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Book Reviews

Archetypes and Ancestors. Palaeontology in Victorian London 1850-1875

By Adrian J. Desmond
Blond & Briggs
287 p., 1982, £15.95; cloth

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Adrian Desmond is renowned (some might say notorious) for his book *The Hot-Blooded Dinosaurs* (1975), that very effective marshalling of evidence for a thesis first advanced by Thomas Henry Huxley in 1868 and given little credence until recently. Desmond's work on the history of paleontology may be less familiar, but his analysis of the development of Richard Owen's concept of the dinosaur (*Isis*, 1979, v. 70) deserves attention in an age when much that is ridiculous is written about the history of study of those vertebrates.

The twenty-five years of scientific endeavour treated within this new study may seem, at first sight, rather arbitrarily chosen. However, as Desmond points out, these years served as a cultural watershed in which paleontology changed from being a pastime of the (usually wealthy) amateur to a profession of specialists. It is a period that often has been viewed in simplistic terms, when an evolutionary St. George (Huxley himself) fought and defeated – even if he did not quite slay – the dragon of the Genesis account of the Creation, its fire breathed largely by Sir Richard Owen.

Desmond, having expounded an idea of one of these great contenders and interpreted some concepts of the other, is unusually well equipped to assess the veracity of this picture. Even though we are used nowadays to finding the blacks and whites of traditional history subdued by new enquiry into shades of grey, the result will surely surprise most readers.

The scene is set in the Introduction by a good sketch of the circumstances of Victorian London, in 1850:

> Despite the comparative affluence of the period, there was little money and less prestige in 'pure' research . . . With individualism the dominant creed . . . scientists found Treasury funding notoriously difficult to obtain. (W.H.) Flower once complained that he "could make more thousands as a surgeon than he ever would hundreds as a man of science . . ." One might, at most, hope to live off writing or a profitable practice and take up fossils as a hobby (though the toll this double life took on Gideon Mantell's health and marriage should have been a caution to all). (p. 16)

Even the most eminent scientists received only a meagre renumeration for their work. Richard Owen, though he had been Hunterian Professor for two decades and, as comparative anatomist, had a European reputation second only to that of Cuvier, had a salary of only 300 pounds per annum – about what an Assistant Clerk in the civil service could expect to earn (p. 23); indeed, Owen encountered profound difficulties even in financing his publications (p. 28-29). For Thomas Huxley, returned from his voyage on H.M.S. *Rattlesnake* and already, at twenty-six years of age, a Fellow of the Royal Society, the problem of publishing his results was only less extreme than that of finding money on which to live.

At that crucial stage of his career, Huxley was helped repeatedly and very considerably by Owen. However, the conscious condescension with which that help was given to the young biologist irritated him immensely (p. 34). In turn Owen, who expected (and had been hitherto accorded) deep respect from his juniors, was appalled by Huxley's subsequent temerarious assaults upon his most cherished ideas (p. 38). The growing personal hostility between Owen and Huxley did not result from the controversy over *The Origin of Species* and the ideas advanced therein; rather, it found its focus in that controversy.

Owen was a believer in an

> . . . Archetype, the "primal pattern" on which all vertebrates were based. This was a kind of creative blueprint, "what Plato would have called the 'Divine Idea' ". In practical terms, it was simply a picture of generalised or schematic vertebrate; but this in itself provided him with a *standard* by which to gauge the degree of specialisation of fossil life . . . an indispensable aid in determining the true pattern of emergence of "new living species".
>
> Although the Ideal Form was fleshed-out in increasingly specialised guises according to the "predetermining Will", *the Archetypal pattern remained static.* Owen's secondary causes, metagenesis or whatever, were simply the means of translating the Word into flesh, the "Vertebrate idea" into the cavalcade of fossil life. (p. 43-44)

