Book Reviews / Critique

Book Reviews

Environmental Geology of Urban Areas

Edited by Nicholas Eyles
Geological Association of Canada
GEOtext 3
1997, 590 p., hardcover
CDN$125.00 (member)
CDN$250.00, US$215.00 (non-member)

Reviewed by Brian J. Moorman
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As the impact of humans on the natural environment increases, there is a growing demand to understand and manage the interaction between society and the environment. Some of the most significant environmental impact occurs in urban areas with high concentrations of population and industry. With more than 70% of the world's population living in urban areas, the impact of human habitation is considerable. As a result, the field of environmental geology is growing rapidly, with a major focus on urban environmental geology. In Ontario, the field of environmental geology is now larger, in terms of annual revenues to the provincial government, than those derived from the Ontario mining industry (see Eyles, 1997, *Geoscience Canada*, v. 24, n. 2, p. 109).

Owing to the relatively recent emergence of this area of study, there is relatively little environmental geology reference material available, and much of it can only be found in the grey literature of government and private-sector reports. The purpose of *Environmental Geology of Urban Areas* is to provide a review of environmental geological case studies from across Canada, which it does admirably.

Topics ranging from geophysical data collection to environmental law are covered in this 590-page volume. Because this is a collection of research and review papers, the entire spectrum of urban environmental geology topics is not uniformly addressed; rather, specific topics and case studies are covered in greater detail. There are case studies from Halifax to Vancouver, however the emphasis is on the most heavily urbanized portion of Canada, southern Ontario. The volume includes 39 papers that are roughly divided into ten themes: an introduction to environmental geology of urban areas; urban ground waters: sources of contamination; urban ground waters: resource evaluation and protection; surface-water contamination in urban areas; urban waterfronts; urban waste management; contaminated substrates in urban areas; urban geological hazards; site investigation, remediation and data management; and finally, environmental assessment legislation.

Environmental problems associated with water supply and quality are a major emphasis of this book. This reflects the focus of an industry primarily driven by the tremendous need for clean water in modern cities. The pollution of surface and ground water are given good treatment, as are lake and harbor pollution. Several types of groundwater contamination are covered in detail. Urban waste management and mine waste are also addressed in detail.

The section on urban geological hazards contains two papers on earthquake hazards and one on radon hazards. Landslide hazards (*e.g.*, catastrophic sensitive clay flows that are endemic to several areas of Canada) are not covered, however.

This book provides an excellent introduction to many important environmental issues across Canada, the geological processes associated with them, and the strategies currently being used to investigate and resolve them. Both professionals and academics interested in the environmental earth sciences will find this book very useful. Despite the cost, this book would make a wonderful resource for senior undergraduate or graduate courses.

GEOSCAPE Vancouver Living with our Geological Landscape

Produced by Robert J.W. Turner,
John J. Clague and Bertrand J. Groulx
Geological Survey of Canada
Open File 3309
1996, poster, $15.00
Available from GSC Publication Office:
101-605 Robson Street
Vancouver, British Columbia V6B 5J3
(604) 666-0271
Cette publication est aussi disponible en français.

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Although called a poster, *GEOSCAPE Vancouver* is a well-illustrated "book" displayed on a single 91x154 cm sheet, with a variety of colored block diagrams, cross and columnar sections, photographs, maps, landsat images, and text, explaining how the geology of the greater Vancouver area affects everyday life. On first view, the complexity may cause your eyes to wander, but they soon focus on the major illustration of the poster — a landsat

mosaic showing the area covered — Vancouver and the Fraser Valley, as far south as Bellingham, Washington and Mt. Baker, and the large drainage area to the north that includes Mt. Garibaldi and Mt. Meager. This mosaic is topped by a short introduction explaining the development of the landscape, the necessity of understanding our landscape to ensure its wise use by protecting resources, and avoiding and reducing the risk of hazards to our rapidly expanding population.

The introduction and mosaic are bordered by 10 plates of variable sizes and shapes, illustrating aspects of the geology of the area. The "introduction" should probably be emphasized more; it's not something you focus on immediately. The relatively small lettering is obscured by the various shades of the background mosaic. As the plates are not organized in any particular order, the viewer doesn't really know where to begin. Once you start reading and studying the illustrations, however, there will be no confusion. Each plate is an entity in itself, extremely well-illustrated with appropriate text, written in concise, precise, simple English. The topics covered in the 10 plates are:

• **Mountain Watersheds** explains the importance of drainage systems to our water supply, and problems with acid waters.

• **When the Fraser Floods** emphasizes the great flood of 1948, but mentions past floods and the dyke system that has been constructed to prevent flooding.

• **What's Under our Feet?** displays a columnar section of the geology of the area and a map of the surface outcrops.

• **The Fraser River Delta** shows the development of the delta from 10,000 years ago to today, and explains the problems of the unstable delta front, and what could happen if an earthquake occurs, illustrated by superb, extremely informative block diagrams.

• **Earthquake, On Shaky Ground** warns us of the earthquake hazard in the Vancouver area, what kind of drainage can occur, where and when earthquakes have occurred in the past, and an explanation of the origin of earthquakes, using another superb block diagram.

• **Living in the Shadow of Volcanoes** explains in graphical detail the unstable slopes caused by past eruptions of Mt. Garibaldi, the potential for Mt. Baker to erupt and the possible source of geothermal energy from Mt. Meager that erupted 2,400 years ago and is still hot.

• **Sea to Sky** covers the development of the landscape and hazards encountered along Highway 99 from Vancouver to Squamish, pointing out the problems brought about by the Britannia mine, and the common occurrence of debris flows.

• **Mountain Corridors – Our Economic Life Lines** shows the importance of the mountain corridors in transportation, communication and energy transmission for the Vancouver area, as well as related hazards such as landslides, rockfalls and avalanches.

• **Water Underground – Vital but Vulnerable** explains the occurrence of ground water, the importance of ground water for our water supply, and the problems with contamination.

• **Earth Resources – A Living from the Land** points out the various locations of rocks and sediments that we commonly use, ranging from gold and copper-bearing granite and metamorphic rocks, to sand and gravel.

The quality of both prose and illustrations of the topics varies somewhat, but in general, all are extremely good. The many contributors have used a variety of art forms to ensure that the poster is exciting and eye-catching. Time is needed to review the poster, but if the viewer takes the time, perhaps an hour, he/she will learn a great deal about the geology and landscape of the Vancouver area. There is an overwhelming amount of information.

This is an outreach poster that is intended to inform the general public. I can see this poster in schools, universities, public and private buildings, as well as in homes. The contributors have done a marvellous job, something that should be done for other major centres. The main problem, as I see it, is to get people to take full advantage of what the poster has to offer. Time spent studying the poster will be fully repaid by an increased understanding of the geological makeup and challenges of Greater Vancouver, Canada's third largest urban area.

