not described in this section or elsewhere in the book. This is inexcusable given the importance of these rocks in igneous petrology, and is surprising considering this book was published 8 years after the landmark *Basaltic Volcanism on Terrestrial Planets* volume of the Basaltic Volcanism Study Group which provides a wealth of modern data on oceanic (and other) basalts. Archean basalts are discussed under a separate heading, but the discussion represents our knowledge as of a decade ago. Although this book is dated 1989, in reading it, I had the overwhelming impression that the bulk was prepared in 1981-1982. For some topics, this datedness is not a problem; for others, it is, and severely limits the utility of the volume. For example, anorogenic granites are not discussed, and trace element classification schemes for granites are not noted, as the most popular of these was not introduced until 1984. What is present is a good summary of knowledge and methods of granite studies until 1980.

Although the volume covers techniques in both igneous and metamorphic petrology, the section on volcanic rocks only looks at alkali-silica diagrams for volcanic rock classification and ignores other common diagrams such as the AFM plot, the Jensen plot, and many ternary trace element plots (although some of them are used in some sections). Rare earth chondrite plots, however, are given special note in the volume, and accompany many articles. Other topics not discussed are Pressure-Temperature paths in metamorphic petrology (possibly related to the aforementioned datedness of the book), peperites, and the use of isotopes in igneous petrogenesis (*e.g.*, Sr, Nd, Pb).

Many of the criticisms noted above can be made of many igneous or metamorphic petrology textbooks as well, and credit should go to the editor for doing an excellent job of providing a book of the scale and scope of the encyclopedia. However, these limitations and omissions do affect the potential audience and utility of the volume, and hopefully can be addressed in a future edition.

If this book sold for $40 or $50, I would have no hesitation in recommending it to most *Geoscience Canada* readers, even with the weaknesses noted above. Given these weaknesses, particularly its datedness, the high cost of this book makes it unsuitable for personal purchase, and indeed, for most libraries.

Microcomputer Applications in Geology 2

Edited by J.T. Hanley and D.F. Merriam
Computers & Geology, Volume 6
Pergamon Press, Oxford, UK
303 p. 1990; US $49.50, cloth

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This book presents a collection of 22 scientific papers on microcomputers and their applications to the geosciences. It is the sixth volume of a series titled "Computers & Geology", and the second volume dealing with applications of microcomputers. Eighteen of the papers discuss some kind of proprietary software for use in studying or analyzing geostatistical, lithological, structural, geochemical, mineralogical, and image (magnetic or radar)/spatial data. Seven of the programs are Macintosh-compatible, the rest being for use on DOS-compatible computers. Seventy percent of this software is available through the public domain software library of the Computer Oriented Geological Society (COGS). The remaining papers in the book discuss the future of microcomputers in geology and geologic education, and how to implement databases for various geological applications, such as hydrogeologic studies and gold deposit modelling.

The quality of the book itself is excellent — the text is clearly printed on heavy bond paper which is bound in a strong hard cover. Typographical errors are few and far between, and the plots and diagrams are relatively clear and legible. The book also contains a few good quality colour templates at the back.

At first glance it appears that this book contains such a diverse range of specialized topics and related computer applications that most readers will find only one or two papers of interest — spending US$49.50 to purchase the book is probably not necessary as most people can access it through a library. However, after some inquiry into the availability of the software, it is apparent that there are some complications and a number of discrepancies regarding use of the software.

According to COGS, "no documentation files are included, so you should have the book when you use these files". Many of the papers do actually act as user guides for the respective program, so it would appear that the book is necessary if one wishes to purchase any of the software. However, some papers, such as the paper on XMIN-S, a mineral identification program, state that both the program and the user's manual are available through COGS. In addition, COGS offers these programs only as two "Multi-Disk Packages" (MDP) — one for the Macintosh programs and the other for the DOS-compatible applications — which means that a number of totally unrelated programs have to be purchased even if only one is of interest. The price of $20.00 per MDP is negligible; however, one would expect that the editors of this book and COGS would have straightened out these discrepancies beforehand.

(For those interested in the XMIN-S program, there is a new version — XMIN-F — that is available from the authors at no charge. Contact D. Wright at the University of Alabama).

It is also extremely important to carefully read the description of each program in the MDPs offered by COGS. Some of the programs offered in MDP #6, for example, including DTM (Digital Terrain Model), OUTLINE, and SHELLGEN, do not offer executable versions — only source code and, if you are lucky, data sets are available. If you do not have a compiler in the language in which it was written (FORTRAN, PASCAL, C, *etc.*), then you cannot compile the program.