In other words, Owen's "God was a traditional British craftsman working to a blueprint" (p. 48). However, Owen was perfectly able to accommodate the fossils he studied within this conceptual framework. Not only did Owen encourage the British Museum to purchase the first *Archaeopteryx*, but also he described it carefully – "unequivocally a bird" but showing "a closer adhesion to the general vertebrate type" (p. 125). The Carboniferous amphibian *Archegosaurus* was treated by him as an "annectant form, intermediate in design between fishes and reptiles" (p. 65-66, 68). It is surprising to discover that it was Owen who first recognized mammalian features in the Triassic reptiles of South Africa, linking them in particular to the marsupials and lowly placentals (p. 198) and who, as early as 1851, first placed into sequence the fossil horses from the Eocene *Palaeotherium* to the modern *Equus*, noting that the horse had grown "swifter by reason of the reduction of its toes"! (p. 166)

In contrast, Huxley was – most astonishingly! – "relatively unimpressed" by *Archaeopteryx* until other scientists made its

importance apparent to him (p. 124, 128), and he ignored *Archegosaurus*. Moreover, he took no note of Owen's work on the mammal-like reptiles, seeking instead – and vainly – for Late Paleozoic "promammals" (p. 199-200). Nine years after Owen had first outlined the morphological comparability of *Palaeotherium* with *Equus*, Huxley was still denying that the former was more "generalised" than the latter; only with his visit to the United States did conviction develop concerning the origin of the horses.

All in all Huxley, even after he had taken upon himself the role of prime advocate of Darwinian evolutionary theories, was curiously slow to perceive the value of fossils as supporting evidence. This is in part because he was a biologist and had devoted little time and attention to paleontology; in 1854, he had refused an appointment as Paleontologist and Lecturer in Natural History at the School of Mines because he "did not care for fossils" (p. 57). Desmond speaks correctly of this "anachronistic attitude towards classification and the fossil record", quoting an address of 1869 in which Huxley stated,

> . . . I confess it is as possible for me to believe in the direct creation of each separate form as to adopt the supposition that mammals, birds, and reptiles had no existence before the Triassic epoch. . . . The course of the world's history before the Trias must have been strangely different from that which it has taken since, if some of us do not live to see the fossil remains of a Silurian mammal. (p. 84)

Indeed, he talked of a "pre-geologic date" for all major evolutionary breakthroughs (p. 128).

This adherence to "persistence" explains why Huxley was so unexpectedly reluctant to speculate on the origin of the major animal groups (p. 85) or even to use effectively the evidence that Owen was himself furnishing from the fossil record in his battles against Owen. It is not surprising that, before 1859, Huxley had striven to refute the idea that life was a progression (p. 93); it *is* surprising to find him so clinging to the idea of a Paleozoic origin for the major vertebrate groups that he failed to accept, even as late as 1870, such demonstrable evidence as *Archaeopteryx* that some arose very much later (p. 130). It was not until 1875 that Huxley jettisoned that inhibiting belief.

When Huxley did make direct contributions to the interpretations of fossils, it seems often to have been a consequence of his desire to cock the snook at Owen. The venerable anatomist had reconstructed his dinosaurs as huge, heavy quadrupeds. During a visit to Oxford, Huxley discovered that John Phillips doubted the correctness of the restoration of *Megalosaurus* and was able gleefully to rebuild it with him, reconstituting the pelvic girdle from misplaced shoulder bones (p. 133). A smaller, birdlike dinosaur, *Compsognathus*, was already known and recognized to be a biped; here was evidence that some giant dinosaurs also were bipeds, reinforcing Huxley's belief that the dinosaurs gave rise to the birds and enabling a reclassification. Unfortunately, Huxley believed that the connection was through the Ratites or running birds, misinterpreting dinosaur footprints in the Connecticut Valley as evidence for Triassic ostriches; whereas, even yet, no fossil bones of running birds are known earlier than the Paleocene. However, his consequent suggestion that dinosaurs had warm blood and a bird-like heart and lungs (p. 127) still affords grounds for profitable discussion.