The Geologic and Tectonic Development of the Caribbean Plate Boundary in Southern Central America

Edited by Paul Mann
Geological Society of America
Special Paper 295
1995, 349 p., US$100.00

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This volume contains 17 papers that probe the past and present tectonics of the western margin of Panama and Costa Rica. It is a well-produced paperback volume with good black and white figures, four excellent foldout enclosures, but disappointingly dark reproductions of many photographs. At US$100.00 it is subsidized, but the price is still not competitive with comparable AAPG publications.

The study area is contained within the Panama Block that is parked at a global tectonic crossroads. To the north it overrides the Caribbean Plate. Along its southern margin it forms a triple junction with the Cocos and Nazca Plates. The Cocos Plate is undergoing northwestward subduction, whereas the Nazca Plate is involved in left lateral transpression against the Panama Block, as well as eastward subduction beneath the South American Plate. The relative movements between the plates are now well constrained by global positioning system (GPS) measurements that show a reassuring correspondence with modelled kinematics. The setting makes for much interesting geology, both paleogeographically and in terms of contemporary tectonics.

The Late Cretaceous-Early Cenozoic development of the area is approached *via* paleomagnetism, igneous petrology, and geochemistry. These tools do not delineate the paleokinematics unambiguously, but they do provide constraints. New paleomagnetic data define four terranes that probably originated in the Paleopacific and docked against the Caribbean Plate. Compositions of onshore volcanics suggest a Pre-Cenozoic island arc, steeply inclined subduction in Early Cenozoic time

and shallowly inclined subduction later.

Seismic reflection profiles across the northern margin of the Nazca Plate show high-angle faulting, consistent with transcurrent offsets. To the east, faulted oceanic crust of the Nazca Plate can be seen to underthrust the Colombian Accretionary Complex. Due to lack of velocity contrast, the data record remarkably little internal structure other than a few hints of faults and shale diapirs. Long-range sidescan sonographs of surface morphology are more revealing. North of Panama, the accretionary wedge abutting the Caribbean Plate exhibits more folding and backthrusting than the Colombian Complex. It is also well-documented by reflection seismic profiles and sidescan sonar, but not by well data. Across the study area, seismic data provide appetizing glimpses of tectonic processes, but the grids are too loose and supported by too few wells to yield detailed geological histories.

Greater focus can be obtained from fieldwork. A significant body of biostratigraphic data exists, sufficient to sustain regional mapping, but not enough apparently to correlate with Exxon's global sea level curve "because of lack of detail in our stratigraphic and age control." It would be truly amazing if such correlations were possible in the Panama block! On the other hand, paleostrain analyses of Late Cenozoic faults on several islands offshore of Panama agree with the trans-current senses of slip inferred for larger structures. The region also offers great opportunities to relate topographic morphology to tectonic activity and thereby map morphotectonic terranes. Earthquake activity is omnipresent around the plate margins. Numerous epicentre determinations document the Benioff Zone along the Cocos Plate margin, but few focal mechanisms have been calculated for the region. Those reported generally support the plate convergencies documented by GPS.

Thus, these studies provide a refreshing update of progress across a broad spectrum of investigations, but there is one serious proviso. This is the disconcerting lack of locally authored contributions. The 60 co-authors are predominantly North Americans and Europeans; only nine have Central American affiliations. None of the nine are first authors. Moreover, the bibliographies are dominated by works written in English or published in English-language journals, whereas a generation ago similar compilations were rich in Spanish citations. A depressing level of scientific colonialism is taking hold, an apparent consequence of the ever-widening gap in technology between First and Third Worlds.

Petroleum Basins of South America

Edited by A. J. Tankard,
R. Suárez Soruco and H. J. Welsink
American Association of Petroleum Geologists
Memoir 62
1995, 792 p., US$74.00

Reviewed by J. S. Bell
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AAPG *Memoir 62*'s 792 pages are aimed at geologists involved in exploration for oil and gas, who need a ready reference to the basins of South America and to their proven or unproven potential. The volume presents the fruits of a meeting on Gondwana geology held in Santa Cruz, Bolivia, in August 1992. Forty-one papers are included, covering: the Regional Setting (6), Paleozoic Basins (7), Mesozoic Rifts (7), Andean Basins (8), and Northern South America (13). Most of the major hydrocarbon basins are covered, with the exception of those on the Atlantic continental shelf. Cited references extend into 1994 and the contributions are supported by extensive bibliographies. The volume is handsomely produced with numerous figures and foldouts.

To review a book of this scale and scope with a few well-chosen words is as daunting as trying to summarize basinwide insights on figures that are obliged to fit onto 8½" x 11" pages. Both tasks are well nigh impossible and, unfortunately, the latter problem is a drawback of this compendium. While it is indeed a pleasure to encounter evocative water color paintings of landscapes in an AAPG Memoir, it is a pity that color could not also have been applied to more of the maps and sections to make them easier to decipher. There are a number of complex black and white figures that have not reproduced effectively after reduction.

Most of the contributions represent second- and third-generation science, being compilations built from earlier studies. The need for brevity invites unsupported assertions and makes it difficult to assess much of the information. Nevertheless, the papers are excellent entry vehicles to new areas, although they do need to be read critically. These quibbles apart, the volume contains extensive information about South American oil and gas accumulations and basin structure. Most of the hydrocarbons are trapped in Mesozoic and Cenozoic reservoirs and sourced from rocks of these eras. The major oil-producing basins of Venezuela are described, with particular emphasis on Maracaibo and eastern Venezuela, where huge new discoveries have been made in recent years. Numerous papers discuss the structure, trapping regimes, and reservoir geology of the Sub-Andean basins, of which those in Colombia, Ecuador and Peru have proved the most productive. In contrast, the Mesozoic cratonic rifts have not yielded great oil riches except in the Cuyo Basin of Argentina and in the San Bernardo Belt of Patagonia. To date, the only oil and gas discovered in Paleozoic sediments in South America has been found in the Chaco-Tarija Basin of Bolivia and Argentina, and in the Paraná Basin of Brazil, where the source rocks are believed to be Devonian shales that matured in Cenozoic time.

As well as addressing hydrocarbon habitats, *Memoir 62* contains much material of general geological interest. There are useful descriptions of tectonic inversion, and good accounts of petroleum system modelling. Many clean reflection seismic sections are printed beside versions annotated with tracings of events and faults, so that the interpretations can be assessed. Structural cross sections through oil fields are plentiful. The Sub-Andean fold and thrust belts in Bolivia are illustrated spectacularly with balanced cross sections that fold out. There is even an oroclinal enquiry. After sifting through much structural and paleogeographic evidence, as well as paleomagnetic data, Barbara Sheffels concludes that the bend in the Bolivian Andes is not an orocline, but is a rotational feature. Echoing Van Bemellen, Peter Jones invokes gravity-driven slip to account for structures in the eastern Andes of Colombia, and thereby avoids the kinematic improbability of the bilateral thrusting model that has been widely applied to this and other mountain ranges. Jones' model may apply also to the Pyrenees. In short, this is a timely source volume at an excellent price. Every soft rock geologist will learn something useful from perusing it.