As far as the papers themselves are concerned, most of them do offer very good descriptions of the problem and the computer methodology used to resolve it. Many of the presentations are extremely mathematically oriented, however, so the average earth scientist may find them difficult to follow. In addition, as previously stated, some of these papers describe in detail instructions on how to use the application, which may be of importance to some users. The reference lists at the end of a few papers are also generally quite extensive, giving the reader a much broader information base on that particular topic. This in itself may be reason enough to pick up a copy of this book.

It is my impression that the primary purpose of this book is to show us that microcomputers and their applications are being used more and more extensively in the geoscience fields, and that this growth will continue in the future. The book itself is just a collection of some of the more recent advances in geoscientific software development which, according to Merriam, "are meant to ... provide a stimulation for additional and novel use". An extensive computer user myself, I could not agree with him more. However, due to the specialized nature and complexity of most of the papers I believe that primarily those involved in the academic disciplines would find it of interest, and even then only as reference material.

Frozen Fauna of the Mammoth Steppe. The Story of Blue Babe.

R. Dale Guthrie
University of Chicago Press, Chicago and London
323 p., 1990; US $50.00 cloth,
US $16.95 paper

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The title of this work contains two elements which require explanation. The "mammoth steppe" is the name proposed by Dr. Guthrie for the arid steppe extending across northern Eurasia and Alaska during the Pleistocene, the principal element of whose fauna was the mammoth. "Blue Babe" was the name of the giant ox that accompanied the legendary woodsman Paul Bunyan; and, since the carcass of a giant Pleistocene steppe bison discovered in an opencast mine near Fairbanks, Alaska was coated with blue vivianite crystals, the name came naturally!

This admirable book reports and analyses the discovery in a fashion that should fascinate anyone able to appreciate good detective work; one need not be a paleontologist to enjoy and admire it. The finding of Blue Babe is set into its historical context in terms of earlier discoveries of frozen Pleistocene mammal remains. The most famous of these have been the finds of mammoths, almost always in Siberia, though there have also been a few in Alaska (p. 2, 38). Particularly useful is the exhaustive review of recent finds in the USSR, hitherto reported in detail only in Russian publications: the account of Dima, the frozen baby mammoth from the Kolyma River region (p. 7-11), and the analysis of this discovery's significance (p. 11-20) are especially important.

Most paleontologists will be aware that woolly rhinoceroses have also been found frozen in Siberia and "pickled" in a petrochemical seep within a salt deposit in Galicia. However, few will know of the find at Churapachi, near the Lena River, in 1972 (p. 34) and fewer still will have learned of the frozen horses also found in Siberia in 1878, 1950 and 1968: the latest discovery, at Selerikan, is given full consideration (p. 30-34).

Indeed, many more frozen mammals have been found than this reader, in particular, was aware. Three other Pleistocene bisons, one in Siberia and two in Alaska (p. 37-38), several partial carcasses of the extinct stag-moose *(Cervalces latifrons)* and one of the extinct helmeted muskox *(Bootherium bombifrons)*, along with other frozen remains of moose, bison and horses, plus such small fry

as ground squirrels, mice and pikas, all from Alaska (p. 41, 43) — the list is indeed startling. The problem has been that the very mining techniques that brought these fossils to light — the spraying of jets of water to hasten the thaw of the permafrost and wash silt — have also destroyed them, if indeed they have been noticed at all; thus, a wealth of scientific information has been lost.

How much might have been learned is made clear by Dr. Guthrie's meticulous study of Blue Babe. He is able not only to demonstrate that this steppe bison was killed by one or more cave-lions, but to elucidate the season and circumstances of the event. He reconstructs not only the original morphology of those parts of the steppe bison that are preserved, but also, by comparison with cave paintings and by other means, those that are not. Diet and habit are elucidated; the taxonomy of the Quaternary bison is considered; and, by drawing upon other studies, the whole environment of the Alaska of Blue Babe's time — one very different from that of today — is recreated for the reader.

The illustrations valuably supplement the text and are, in general, of as high quality as the publisher's method of reproduction permits; it is not kind to some of the photographs. Figure 2.24 (p. 75) is inadequately explained and Figure 8.2 (p. 205) is difficult to comprehend; all others are readily comprehensible. Proof-reading has been excellent — I noticed only a single misprint, on p. 178 — and the text is both well written and, in general, easy to understand (though a few botanical terms proved unfamiliar to this reader). Personally, I blenched at the writer's use of "quite different than" (*e.g.*, p. 23, 192), but my wife tells me this is nowadays acceptable, in the United States at least!