Owen was to react very adversely to these reinterpretations, denying the affinity of dinosaurs with birds and deciding that several morphological features of dinosaurs – the laterally compressed tail of *Iguanodon*, for example – were adaptations to an aquatic life (p. 146). This concept of an essentially aquatic habitat for dinosaurs has bedevilled vertebrate paleontology for a century and is not yet wholly discarded. Nevertheless, as Desmond puts it,

> (Owen's) splendid (18)41 pachyderm, already crippled by Huxley's shafts, was forced to flee into water and swim away. (p. 146)

Furthermore, Owen's success in undermining Charles Lyell's faith in the significance of *Dryopithecus* (p. 225) delayed the recognition of an important component of man's phylogeny. In contrast, Owen's blunders concerning the interpretation of the brain of the gorilla (p. 75) were so blatant that they served, not to set back acceptance of the concept that man was descended from the apes, but rather to facilitate it.

From Desmond's reassessment, the verdict of posterity on Huxley and Owen is seen to be unduly kind to the one, unduly ungenerous to the other. This is, in large measure, a consequence of their very different personalities. Owen was an odd and difficult man, with a high respect for his own ability and little for that of others. Indeed, he was deeply suspicious of younger rivals (p. 134). He had a high respect for both aristocracy and clergy and, in his writings, was "desperate lest he offend" those groups (p. 64). From a scientific viewpoint, a much more serious liability was his "inability to retract any point except by way of evasive manoeuvre" (p. 76) and, in that particular, the "professional disgrace" resulting from his clinging to untenable positions was "largely his own fault" (p. 82). Though he acted as leading spokesman for the anti-Darwinian forces of this period, his personality made it impossible for him either to rally round him a "pressure group" of adherents or even to retain the affection of his associates.

In contrast, Huxley was the self-appointed – but very much welcomed – spokesman for those trying to lead England into the new reformation they felt must come as a consequence of the application of scientific ideas. In Huxley's own resounding phrases:

> Will England play this part (of leader in this new age)? That depends on how you, the public, deal with science. Cherish her, venerate her, follow her methods faithfully and implicitly in their application to all branches of human thought; and the future of this people will be greater than the past.
>
> Listen to those who would silence and crush her, and I fear our children will see the glory of England vanishing like Arthur in the mist . . . (p. 110)

Furthermore, as Desmond notes:

> Unlike Owen, Huxley was approachable, interested and willing to speculate (which gave his science the tinge of excitement Owen's now lacked). (p. 135)

His personal encouragement of their investigations rallied younger scientists – especially the non-Oxbridge men who, at that period, were "almost second-class citizens" (p. 122) – firmly about whatever banner he was choosing to unfurl.

Yet, as Desmond stresses, not only Huxley, but Owen also, made lasting contributions to the understanding of fossils and of evolution. Nevertheless, Huxley is, in retrospect, as he was at that time, the more likeable figure; Owen's coldness, and his treatment of poor Gideon Mantell (when alive and posthumously) defy any attempts at a rehabilitation of his personal image.

Since this work is a portrait of a period, many other figures are also to be seen on its canvas. Charles Darwin, of course, is ever in the background; and it is interesting to be reminded that, like Alfred Russel Wallace, he was "a staunch believer in the permanence of continents and oceans" (p. 106). There is the tortured figure of St. George Mivart, sincerely admiring Darwin but forced, by his devout Roman Catholicism, to attack Darwin's concepts – only to be ultimately excommunicated from his church for his efforts (p. 107, 190). There is P. Martin Duncan, preaching a polyphyletic origin for verte-

brates (p. 185), and William Boyd Dawkins concealing, insofar as he could, his own opposition to Darwin (p. 181-183). There is Harry Govier Seeley, arch-harrier of speakers at Geological Society meetings, to whom Desmond admits that the doing of justice is "an unusually difficult task" (p. 137). There are Ray Lankester, a "publicist *par excellence*" (p. 109) and a powerful figure in Victorian science, yet with "almost a genius for putting himself in the wrong by explosive and unconsidered action in a just cause" (p. 234), and the "fiery and uncompromising" Robert Grant, certainly a focus for Owen's particular hatred but defeated more by his own unconventionality in an age of conformism (p. 116-118).