The Geochemistry of Reservoirs

Edited by J.M. Cubitt and W.A. England
Geological Society of London
Special Publication 86
1995, 321 pages, US$48 (member)
US$108 (non-member)

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In the last quarter-century, the evolution of the North Sea from a frontier area to mature petroleum province provides the framework, and much of the data, for *The Geochemistry of Reservoirs* edited by Cubitt and England. Geochemical reservoir characterization focuses on the analysis of hydrocarbons (oil, condensate and/or gas), water and rock. These data are integrated with basic geology (*e.g.*, lithologic architecture, depositional sequences, seismic and source-rock data) and thermal and tectonic histories to provide predictive models of hydrocarbon occurrence and quality. This volume, to use the editors' own word, is a "snapshot" of the current state of understanding of producing horizons in one of the world's best studied petroleum basins.

This volume is difficult to characterize because of the breadth of the material and the complexity of the subject matter: the geochemical characterization of hydrocarbon reservoirs. Despite the difficulties, the wealth of information contained in this volume demonstrates the utility of the process. Integrated geochemical analyses provide clues to the mechanisms of economic hydrocarbon formation, migration and emplacement. In addition, understanding the distribution of hydrocarbons in a reservoir facilitates efficient (read economic) extraction.

The editors have divided the volume into two sections: General Reviews and New Techniques and Case Studies. The first section is comprised of seven chapters that, collectively, demonstrate the utility of integrated geochemical analyses of reservoir components. Refinements in analytical techniques, particularly those for characterization of hydrocarbon components (gas chromatography, gas chromatography-mass spectrometry, liquid chromatography), are covered extensively. New techniques, well described and referenced, include more quantitative characterization of high molecular weight hydrocarbon compounds (>C40) and NSO's (organic compounds containing nitrogen, sulfur and oxygen), improved resolution of formation water heterogeneities by core centrifugation, and characterization of tar mat geochemistry that provides clues to degradation processes during migration and production. Standard techniques discussed include formation water analysis coupled with thermodynamic modeling, fluid inclusion analysis, stable isotopes and 87Sr/86Sr analysis.

Case Studies include eight applied studies of UK and Norwegian North Sea reservoirs. Seven of these are applied geochemical analyses and one is a modelling study of density-driven mixing.

At first glance, this appears to be a volume for geochemical reservoir and production specialists. However, the real appeal of this collection is the large amount of geochemical data presented and the comprehensive coverage of the North Sea area. Geochemists and others interested in the application of geochemistry will find most of this volume worthwhile. Tables and diagrams are crisp, easy to read, and for the most part, well-labelled. Overall, the production quality is very high. The references (>650) are extensive and provide additional specific information on many of the analytical techniques discussed. *The Geochemistry of Reservoirs* will be a welcome addition to academic, industrial and research libraries.

Tales of the Earth. Paroxysms and Perturbations of the Blue Planet

By Charles Officer and Jake Page
Oxford University Press
London and New York
1993, xiii +226 p., $16.50 paperback

Reviewed by William A.S. Sarjeant
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The task of popularizing geology is one that has been undertaken, over the years, by all too few scientists. In the 19th century, major geologists such as Gideon Mantell and Hugh Miller attained contemporary best-seller status with their popular writings, while Frank Buckland — Francis Trevelyan Buckland (1826-1880), the son of the more eminent William — reached out to a large audience with such scientific *pots-pourri* as his series on the *Curiosities of Natural History.* In this century, Willy Ley — not a geologist, but an excellent scientific writer — entranced readers such as my young self with his *The Lungfish, the Dodo and the Unicorn* (1948) and *Dragons in Amber* (1951), in which many aspects of paleontology were treated very entertainingly. A few other writers — notably Richard Carrington, with *Mermaids and Mastodons* (1957) and Robert Silverberg, with *Mammoths, Mastodons and Man* (1960) — followed in Ley's footsteps for a while; but, in general, popular writings in paleontology in recent years have concentrated only upon dinosaurs or upon fossil man.

As for the broader aspects of geology, we owe much to those two men from Harvard, Stephen Jay Gould and Niles Eldredge, for reaching out to the public in their writings. Most geologists, alas, are content merely to address each other in their private scientific lingo, turning their backs upon the public at large and considering them an uninformed mob who are merely a nuisance to good scientists.

Why do I write 'alas'? Well, because there has never been a time when geologists have greater need to reach out to the public. We need to explain why our researches are interesting and worth-

while, well meriting funding even in a time of dwindling resources, natural and financial. Moreover, we have the prospect of enlisting the direct aid of the public in our work, as archeologists have done so successfully. Vertebrate paleontologists have managed this, to a point where the Government of Alberta seems to think it can legitimately *charge* potential participants for the privilege of engaging in the hot, hard and dirty work of dinosaur digging! However, there are other areas of research — the guided collecting of invertebrate fossils, the logging of temporary outcrops — where amateur aid could likewise be of value.

All such endeavors ultimately depend on educating the intelligent public. Yet the few scientists willing to do this, and able to do so successfully, are often condemned for "trivializing science" by colleagues unwilling to deviate from their own esoteric endeavors. They gain little academic credit and, usually, earn no merit increases in salary for their efforts. Nevertheless, they deserve great praise for the beneficent attention they are bringing to our science.

To the small roster of geologists able to expound the earth sciences clearly and interestingly, we must now add the name of Charles Officer who, with the aid of science writer Jake Page, has produced this lucid and highly readable volume. First it recounts the natural events — earthquakes, volcanic eruptions, floods and comets — that have affected our Earth and harassed its inhabitants. Familiar stuff, you will say, but here incorporating direct quotes from contemporary sources, bringing in much esoteric information, and presented in lucid relation to geological explanations and interpretations. Next, less familiar ground is covered when fluctuations in the earth's climate are discussed and the causes of major change in biological communities are considered. The final and very salutary section deals with man's effect upon the globe he inhabits and the prospects of our attaining a future harmony with nature.

As a historian, themes dealt with which interested me particularly were the accounts of Benjamin Franklin's thinking concerning the effects of volcanic eruptions (p. 15-16) and on the mammoth (p. 136); the contrasting responses to the Lisbon earthquake of 1755 by Voltaire and Rousseau (p 55-58); the good rendition of the Epic of Gilgainesh, in relation to 'Noah's Flood' (p. 67-72); and the intriguing exposition of a theory concerning the location of the Garden of Eden (p. 81). As a geologist, I appreciated in particular the unusually clear exposition of the much-misunderstood Richter Scale of earthquake intensity (p. 34-35); the account of the Little Ice Age (p. 97-99); the discussion of the significance of the Milankovitch cycles of solar energy (p. 109, 119); the consideration of the chaos theory in relation to geology (p. 110-112); and the lucid and sensible assessment of the various hypotheses concerning dinosaur extinction, with a well-justified rejection of meteorite impact as cause (p. 140-149).