All in all, then, this is a fascinating account of a unique discovery and embodies scientific detective-work of the highest order. It serves both to stimulate the imagination and arouse a desire for emulation — admirable effects!

ERRATUM

In a recent review of *The Field Naturalist: John Macoun, the Geological Survey and Natural Science* (see *Geoscience Canada*, v. 17, p. 202), we omitted the name of the publisher. *The Field Naturalist* is published by The University of Toronto Press.

Principles of Stratigraphy

By Roy L. Lemon
Merrill Publishing Co., Toronto
559 p., 1990; $55.95, cloth

Reviewed by Bruce S. Hart
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This book was intended as a textbook in stratigraphy for courses taught in second or third year of an undergraduate program. In the Preface, the author suggests that the fields of magnetostratigraphy, seismic stratigraphy and numerical biostratigraphy should be given considerable weight in a stratigraphy text. Subsurface data acquisition, and Quaternary and Precambrian stratigraphy are listed as subjects which deserve better treatment than is usually offered. He is right, of course, but this book contains too many flaws to be of use to its intended audience.

The book is divided into four "parts", each separated into two to six chapters. Part One is entitled "Time and Timekeepers", and is composed of chapters which treat the episodic nature of sedimentation, "The New Uniformitarianism" (with heavy emphasis on impacts and mass extinctions), litho- and chronostratigraphy, "cyclical phenomena" (rhythmites, growth bands, Milankovitch cycles, *etc.*), radiometric dating and magnetic [sic] stratigraphy. In Part Two, "The Fossil Record", chapters are entitled "Fossils and Biogeography", "Species Through Time", and "Biostratigraphy". Part Three, "Lithostratigraphy", discusses subsurface data acquisition, seismic stratigraphy, and depositional sedimentary environments. Finally, in Part Four, "Last and First Things", the author examines Quaternary and Precambrian stratigraphy in separate chapters.

The book is abundantly, if not satisfyingly, illustrated; many of the figure captions need expanding, and figures need better labelling. References are supplied at the end of each chapter. Key terms are printed in bold typeface when first employed (although not always) and are defined in a glossary at the end of the text. Appendices include charts of time scales, a list of abbreviations, and a copy of the North American Stratigraphic Code. There are about as many typographic errors as might be expected for a first edition.

I did not enjoy reading this book. The problems begin with the first chapter, with the author's use of generalizations and technical terms before defining them. I hoped that this style, arguably appropriate for an "introductory" chapter, would be replaced by a more rigorous approach in later chapters, but this was not to be the case.

There are two "terminal" flaws with this book. The first involves the relative weight assigned to important concepts and illustrative examples. Colloquial generalizations are all too often used as definitions in the text. For example, when describing how the lithology and thickness of a formation can change away from its stratotype, the author states (p. 65) that "eventually it becomes unrecognizable, and, in fact, has become another formation, presumably with a stratotype somewhere else". Exception should be taken to lines such as "In continental interiors ... eustatic sea level changes normally have little influence". Offhand, I can think of several prominent exceptions to this rule (if it is one, which I doubt) from the Cretaceous Western Interior Seaway. This type of treatment contrasts with that given to topics of marginal importance (*e.g.*, six pages on cosmic impacts). It is perhaps telling that "Oort cloud" is defined in the glossary, whereas "Datum" is not.

The second flaw involves the organization of the book. Some key topics are spread out over several chapters, and key terms are commonly employed before being properly defined. Why are mass extinctions discussed (Chapter 2) *before* evolution (Chapter 8)? Why are the principles of seismic stratigraphy divided into two chapters (11 and 13) separated by a chapter on sea level change, and how can the "EXXON" method for constructing eustatic curves (Chapter 12) be understood before "coastal onlap" and similar terms are defined (Chapter 13)?

I find the contents of the book to be lacking in two other areas. First, Lemon has chosen not to discuss the field of sedimentology in any great detail (probably a defensible enough position for a stratigraphy textbook), but provides a chapter (14) which is intended to "provide a link" with sources in that field. Why then are there no references to standard textbooks such as *Facies Models* or *Sedimentary Environments and Facies*? Second, for a 1990 publication, one would have liked to have seen an attempt to incorporate some of the material from SEPM Special Publication 42 into the chapter(s) on sequence/seismic stratigraphy.

This book will be of no interest to professional geologists. I pity the unfortunate undergraduate having to wade through this text as an introduction to stratigraphy. The problems are probably too fundamental to be remedied in a second edition.