It is salutary to be reminded how small a role British geologists and paleontologists played in these earliest decades of the evolution controversy, in particular because of their reluctance to investigate vertebrate genealogies. Perhaps, indeed, this was because

> Geology had a fierce pride in its untainted inductivist base (cultivated in the thirties partly to disbar the lunatic fringe of Scriptural cosmogonists . . .). (p. 149)

Nevertheless, it remains true that the major paleontological evidence for evolution was mustered either by biologists or by Continental European paleontologists like Gaudry, Rütimeyer and Kovalevskii.

The text is singularly free from errors. I noted only two misprints ("sauve", p. 137; "phyllum", p. 154). The statement that "in Australia . . . the small kiwis (were preceded by) huge moas" (p. 104) is clearly an inadvertent mistake, from its context. However, it was Henry Thoreau, not Ernst Haeckel, who coined the word "ecology" (p. 168), even if Haeckel was the first to use that word in print; and, in view of the rapid evolution of the sebecosuchians in the Tertiary, I cannot accept that there was "little or no advance" in the crocodile lineage after the Cretaceous (p. 171). Reading that "the entombing sediments were often fine enough to record hair or feathers" on pterodactyls "had they existed" (p. 190), one regrets that the recent Soviet discovery of the "hairy pterodactyl" *Sordes pilosus* passes unmentioned.

However, my criticisms are few and minor. This book is a landmark in the study of the history of paleontology and evolution. It should be essential reading for anyone seeking to understand the development of our science at a crucial period of change in the social and intellectual development of our world.

Geology of Canadian Gold Deposits

Edited by R.W. Hodder and William Petruk
Canadian Institute of Mining and Metallurgy
Special Volume 24
290 p., 1982, $45.00 ($20.00 CIM members and students); cloth

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The proceedings of a CIM Gold Symposium held at Val d'Or in September, 1980 have been published in 1982 to fill the gap in the literature on Canadian gold deposits that has existed since the publication of the CIM Jubilee and Congress Volumes, in 1948 and 1957, respectively. The current volume contains a review article on gold deposits, fifteen articles on mineralization in the Abitibi Belt, two articles on the Red Lake district, a review of deposits throughout the Superior Province, a review of Nova Scotian deposits and two articles on a deposit in the Queen Charlotte Islands. Two additional papers describe geochemical techniques for gold exploration in glacial drift and lake sediments.

Highlights of the volume include descriptions of stratigraphy in the Quebec portion of the Abitibi Belt, a detailed account of the petrography and microthermometry of fluid inclusions in La Mine Doyon and descriptions of lesser known deposits, such as the Chadbourne Mines and several past producers in the Matachewan area. Two interesting geochemical studies demonstrated (1) the existence of a large, well developed alteration zone encompassing many of the current and past producing mines in the Red Lake Camp, and (2) that fluids responsible for Archean gold mineralization differ greatly from those depositing base metal deposits. A welcome addition to the volume is a contribution describing, from the Chief Mine Geologists's point of view, the rationale behind locating the site for a new shaft in the Dome Mine.

Perhaps the greatest weakness of this publication, one not to be found in its predecessors, is the heavy geographical bias, with 75 per cent of the geological articles focusing solely on the Abitibi Belt. This undoubtedly reflects the focus of much "academic" attention, but to the detriment of other areas of Canada containing significant producing, or past-producing, hard rock and placer deposits.