Of course, in a work of such broad compass, there are errors. That all-too-familiar mistake, that Archbishop James Usher — the more correct spelling of his name — determined not only the year of Creation but also its month, day and time, is reiterated (p. 116). Not so; Usher identified only the year; it was John Lightfoot who refined the calculation to such an incredible degree of precision. James Hutton did *not* propose the theory of uniformitarianism, as p. 74 states; yes, he anticipated it in part, but that concept was only fully formulated by Charles Lyell and given its name by in 1832 by William Whewell. The correct generic name of Thomas Jefferson's ground sloth is *Megalonyx*, not *Megalonix* (p. 137, 138). The extinction of dinosaurs was *not* the last major one before us humans caused the present and severest of all (p. 140); the wave of extinctions caused by the spread of grasses in the Oligocene was quite as major.

I must also challenge the statement that the 1956 passage in Great Britain of the Clean Air Bill meant that the days of the London "pea-soup" fogs were over (p. 156). Five years later, there was a major fog in the Thames valley that lasted for several dreary weeks; I was working then at the Sedimentology Research Laboratory in Whiteknights Park, Reading, and remember a late afternoon when the fog was so dense that, upon leaving, *I could not even see my own feet!* Yes, those were dreadful conditions, and major killers of the elderly and asthmatic; but that Act *was* ultimately effective, albeit less swiftly so than the authors claim.

The proof-checking of the text has been less than thorough; I noted uncorrected spelling errors on 11 pages and must surely have missed others. If there is a future edition, such mistakes should be eliminated, for they are teasing and distracting to the reader's eye.

Personally, I hope there will be future editions, for this is the sort of book that can attract, and hold, the interest of the uninformed reader and cause him to ponder about our Earth, not only in times past, but in times future also.

Men Among the Mammoths. Victorian Science and the Discovery of Human Prehistory

By A. Bowdoin van Riper
University of Chicago Press
Chicago and London
xv + 282 p., 1993, US$45.00 hardcover
US$16.95 paperback

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1859, as is well known, was a crucial year in the history of science: did it not see the publication of Charles Darwin's *On the Origin of Species by Means of Natural Selection, or the Preservation of Favoured Races in the Struggle for Life,* arguably the most seminal work in the whole story of the expansion of human knowledge?

Yet that year also saw the presentation of another work that caused a revolution in human understanding: one that, by now, has been almost forgotten. On 26 May 1859, Joseph Prestwich delivered to the Royal Society a paper which, to his contemporaries, must have seemed quite as dramatic as Darwin's master-work. It furnished the first geologically sound demonstration that the flint implements of primitive men were to be found among the remains of long-extinct creatures, thus giving an immensely greater length to human history and throwing doubt upon the historicity of the sacred scriptures, then believed so exactly factual by most learned persons. Consequently, even before Darwin's book was published, that year had brought an immense enlargement of human understanding.

Yes, this coexistence of man and extinct creatures had been proclaimed early, but always by persons of questionable scientific attainment and from geological circumstances capable of alternative ex-

planations. It was the careful work of a reputable local geologist, William Pengelly, in Brixham Cave, Devonshire, under supervision by a Geological Society of London committee that had provided unequivocal evidence of flint implements in an undisturbed stratigraphical situation and with associated fossils that could not be misinterpreted.

This discovery stimulated two members of that committee — Prestwich and Hugh Falconer, along with archeologist John Evans — to go to France and reexamine the sites from which one of those "dubious scientists," Boucher de Perthes, had been earlier reporting comparable, but even more dramatic finds. To those geologists, their journey was a revelation; moreover, their findings were convincing to the learned public at large. Within 6 years, it was accepted almost universally by scientists that primitive man had been coeval with extinct beasts; with 15 more years, this had become an article of faith for the next generation of what were coming to be called "prehistoric archeologists."

The recognition of human prehistory was thus brought about by the work of geologists: the techniques that came soon to be used by those prehistoric archeologists were borrowed from stratigraphy. Similarly formed artifacts, it was realized, could be correlated in exactly the same fashion as index fossils and likewise enabled the establishment of time divisions. The order of superposition became as crucial to archeology as it had long been to paleontology, albeit with qualifications resulting from the different rates of cultural progress in different regions of the world. By 1880, the divisions of prehistory were as close to being resolved as were those of geological history: and, if the structure has become more complicated subsequently in both disciplines, the framework was just as firmly established. All that remained was to begin transforming relative into absolute dates: a process that, even now, is not completed.

Dr. Bowdoin van Riper's account of developments before and during those crucial 21 years is excellently presented and very readable. It serves to remind us just how new is our concept of the antiquity of man and just how important we geologists were in founding a discipline — prehistory — from which we have now been very largely excluded. My only regret is the paucity of illustration: the text-figures (sections, illustrations of a few artifacts, and one map) are all useful, but it would have been pleasant also to have had pictures of localities and portraits of the protagonists.

Recommended strongly, then. Sad, though, to find that the only Canadian mentioned — Sir John William Dawson — should have expended so much energy and verbosity (in speech or in print) to defend a position already shown by his peers to be indefensible.

Pangea: Paleoclimate, Tectonics, and Sedimentation during Accretion, Zenith, and Breakup of a Supercontinent

Edited by George D. Klein
Geological Society of America
Special Paper 288
1994, 295 p., US$72.50

Reviewed by T. P. Poulton
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Even those of us enduring a continental climate might not relate well to conditions on a continent the size of all others combined, but we are permitted a glimpse, as earth system theory, computer modelling, and rock and fossil observations are brought together. The most recent amalgamation of the continents, Pangea, encompassed for about 150 million years (Carboniferous-Jurassic) extremes of climates, sedimentary environments, and atmospheric CO_2. This is "an ideal interval during Earth history from which to evaluate the processes and magnitude of environmental variability and develop a predictive rationale for evaluating current global environmental concerns." This volume contains state-of-the-art syntheses presented during a 1992 international workshop to define the research direction of Project PANGEA of the Global Sedimentary Geology Program (GSGP), and an introductory summary of workshop recommendations. GSGP is one of several IUGS initiatives that attempt to understand ancient earth systems holistically and to extract those items of knowledge that can be applied to current environmental and resource concerns.