If one compares the 1948, 1957 and 1982 volumes, it is instructive to note how geologists' ideas about genetic aspects of gold mineralization have evolved. The two earlier publications stressed the syntectonic nature of mineral deposits; indeed, their titles were *Structural Geology of Canadian Ore Deposits*. *Concepts* in 1980, however, reflect the lessons learned during development of our understanding of base metal massive sulphide deposits. Early theories that emphasized structural controls and replacement as dominant factors in the ore-forming process were supplanted by the currently accepted exhalative model. This genetic concept, developed for base metal massive sulphide deposits, has since been applied to gold deposits and has achieved some measure of acceptance amongst not only academic geologists but, in addition, mining and exploration personnel.

While a small number of articles published in this volume have already been superceded by further research, many of the deposit descriptions will remain standard references for some time. Within the evolving field of economic geology, and especially the highly emmotive and controversial topic of gold mineralization, special symposia and volumes, such as this one coordinated by the CIM, are required at frequent intervals, both to increase our inventory of individual deposit descriptions and to monitor current thoughts on genetic processes.

While most of the plates and diagrams are of high quality, both a frontispiece colour photograph and a number of diagrams early in the volume have not reproduced well. These minor criticisms notwithstanding, any geologist interested in remaining abreast of current (1980) concepts concerning the geology and genesis of gold deposits will find the volume indispensible.

Glacial Geology

Edited by N. Eyles
Pergamon Press
409 p., 1983, $26.20 Cdn.; paper, $87.50 Cdn.; cloth

Reviewed by G.H. Eisbacher
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The age of instant books is upon us and a steady flow of multi-authored, state-of-the-art summaries in the earth sciences keeps students and professionals hopping. However, in some recent efforts publishers in the field of earth sciences have let a basically good thing go a little bit too far.

Quality is lost in the quest for bulk. *Glacial Geology* is an example.

The book contains a series of contributions by fifteen British and Canadian workers in the field of glacial and engineering geology; it will, therefore, undoubtedly attract professional interest in Canada. The main problem with this text is brought into focus by its opening "rationale": " . . . this book is designed as a basic introduction to the geology of glaciated terrains for mid to senior level undergraduates, college students and industry and government employees engaged in engineering and earth science courses and projects associated with glacial sediments and stratigraphies in the mid-latitudes". To achieve this, the book has been organized into two overlapping halves. The first half deals with the broad spectrum of glacier-related processes through a "landsystems approach". This approach builds on classic sedimentary facies analysis: glacial landscapes are reconstructed or inferred from the sedimentary and geomorphic record left behind by retreating glaciers. Many line drawings and instructive photographs accompany the text. However, the text itself suffers from a severe dose of *dissertationitis* and could have been streamlined substantially. The reduction of the original typescript pages makes for eye-straining reading. At the end of major sections there are concluding paragraphs which will leave even the seasoned professionals scratching their heads, for instance, "The vast majority of glacial stratigraphies have been and are still being described by simply reference to analytical data (i.e. grain-size, clay chemistry, bulk geochemistry, clast lithology, calcite/dolomite ratios, colour etc. etc.) but the true nature of the stratigraphy remains anonymous." In well-dated glacial successions of flatland regions, inference of past glacial landscapes from processes derived in scattered exposures may be feasible. In rugged terrain such as in many parts of Canada most of the glacial record is lost in stratigraphic gaps. The landsystems approach alone is clearly inadequate. It must be accompanied by solid regional mapping and radiometric dating of key horizons, techniques pioneered in this country.

The second half of the book concerns itself with geotechnical aspects of glaciolacustrine-glaciomarine clay and lodgement till, followed by chapters on engineering geological mapping, site investigation, foundation work, road construction, dam sites, and hydrologic conditions in British glacial deposits. Except for the fine review of water-laid clays in eastern North America by R.M. Quigley, these articles do not establish the expected link with the landsystems approach promoted in the first half of the book. Students and other non-experts will be left bewildered.

A massive bibliography with about 800 entries covers English-language literature on physical and geotechnical aspects of glaciation.

In summary, the title of the book promises something with a broader scope, particularly for a Canadian readership; the approach adopted will stimulate discussion among earth scientists directly involved in the subject; the price of the softcover edition is reasonable. However, as an introductory textbook, it misses the mark.

Glacial Lake Agassiz

Edited by J.T. Teller and Lee Clayton
Geological Association of Canada
Special Paper 26
451 p., 1983, $34.00 ($28.00 G.A.C. members); cloth

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Glacial Lake Agassiz was big. That has been known since the first half of the last century. However, it is only in the past fifteen years that more detailed geological mapping has revealed that Lake Agassiz sediments cover an area approaching a million square kilometres. The new mapping, both in the U.S. and Canada, is the foundation for most of the work reported in this volume. Based on the proceedings of a GAC symposium at the 1982 Winnipeg meeting, the book "attempts to summarize all major aspects of Lake Agassiz – its stratigraphy, history, hydrology, biology and post-glacial legacy."

The book consists of an introduction followed by sections on the lake history and biota, lake inlets and outlets, and the region after Lake Agassiz. Some of the papers are reviews, others original contributions. One of the most important contributions of the book is a fold-out map by Teller and others of the maximum extent and major features of the lake. The map, although incomplete on the eastern shore, is a major synthesis of a large quantity of both published and unpublished data.

Other particularly useful papers include one by Ritchie, who uses statistical analysis of the paleo-environmental implications of pollen data to reconstruct climate since 11,000 years B.P. Another interesting paper, by Mollard, discusses in a well balanced way the origin of doughnut-like and brain-like patterns on the lake floor. Matsch calculates that in "a few thousand years", 50-75 $\times$ 10^9 m^3 of drift and bedrock was eroded from the southern outlet of the lake, and Last and Teller include stimulating discussions of the paleo-environmental implications of lake sediment geochemistry.

Sedimentologists interested in basin analysis will surely be intrigued by the possibilities of research in the area, since there appears to be little work being done on patterns of sedimentation within the lake. The chronological framework presented within this volume could provide the basis for useful sedimentological research.

Unfortunately, geologists unfamiliar with the area will be frustrated by a general shortage of location maps and a lack of directions and scales on maps in several of the papers. However, this does not seriously detract from a volume which, although not the final word on the subject, accurately records the current state of research on Glacial Lake Agassiz.

In The Beginning . . . A Scientist Shows Why the Creationists are Wrong

By Chris McGowan
Macmillan of Canada
208 p., 1983, $18.95; cloth

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With war having been declared on the concept and process of evolution by the fundamentalist creationist establishment, many new articles and books have begun to appear in the past few years that address the complex morass of illogic and misrepresentation that seem to characterize the debate. Chris McGowan has produced a very readable, popular, easily understandable, entertaining, and, most important, solid book that attacks many of the misrepresentations and misconceptions of fundamentalist creationists and lays out clear explanations of the foundations of science itself, the concepts of geologic time, superposition of strata, and many others. Most of the arguments presented or attacked in this book are old ones and have been used by both sides in the debate many times. However, the author takes many of these old arguments and refreshes them with an entertaining, light and informative style that makes it difficult to put the book down once begun. It is easily accessible to the non-specialist and worth reading by the specialist, for it forces one to re-think many of the fundamental assumptions, often taken for granted, that govern how geological science proceeds.

There are fourteen chapters, each of which tackles a major theme in the creationist debate. Chapter one, for instance, deals with the fundamental laws of nature, how science works, and how both creationists and evolutionary scientists work; Chris McGowan's debunking of the "creation science" methodology is skilled and insightful. The chapter ends with a statement, in point form, of the major creationist precepts and some of the fundamental predictions derived from the fossil record. Chapter two briefly outlines how Darwin arrived at his conclusions about speciation and evolution. Among the most enjoyable chapters is one entitled "Noah's Ark: Fact or Fable"; it deals with one of the favourite and, in fact, weakest themes in the whole creationist debate, that of the Great Flood. This chapter is full of little gems and is a wonderful grab bag of anecdotes and logical exercises that could be very instructive and entertaining material for a first-year undergraduate lecture. Following an outline and discussion of the major logistical problems Noah must have faced in housing two and more of every one of 1.5 million animal and plant species, and all their feed for an extended voyage, the author goes on to outline the creationist model of how the stratigraphic column and the fossil record came to be during and following the mythical Flood. Each of the major points in the creationist model are systematically dealt with in a logical and scientific manner that is a model of serious restraint on the part of the author.