Global treatments include a summary by J.J. Veevers relating the tectonic evolution of the supercontinent to its major heat-flow, emergence/submergence, atmospheric CO_2 and stable isotope characteristics. Thomas Crowley discusses the Gondwana glaciation, extreme annual cycles, coal deposits, and Mesozoic deserts, and poses tests to resolve the sometimes conflicting results of energy balance and general circulation models with the rock and fossil data. With Thomas Moore and others in a major synthesis, he relates global land area and average latitude in a series of Phanerozoic time slices to atmospheric CO_2 levels and surface temperatures *via* the weathering rate of exposed silicates. Moore and Worsley further expand on the major role of the height and latitude of orogenic highlands on silicate weathering rates and their capacity to initiate continental glaciation. These papers relate model results to the actual distribution of climatic indicators in the geologic record, pointing out problems and proposing additional studies.

Several papers by Gerald Friedman, Warren Manspeizer, and J. Veevers and others, propose that Pangean tectonics and climates ultimately resulted in the great Permian–Triassic and Late Triassic extinction events. Friedman considers the Permian mountains to have been among the mightiest in Earth history, and Manspeizer elaborates on the breakup tectonics of the supercontinent and its impacts. Palynological and tetrapod evidence from the Newark Supergroup support the multiple-impact hypothesis for Late Triassic extinctions according to S.J. Fowell and others, who attribute sedimentary and palynological cycles to orbitally controlled variations in solar radiation. John Kutzbach discusses the effect of orbital changes on Pangean climate. Ethan Grossman has compiled the stable isotope data available for Pangea time and discusses the paleoclimatic, oceanographic and carbon-storage implications.

More specific modelling contributions include applications to Triassic climates (Wilson and others), to modern and Pangea deserts (Chandler; including a more general evaluation of hydrologic diagnostics), and to Indian and Australian Pangea climates (Fawcett, Barron and others). Benoit Beauchamp documents dramatic cooling recorded in Permian fossils and sediments of Arctic Canada, while J.C. Youle and others have identified sequences and sea level fluctuations with

resolution to 100,000 years in the Pennsylvanian cyclothems of the central United States. In a discussion of the many controls on and paleogeographic and paleoclimatic implications of Permian and Triassic reef distributions, Erik Flügel has highlighted the critical need for more and better information on the fossil data base.

All geoscientists concerned with placing the sedimentary and biologic record into a larger Earth perspective will be interested in this book. This soft-cover volume is reasonably priced and well-produced. We look forward to seeing a follow-up synthesis of the results of the research that has been stimulated by the 1992 workshop.

Geology of the Mexican Republic

By Dante Morán-Zenteno
Translated and with additional bibliography by James Lee Wilson and Luis Sanchez-Barreda
American Association of Petroleum Geologists
AAPG Studies in Geology 39
1994, 160 p., US$67.00 hardcover

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The role of geology is extraordinarily obvious in Mexican history, art and economics, since the native people and the conquering Spanish exploited its rich mineral wealth and landscapes, and were impressed with its volcanic and earthquake activity. Modern geologists understand it (poorly still) as a complex land containing mutually interacting elements characteristic of the southern part of the North American continent, the eastern Pacific oceanic plates and spreading ridges, and the Gulf of Mexico and the Caribbean. For Canadians, besides its natural and cultural diversity and wonderful people, Mexico is a showcase for volcanic and reef processes, a fellow producer of immense oil and gas reserves, and an attractive target for metallic mineral exploration.

The original volume was produced by an instructor and paleomagnetics researcher with Mexico's national university (UNAM) with dual objectives: a geological synthesis of Mexico for use as a general reference, and as a tool to be used in upper level university courses. Its major breakdown is geographic, dividing the Republic into four regions with more-or-less natural limits, and then into smaller areas, presenting for each of these areas a synthesis that incorporates tectonic understanding up to about 1983 and a summary of its economic deposits. Considering its synthesis character, this book contains a considerable amount of basic detail where it is available, including a brief description, appropriately supported by references, of major sedimentary formations and their fossil types, batholith compositions, radiometric ages, *etc.* The eight 1:1,000,000 maps included with the original are not present in the translation, and in any case have been replaced by a 1:2,000,000 scale updated version that is available independently; but this volume contains a large number of simplified schematic maps and cross-sections showing the distribution and tectonic interpretation of rock units, lithologies and mineral deposits. A comprehensive index map would have made it easier to relate the geographic headings and distribution maps to the larger context, and the absence of photographs of the magnificent geologic vistas available is unfortunate.

My Mexican sources speak well of the original Spanish version of this book and English-speaking geologists should be grateful for this well-organized introduction to Mexican geology, to AAPG for publishing it, and for the competent work of the translators. Although it is now more than 13 years old and new interpretations are available for many areas, this comprehensive reference will long be a basic reference for geologists of all stripes interested in southern North America and the Gulf of Mexico, from senior undergraduate student through academic to exploration geologist. The translated version contains a relatively complete, more recent bibliography of Mexican geology, including about 1500 references up to 1993. Given this book's lack of an overall national treatment, it is perhaps appropriate to recommend as reading companions the only other recent overviews of Mexico that are widely available in English: *Outline of the Geology of Mexico* by Zoltan de Cserna , published (1989) in the Geological Society of America's centennial DNAG Series, The Geology of North America, v. A, An Overview, p. 233-263 and *Tectonostratigraphic Terranes and Tectonic Evolution of Mexico,* GSA Special Paper 278.

The Tectonics, Sedimentation and Paleoceanography of the North Atlantic Region

Edited by R. Scrutton, M.S. Stoker, G.B. Shimmield and A.W. Tudhope
Geological Society of London
Special Publication 90
1995, 309 p., US$48 (member)
US$100 (non-member)

Reviewed by Andrew D. Miall
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As explained by the editors in the Preface, the stimuli for the papers collected in this volume were twofold: the return of the Ocean Drilling Program to the North Atlantic, and the exploration industry's advance into the deep waters off the northwest margins of Europe. The book consists of a collection of 17 papers dealing primarily with the structural and stratigraphic geology, and the tectonic and sedimentologic evolution of the area bounded by Newfoundland, Greenland, the Irish-Scottish continental margins, and the Atlantic continental margin of Spain. The book does not represent a synthesis of the geology of this area, but a selection of papers dealing with various research questions within the overall theme. As such, it should be of interest to specialists in the tectonics and petroleum exploration of extensional continental margins, but there is little here for the non-specialist reader.

The area covered by the book is a classic area for the study of extensional margins because of the extreme complexity of the rifting and spreading history. Although the extensional plate-tectonic history of the Atlantic Ocean was first recognized in the 1960s by Tuzo Wilson, and excellent syntheses of preliminary exploration data have been published by individuals such as Hubbard, Tankard, Hiscott, R.C.L. Wilson, and others, the details of the spreading history are still being worked out, as more detailed oceanographic and seismic data become available. There is still room for refinement in our knowledge of the kinematics of fault movement and ridge migration in the area.

Even such fundamental questions as the precise age and location of the break-up unconformity and the relative importance of pure-shear *versus* simple-shear in the extensional tectonism, remain to be answered for much of this area. Papers in this book address these and other questions by the use of new exploration data in specific areas of the North Atlantic region.