Other themes dealt with in the book include the nature of fossils and the process of fossilization (chapter 8); geological time and historical geology (chapter 9); the origins of the birds (chapter 10) and of the mammals (chapter 11); and the transition to land (chapter 13). Each of these provides heated argument in the creationist debate. Chris McGowan nicely develops each of these themes from basic principles in an easily understandable manner, and simultaneously debunks creationist arguments and alternative models. It all is skillfully done without the use of complex terminology or the need for a specialized background.

The general thrust of this book is threefold: first, to present clear outlines of the scientific bases for many of the fundamental principles and concepts of modern paleontological and evolutionary science that have become favourite targets of creation "science"; second, to show the fallacies in both the factual basis and the methodology of creation "science"; third, to show that creation "science" is not science. The author has succeeded in all of these, and has produced a book that is enjoyable to read and useful; it should be read by both those looking for reasonable counter-arguments to the many broadsides levelled by the creationist establishment and by the specialist seeking a guide to handling the increasingly necessary defence of modern evolutionary science.

Marine Geology of Korean Seas

By S.K. Chough
International Human Resources Development Corp.
157 p., 1983, $35.00 U.S.; cloth

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This slim volume contains a wealth of information on the crustal structure, stratigraphy, surficial geology and evolution of the marine areas surrounding the Republic of (South) Korea. For those interested in the geology of the westernmost Pacific, backarc basins, epicontinental seas or ria coastlines, this book will be an invaluable reference.

The author begins with a general overview of the geology of Korea and in subsequent chapters describes the deep structure, stratigraphy, shallow structure, Quaternary history, surficial geology and sediment dispersal processes of the Yellow Sea, the shallow shelf area lying to the west of Korea, and the Sea of Japan, a backarc basin to the east of the Korean peninsula. Specific attention is focused on the continental shelf off eastern Korea and on the Ulleung Basin, the southwesternmost of the deep basins in the Sea of Japan. A chapter is devoted to the physiography, oceanography and sedimentation in the coastal embayments along the southern coast. The final chapter, a concise summary of the geologic evolution of the region from the Precambrian through the Quaternary, is followed by an impressive, up to date, twelve-page bibliography. This reference compilation is a gold mine for anyone wishing to pursue virtually any aspect of the marine geology of the Korean Seas, as it contains numerous theses from Korean universities as well as many Japanese, Korean and United Nations articles and publications. An addendum presents a far too brief account of recently interpreted seismic and well data from offshore areas to the south and southwest of the Korean peninsula.

Valuable though the information in this synthesis may be, the book itself is not without shortcomings for which, I feel, the editors and publisher must shoulder much of the blame. The style and grammatical constructions are frequently awkward which, though rarely completely obscuring the intended meaning, do make the book less readable than it might be. Typographical errors are common throughout.

It is, however, the figures which create more serious problems for the reader. In some instances geographic names identified in the text do not appear on the accompanying figure. The illustrations are frequently reduced to such minute dimensions that fine lines disappear, patterns "blotch out" and closely spaced contours become solid black masses. For some reason the publishers have, in many cases, chosen to set figure captions *beside* rather than beneath the illustrations, thus necessitating a substantial reduction in the size of a diagram (the remaining half to two thirds of such pages remains blank). The reproduction of many of the seismic profiles is so poor that virtually no sub-bottom reflectors can be distinguished through the almost solid black records.