In the first paper, N.W. Driscoll and his colleagues examine the evidence for the rift-drift transition and the age of the break-up unconformity by carrying out a tectonic and sequence-stratigraphic analysis of reflection seismic and well data on the Grand Banks of Newfoundland. I.K. Sinclair compares the tectonic and stratigraphic evolution of the Jeanne d'Arc and Porcupine basins, two basins facing each other across the Atlantic Ocean on the Grand Banks of Newfoundland and the Irish continental margin, respectively. Although the timing of the tectonic events in these two basins is similar, the stratigraphic response is not. C.C. Ebdon and coworkers present a basin analysis of the Early Tertiary of the Faeroe–Shetland Basin, an area with prospects for petroleum production from submarine fans in rift settings. Two papers follow dealing with the tectonic evolution of the Galicia margin, the continental margin off the west coast of Spain. The first is by C. Boillot and coworkers, and consists of a detailed analysis of reflection seismic data. The second paper, by T.J. Reston and others, focusses on a prominent seismic reflector, the nature of which remains obscure. Their conclusion is that the reflector represents a major detachment surface, and they discuss various configurations of the crustal blocks and seismic reflectors that could explain the observed seismic architecture.

Four papers follow dealing with the offshore geology of the Faeroe Islands area. First, Kiørboe and Petersen discuss the basalts of the Brito–Arctic Igneous Province, as developed in the offshore near the Faeroe Islands. The focus of this paper is the appropriate processing and interpretation techniques for dealing with the occurrence of basalt layers in seismic reflection data. Vanneste and co-workers follow with the results of a reconnaissance reflection-seismic survey of two bank areas southwest of the Faeroes. Andersen and Boldreel provide a short paper discussing the flow of cold bottom waters through a channel across the shelf and into the deep North Atlantic Ocean. This flow is thought to explain the presence of a series of erosional unconformities in the Miocene stratigraphy of the channel area. In the last paper in this set Boldreel and Andersen describe the seismic stratigraphy of the younger Tertiary section in the shelf around the Faeroes, and discuss the broader effects of bottom-water movement on stratigraphic development.

The surficial stratigraphy of the continental margin off the Hebridean Shelf and the West Shetland Shelf is the subject of the next paper, by M.S. Stoker. It is shown that the margin has been sculpted by glaciation, which has left a slope apron consisting of sediment-gravity-flow deposits and thin slope clinoforms. Dredged samples from the shelf southeast of the Faeroes are used as the basis for a discussion of the sedimentary petrography and palynostratigraphy of the Paleogene section in that area, in a paper by R. Waagstein and C. Heilmann-Clausen. The next paper, which seems completely out of order, is by E.J.W. Jones and co-workers, and discusses the evolution of bottom-water flow in the equatorial central Atlantic Ocean, the area between West Africa and Brazil. A series of bathymetric maps has been constructed based on the evolution of fracture zones and ocean-floor subsidence during the sea-floor spreading of this area. A short paper on Tertiary compression structures in the Faeroes–Rockall area follows, and then there are two papers dealing with the chrono-stratigraphy of the late Cenozoic record. The first, by S. Haslett, deals with the radiolarian biostratigraphy and paleoceanography, and the second, by J.B. Hunt and co-workers, with the tephrochronology of Late Quaternary deposits. The tephras are not well preserved near their source areas in Iceland because they were mostly deposited on glacial ice. This makes tracking the origins of the distal deposits more difficult. The next paper, by K. Thomson and co-workers, describes the complex of late Tertiary inversion and strike-slip structures in the Inner Moray Firth, and discusses their origins in terms of regional plate kinematics. The final paper, by C.N. Wold, is a computer model of the changing bathymetry of the North Atlantic region, taking into account the sea-floor spreading and thermal subsidence of the evolving ocean. The book ends with a detailed subject index.

This volume is up to the usual production standards of the Geological Society of London, and will certainly be required reading for exploration geologists and oceanographers working in the North Atlantic region, especially along the continental margin west of the British Isles. However, the contents and organization of the book, like those of several other recent special publications of the Geological Society of London, make one wonder at the publication philosophy behind this series. *Tectonics and Seismic Sequence Stratigraphy* (Special Publication 71), *Characterization of Fluvial and Aeolian Reservoirs* (Special Publication 73), *Characterization of Deep Marine Clastic Systems* (Special Publication 94), *Sequence Stratigraphy in British Geology* (Special Publication 103) and *Orogeny Through Time* (Special Publication 121) are examples of books that, like this one, seem to consist of a random set of loosely related papers, arranged in no logical order, that by no means add up to complete and comprehensive statements of the level of knowledge of their subject areas. Commonly, there are papers in these books that are slightly off topic, as if the editor did not quite have the heart to reject them (in the book under review here there are papers dealing with the central Atlantic Ocean and the Moray Firth, which seem decidedly out of place). Individually, most of the papers in these volumes are excellent, but most could equally well have been published separately as regular journal articles, or perhaps collected in a "thematic set" in the Journal of the Geological Society of London. Many potential readers will purchase special books if they appear to be comprehensive landmarks in their field, but none of those listed here qualifies in this category. As a result, their appeal is limited, their sales must be small, and the result is inordinately high prices. At a time of shrinking budgets for libraries and book purchases by individuals, every effort should be made by publishers to streamline and rationalize their publication series. I urge the Society to rethink its policy with regard to their special publications series, and save this line for truly landmark collections, such as the excellent *Tectonic Events Responsible for Britain's Oil and Gas Reserves* (Special Publication 55).

Exploration Seismology (Second Edition)

By Robert E. Sheriff and
Lloyd P. Geldart
Cambridge University Press
Port Chester, New York 10573 USA
1995, 608 p., US$52.95 paperback

Reviewed by J.R. Dietrich
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The highly regarded first edition of *Exploration Seismology* (published in 1982 as a two-volume set) has been updated and expanded in this (1995) second edition (single-volume) book. The second edition *Exploration Seismology* is even more impressive than the original and will undoubtedly continue as a benchmark textbook in the field of exploration seismology for many years to come.

The book is divided into 15 chapters, providing a balanced mix of theoretical, descriptive and interpretative material. The book is weighted toward reflection seismology as applied to oil and gas exploration. There is only one chapter devoted to refraction methods, and sections describing other seismology applications (engineering and environmental work, and coal exploration) are brief. Each chapter begins with an overview and is concluded with an extensive reference list. Most chapters are accompanied by a one or two page section of questions and problems for consideration by students. The first chapter reviews the history of exploration seismology and related technology developments (up to the early 1990s). The next five chapters provide comprehensive reviews of theoretical aspects of seismology including seismic wave theory, wave partitioning and geometry, seismic velocity, and seismic event characteristics. This is followed by four chapters that deal with more practical aspects of seismic data acquisition, processing and interpretation, and three chapters that cover a variety of specialized techniques and applications (such as exploration with shear waves and reservoir geophysics). The final chapter and appendices provide reviews of background mathematics and lists of reference material and symbols.