And, finally, the price. The thirty cents per page seems even more excessive when one considers the enormous margins (two of the margins are nearly 4 cm) and the preponderance of blank space throughout the book. Even allowing for improved, enlarged reproduction of figures, the book could have been printed comfortably in about 100 pages. Though no institutional library should be without it, I doubt that this valuable work will find its way onto many personal bookshelves.

Oil and Natural Gas Resources of Canada, 1983

By R.M. Proctor, G.C. Taylor and J.A. Wade
Geological Survey of Canada Paper 83-31
59 p., 1984, $4.00; cloth

Reviewed by G.N. Wright
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This paper clearly outlines the petroleum geology and resources of Canada in terms of stratigraphy and reservoir rocks, with some comments on source rock and organic maturity. It includes assigned values for remaining discovered reserves and future petroleum potential, and a brief account of the statistical approach to the analysis.

Conventional Canadian reserves and discovered resources total 1173 million cu-

bic metres of oil and 3013 billion cubic metres of gas. The GSC expects there to be an additional 4720 million cubic metres of oil and 9509 billion cubic metres of gas, all in the potential resource category. In summary, the Eastern Canadian offshore and Beaufort Sea-Mackenzie Delta regions have immense potential for oil, while in terms of natural gas, Western Canada (the basin with the most potential) has more gas than the rich Arctic and east coast regions. 1983 estimates are 60 percent greater than the 1976 government figures for oil and 25 percent greater for gas.

The analytical methodology which uses cumulative probability curves is reported as more advanced than the Monte Carlo approach: unfortunately, we are not given an example of the analysis made at the exploration play level and, consequently, the link between understanding the stratigraphy and petroleum geology and arriving at potential reserve is never shown, and it is impossible to gauge how capably the analysis was completed. An appendix could have been useful here or, alternatively, reference to a pertinent open file.

The authors quite rightly warn us that the estimates of potential resources cannot be regarded as assured supplies. Data sources are the Department of Energy, Mines and Resources; Canada Oil and Gas Lands Administration (COGLA); the National Energy Board; and Canadian Petroleum Association, as well as provincial and other published literature. This has been updated to at least 1981, with much 1982 and 1983 information also taken into account. Estimates express a range of quantities for oil and gas for each region, along with the probability associated with different parts of that range, using the phrases "speculative", "average expectation" and "high confidence" levels which refer, apparently, to 5 percent, 50 percent and 95 percent confidence levels. Nonconventional resources (oil sands, heavy oil, and tight gas) are underemphasized, although enhanced oil recovery is certainly discussed. "Economic evaluation reveals an encouraging comparison of the investment cost per cubic metre . . . (of oil sands) . . . when compared to the development of frontier oil. . . ." Enhanced recovery and remaining established reserves of synthetic crude almost equal the "average expectation" figure for potential oil from the rest of Canada. No reason is given for excluding Ethane and Natural Gas Liquids from some tables; the danger here is that the tables appear to be all-inclusive.

The report concludes that the nation will be dependent on Western Canadian conventional reserves for the remainder of the decade. Frontier delays are caused by several problems, including those of a technological and environmental nature (both natural and fiscal). I believe the Beaufort could have been given more attention and that oil from the frontiers is unlikely to be produced on a large scale before 1990.

The volume is easy to read and positive in its approach. The text is supplemented with several tables and 74 black and white figures, including maps, sections, generalized stratigraphic columns and seismic sections. Figures 1.2 and 1.3 give a particularly clear picture of the GSC's reserve and resource comparison between the following regions: Western Canada Sedimentary Basin, Cordilleran Basins, Beaufort Sea-Mackenzie Delta, Arctic Islands, Eastern Canada-offshore, and Paleozoic Basins-Eastern Canada.

The text is remarkably free from clerical and typographical errors and worth considerably more than its $4.00 price tag for the reserve and resource values supplied and the abbreviated descriptions of the regional geology of Canada.