There have been a wide range of improvements and new developments in exploration seismology since publication of the first edition book. New or updated topics covered in the second edition include three-dimensional seismic techniques, vertical seismic profiling, seismic tomography, dip-moveout processing, shear wave and borehole applications, and seismic work station uses.

The book is well organized, indexed and cross-referenced. While mathematical formulas (and derivations) are dispersed throughout the book, the non-specialist reader will find ample descriptive material on every topic. The book contains some 525 figures and 32 tables and includes (as a further improvement from the first edition) eight color plates. The publication of the second edition as a single-volume book is a welcome change from the initial two-volume version.

Exploration Seismology (Second Edition) provides a comprehensive overview of seismic exploration principles and techniques. The book is suitable for undergraduate or graduate university courses and would be invaluable as a technical reference guide for any professional geophysicist actively engaged in petroleum exploration or research.

Life in Stone: A Natural History of British Columbia's Fossils

Edited by R.Ludvigsen
UBC Press
Vancouver, BC
1996, 310 p., $65.00

Reviewed by Paul L. Smith
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Something exceptional is happening in British Columbia. Around the world the geological downsizing that has gripped surveys and universities alike has left paleontology suffering disproportionately in its wake. The remaining paleontologists spend increasing amounts of their research time either in the lab or in front of a computer crunching numbers into models of ancient reality. Field work, if it is done at all, is a focussed, curtailed business bearing no comparison to the now seemingly ambitious field programs of a decade ago. Meanwhile in British Columbia, two brand new earth science departments have sprung up and a 250-strong organization called the Paleontological Alliance bridges the gap between professional and amateur and ensures that not a month goes by without at least one paleontological field trip somewhere in the province.

The Alliance is the brainchild of Rolf Ludvigsen, who compiled and edited *Life in Stone*, with the aim of disseminating the wonders of paleontology to a broader audience, particularly current and potential members of the Alliance. It is an ambitious undertaking involving 25 authors who deal with many of British Columbia's important fossil groups, and a good portion of the geological column.

The introductory chapters concern the hierarchies of taxonomy and geological time, the evolution of the Cordillera and the role of museums in paleontology. Great names from the past, particularly Geological Survey of Canada luminaries such as Selwyn, Dawson, Richardson and Whiteaves are introduced here to subsequently weave their way in and out of the book. I suspect that members of the public will be surprised to read of the important role that some of these geologists played in the history of the province. A recurring point made in these early chapters is that most of British Columbia's impressive fossil wealth is housed outside the province and often outside the country; this is particularly the case with the world-famous Burgess Shale fauna, which naturally features prominently in the book. Consequently, it is galling to see the British Columbia Provincial Museum trumpet the central role of museums in paleontology when, by their own admission, there are no fossils in their permanent displays, there has never been a paleontologist on staff, nor has any effort been made over the years to a build a collection. If science and culture aren't enough, perhaps the lure of potential tourist dollars can loosen the provincial purse strings.

The chapters on Paleozoic fossils concern trilobites, the Burgess Shale fauna and, from a geological perspective, the all-important conodonts. The Mesozoic is dealt with in eight chapters, twice as many as for the Paleozoic, with coverage of the radiolarians, ammonoids (a chapter for each period), vertebrates (fish, marine

reptiles, dinosaurs) and plants. In terms of area of outcrop, Cenozoic rocks are of minor importance in the province but Eocene lake deposits and Quaternary gravel pits have yielded exquisite terrestrial fossils that warrant the eight chapters devoted to this Era. The final summary chapter looks at British Columbia's fossils in the context of the evolution of life. There is no common style to the chapters. Anecdote and description abound but authors frequently use the province's fossil record to explore broader questions. Why are Eocene insects so similar to modern forms? When did the Tethyan and Pacific oceans link up? What do fossils have to tell us about displaced terranes? I suspect there is something new here for everyone with an interest, and next time I am in the Queen Charlotte Islands, I shall certainly have my eyes peeled for the Dawson caribou, an endemic species last seen in the 1920s.

One of the aims of this book is to distill a substantial paleontological literature that, from the public perspective, lies inaccessibly buried in institutional libraries. The book is not meant to act as a bibliographic source but, nonetheless, the reference lists accompanying each chapter are a little too lean. The absence of information on geological and paleontological field guides is particularly distressing, given the target audience. The photographs and illustrations are uneven in quality and the chapter headings sometimes verge on melodrama (Lower Cambrian trilobites: most ancient mariners; The Burgess Shale: a spectacular Cambrian bestiary, *etc.*) but the book is remarkably free of errors and reads very well. In fact, *Life in Stone* is a grand sweep that will promote the province's rich fossil record and inspire British Columbians to explore and treasure their paleontological heritage.

Geologists and the History of Geology. An International Bibliography from the origins to 1978. Supplement 2, 1985-1993 and Additions.

By William A.S. Sarjeant
Krieger Publishing Company
Malabar, Florida
2317 p., 3 volumes, $365.

Reviewed by David A.E. Spalding
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With the publication of this supplement, Sarjeant brings his bibliography of the History of the Earth Sciences up to 1993. The complete work, of which the first parts appeared in 1980, now has an astonishing ten volumes and 8534 pages. All the volumes are still available, and should be in the library of any institution concerned with the earth sciences, and any individual with a particular interest in the history of the field.

As with previous volumes, the content includes histories of geology, its subdivisions and allied sciences; historical accounts of societies, museums and other institutions; histories of the petroleum industry; events significant in the history of geology; and biographies of geologists (with a separate section on prospectors, diviners and mining engineers). Indexes facilitate reference to geologists by countries of birth and work, and by speciality. Authors, editors and translators are also indexed, and like its predecessor, this supplement has a separate index of women geologists. Layout and treatment of the new volumes are consistent with the earlier ones (facilitating use of the entire set).

The latest supplement has a clearer type and more spacious layout than its predecessors. It not only updates the previous volumes, but includes reference to more than 100 periodicals that have not been previously accessible. Indexing has substantially accommodated the changing names of many countries. (Purchasers should be aware that the backs of two of the three volumes of my review copy were damaged in transit, and should insist on adequate packing).

The contents vividly document the rapidly growing interest in the history of the earth sciences, showing extensive revisiting of classic figures as well as better documentation of remoter parts of the world. The pages document such hot topics as the conflict between Earth and "creation" science, the Himalayan fossil controversy, and the Piltdown forgery. Canada is well represented, and a personal test relating to my own research on Canadian dinosaur collectors found important and unfamiliar material published in a New Mexico field trip guidebook and a book on Maltese geology. For the browser, endless intriguing possibilities open up; where else, for instance, could you expect to find references to the folklore of geology in Papua New Guinea, or an update on new work on English fossil collector Mary Anning by eminent novelist John Fowles?

The Pleistocene Boundary and the Beginning of the Quaternary

Edited by J.A. Van Couvering
Cambridge University Press
1997, 296 p., US$120.00

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Just when does the Pleistocene (Quaternary) begin? In 1948 the 18th International Geological Congress (IGC) in London passed a resolution to define, characterize and globally correlate the base of the Pleistocene Series (base of the Quaternary subsystem or the Neogene–Quaternary boundary to some stratigraphers). This volume is the final report by the International Geological Correlation Program, Project 41 (IGCP-41) which defines

the Pliocene–Pleistocene boundary within a marine section exposed in southern Italy at Vrica, Calabria. The boundary lies at the base of a claystone unit conformably overlying the sapropelic bed e and coincides with the first appearance of several cold water faunas in the Mediterranean Basin. New orbitally-tuned time scales dated the contact near the top of the Olduvai subchron about 1.8 Ma.

In the Preface, the editor assures the readers that at long last an internationally accepted definition has been achieved and the Vrica boundary stratotype has gained widespread approval as a global boundary stratotype section and point (GSSP): but has it? It took almost five decades to reach this apparent consensus. Deficiencies of various Italian sites proposed were revealed as new stratigraphic and dating techniques emerged. Moreover, although most papers in this volume were submitted by 1984, it took another 13 years for this report to come out! The papers were revised in 1987 and some were updated in 1992, but disagreement among the authors is still evident.

The book is divided into four parts: Part I outlines the history and politics of IGCP-41 since its inception in 1974. Part II tries to characterize the Plio–Pleistocene boundary stratotype at Vrica, with papers on magnetostratigraphy, biostratigraphy and correlation to deep sea sapropels from the eastern Mediterranean. Part III describes the Plio–Pleistocene boundary in deep-sea sediments, the flora in extratropical Eurasia, and mammals with respect to the emergence of *Homo* in Africa. The final part of the book contains 20 papers describing stratigraphic sequences from various parts of the world. In each paper an attempt is made to identify the Plio–Pleistocene boundary near the base of the Olduvai subchron. The last section shows the greatest amount of disparity on locating the Plio–Pleistocene boundary.

The heart of the problem lies in the common notion that the Pleistocene (Quaternary) is usually associated with global cooling culminating in the "Ice Ages." Quaternarists usually concern themselves with Late Cenozoic paleoenvironments dominated by major climatic cycles. The Vrica site was chosen mainly for historical reasons and the false assumption that the first appearance of cold water faunas in the Mediterranean Basin corresponded to the beginning of the Ice Ages. Nonetheless, modern high-resolution dating tools readily show the diachronous nature of paleoenvironmental change and show that glacial-like conditions in the rest of Europe and in the deep sea record began about 2.5 Ma. The Vrica site technically meets international stratigraphic rules because no relationship between chronostratigraphy and climate is required, however the ideology of the Ice Ages remains. It is unlikely that any geographic site chosen for a stratotype will gain universal acceptance in all parts of the globe.

Ongoing concern about the appropriateness of the Vrica boundary was addressed by a special symposium at the International Union for Quaternary Research (INQUA) 14th Congress in Berlin, 1995 (reported in *Quaternary International*, v. 40, 1997). During the meeting, several researchers proposed that the base of the Pleistocene should coincide with a severe, global climatic cooling that occurs just after the Gauss–Matuyama Chron boundary at 2.5 Ma (corresponding to cold marine isotopic stage 100). Consequently, work has started to propose a new stratotype at the next INQUA congress in 1999. However, considerable disagreement continues to exist.

In summary, although this book provides comprehensive overviews of Plio–Pleistocene stratigraphy in many parts of the world, it is largely out of date and superceded by more recently published papers. The overall quality of the reproduction is poor. Many pages have smeared type and poorly reproduced figures and tables. One should expect more from a book priced at $US120.

Latest Ordovician–Silurian Articulate Brachiopods of the Avalanche Lake Area, Southwestern District of Mackenzie, Canada

By J. Jin and B.D.E. Chatterton
Canadian Society of Petroleum Geologists and Geological Association of Canada Palaeontographica Canadiana 13
1997, 167 p., CDN$51.50 (in Canada) US$51.50 (outside Canada)

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The Avalanche Lake area (discovered by this reviewer in 1975) has been a virtual bonanza for fossils. The extremely rich trilobite faunas, all beautifully silicified, have been the focus of a number of earlier studies by Chatterton and his colleagues, and the description of the almost equally rich brachiopod faunas of the same sections is the focus of the present study by Jin and Chatterton. The brachiopod faunas range in age from latest Ordovician to latest Wenlock (or possibly earliest Ludlow), although the dominant part of the faunas derives from late Wenlock strata. The brachiopod faunas are represented by thousands of specimens, all silicified, most are very well preserved, and the overall diversity is exceptionally high. Sixty-two genera and 86 species are described, 17 of the latter being new; of the total fauna, 20 species are orthids, 23 are strophomenids, 12 are pentamerids, four are rhychonellids, 13 are atrypids, 13 are spiriferids, and one is a terebratulid. The last is a surprise, since only recently have terebratulids been recognized in the Silurian. Most of the shells are small to only moderate in size, as is typical of basin-margin brachiopods. The faunas are divided into four assemblage biozones, but it is only in the highest, late Wenlock, that the zonal diversity is by far the highest (63 out of a total of 86 species!), and where there is a substantial component of large-shelled pentamerids, suggesting derivation from

a shallower water environment, as pointed out by the authors. This is, above all, a taxonomic paper and, as such, it is profusely illustrated. There are no fewer than 50 plates! Each species is well illustrated, and most have detailed and in-depth descriptions and/or remarks sections, and many have accompanying graphs comparing growth-series lengths and widths. The number of specimens from each stratigraphic level is meticulously recorded. My only criticism is that the illustrations, while being good to very good, are somewhat less than "crisp." However, knowing the meticulousness of each author, I fully suspect the fault lies entirely with the journal's photographic reproduction processes!

This publication will fill a large geographic gap between the Llandovery and Wenlock faunas extensively described from the Basin and Range region in the 1770s, and the single large publication on Arctic Islands Wenlock brachiopods. Comparisons among the three major regions is made relatively easy, since all three are relatively deep water, basin-margin settings and, as such, share many common elements.

The publication is very well written, the overall style is attractive — especially the cover with an illustration of Dicoelosia paralata Bassett — and the typographical errors very few. The only consistent omission is the lack of some diacritical marks on Czech names and words. All in all, this is an attractive, well produced, and richly illustrated monograph of a diverse brachiopod fauna from the central Mackenzie Mountains, and should be a well-received and often-cited publication by all Silurian brachiopod workers. Considering the overall quality of the publication and, above all, the sheer plethora of high-quality plates, the selling price of $51.50 (US$51.50 outside Canada) is very reasonable.