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The Last Billion Years: A Geological History of the Maritime Provinces of Canada

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REVIEWS

The Last Billion Years A Geological History of the Maritime Provinces of Canada

Atlantic Geoscience Society
Nimbus Publishing
Post Office Box 9166
Halifax, Nova Scotia B3K 5M8
2001, 212 p., $35.00 paperback
ISBN 1-55109-351-0

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This is an extraordinary book and so it should be: it was planned, written and edited by the entire Who's Who of geoscience and science awareness in the Maritime provinces, undoubtedly under the guidance of the Society's ubiquitous Graham Williams! It is illustrated throughout by exceptional photographs, paintings, and line drawings. Despite the enormous number of contributors, the editors have produced a very engaging text with a consistent, very readable style that should appeal to high school students, interested laypersons, university undergraduates, and also to professional geoscientists (and retirees like me!) who wish to quickly and easily upgrade themselves on the most recent interpretations of Appalachian geology.

The first three chapters provide an introduction to geology, using Maritime examples where available. The authors suggest that these chapters can be skipped by those with backgrounds in the subject. Don't skip them; they are a model for the effective, painless transmission of the essentials of our science. Those three chapters, only 60 pages, leave the reader aware of the many ways in which minerals, rocks, and fossils have served as keys to unravelling Earth history. They provide convincing evidence for changes in continental positions, climate changes, evolution and extinctions and the origin of economically important mineral and hydrocarbon deposits that serve as background for the chapters to follow.

Chapter 4 plunges readers "Into Deepest Time" as the supercontinent Rodinia is described. The Grenville Orogen formed as continental fragments were welded together to form this supercontinent, and a remnant of this orogen is preserved on northern Cape Breton Island. The breakup of Rodinia by rifting and ocean floor spreading dispersed continental fragments all over the globe. The Precambrian core of the present Maritimes originated on or near the edges of these new continents: the Avalon Terrane as a volcanic arc and the Miramichi-Bras D'Or Terrane on a passive continental margin. Complex relationships to explain to the non-professional, you'll agree, but it is done painlessly with the help of illustrations including "boxes," designed to enhance unfamiliar topics. Elsewhere these usually run to a few paragraphs set in a different script fenced in by linear borderlines, but in this book they run from one to six pages printed on attractive peach-coloured, paleontologically patterned paper. Their titles are also attractive: "I've Found a Fossil-Now What?"; "A Quick Guide to Some Continents, Oceans and Terranes"; and "Fish Tales: A History of Early Vertebrates." These colourful boxes quickly clear up any misunderstandings of the text.

The breakup of Rodinia into widely scattered continents created many continental shelves on which life could experiment and led to the "Cambrian Explosion." This event is described in Chapter 5, and Maritime fossil highlights (and there are many) are used in this and ensuing chapters to explain evolutionary progress. Both are closely linked to plate tectonic events. We learn how the Maritime Provinces came into being as various continental fragments, dispersed in rather erratic fashion, and finally assembled as we know them today. The involved history of the opening of the Iapetus Ocean *ca* 600 m.y. ago and then its closing by Ordovician subduction to initiate the Northern Acadian Orogen is well told. The related obduction of island arc remnants and the later emplacement of granitic plutons are clearly illustrated by sequences of cross-sections and global paleogeographic maps. The "Open-and-Shut" case of the Rheic Ocean that followed and produced the Southern Acadian Orogen is also clearly depicted. All the terranes of the Maritime collage were now nearly in place, with the Meguma still sliding westward against the Avalon: all part of the Appalachian Mountain system on the still-growing supercontinent Pangea.

Chapter 6, entitled "Basins and Ranges," traces the history of the Maritimes Basin that dominated the landscape from late Devonian to Permian. The reader learns of the importance of the Cobequid-Chedabucto Fault system in its formation and subsequent history. Also of the changing environments that produced inland seas and evaporite deposits followed by Carboniferous coal swamps. As always, there are fascinating asides, *e.g.*, the soot that smudges exposed skin of coal miners is a product of wildfires 300 m.y. ago. The vertebrate (including some of the earliest known reptiles) and plant life of Late Paleozoic are extensively described and illustrated and the chapter ends with "the Greatest Drying, the Greatest Dying," an account of Permian extinctions.

North America was a chip off the old block Pangea, as its breakup formed

the modern array of continents and oceans as described in Chapter 7, entitled "An Ocean is Born." The photos of colourful Triassic and early Jurassic red beds and columnar basalts of the Fundy Basin enhance the description of rifting that heralded the birth of the Atlantic Ocean. Described in some detail are the treasure trove of vertebrate remains that include Canada's oldest dinosaurs, the smallest dinosaur footprints, and the spectacular early Jurassic finds at Wasson Bluff, near Parrsboro, Nova Scotia. I learned here for the first time that the extinction event at the end of the Triassic was much more devastating than that at the K-T boundary. The story of the early Atlantic is interpreted through the record of the 20-km thickness of Mesozoic and Cenozoic sediments deposited in the Scotian Basin. The chapter concludes with a discussion of the K-T extinction, the subsequent Age of Mammals, and an interesting, fairly detailed explanation of the Tertiary cooling trend.

Earlier mentions of the usefulness of rocks and minerals are all tied together in Chapter 8, "From Rocks to Riches," which would be a best seller as a stand-alone booklet. In 29 pages, it touches on most of the great diversity of geological resources, including soils and water, available in the Maritimes. It also covers the historical background of mining, sustainable development and environmental protection, and the risks of mineral exploration. The various origins of metallic ores, industrial rocks and minerals, and hydrocarbon deposits are dealt with in surprising detail. The last contained the only factual blooper I found: the anticlinal theory of oil entrapment was credited to William Logan in 1842, instead of his colleague, Sterry Hunt, in 1862.

The last chapter, devoted to the Ice Age and beyond, brings the latest information to enlighten readers on how climate changes come about and how glaciation and sealevel fluctuations shaped Maritime landscapes. Its final section, entitled "The Future of the Planet" encourages us to heed the warnings of the geological past as we look to the future.

The Last Billion Years is a magnificent scientific, literary, and artistic achievement with wide appeal. Leave it on display and even when old Aunt Ida and the vicar come to tea I guarantee it will promote conversation. You will not want to part with your copy but at $35.00 it is a great buy, and would be a much appreciated gift to friends and relatives. It has barely been published and already there are rumours of a second printing. Well done Atlantic Geoscience Society!

Depth Imaging of Foothills Seismic Data

Edited by Laurence R. Lines, Samuel H. Gray and Don C. Lawton
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905, 510 5 Street S.W.
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1999, 275 p.
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As the editors explain in the preface, this compilation of published papers and unpublished manuscripts is designed to provide an outline for a short course on the techniques and applications of depth imaging in Foothills exploration. Published by the Canadian Society of Exploration Geophysicists (CSEG) as part of that organization's 50th Anniversary Project, this volume clearly succeeds in meeting its goal.

At issue is the optimum approach, in terms of effort and cost, to processing seismic reflection data in the structurally complex Alberta Foothills of the Cordilleran Orogen. The motivation for these efforts is introduced first, followed by papers that discuss migration concepts and approaches by increasingly sophisticated means. Of particular note are the emphases placed on pre-stack depth migration, migration from topography, and appropriate techniques for layered rocks displaying significant velocity anisotropy. Pre-stack depth migration, using modern velocity analysis tools, is shown to be far superior to the "standard" processing flow of NMO (normal moveout) / DMO (dip moveout) /stack/ migration in structurally complex settings. Of the various migration techniques discussed, Kirchhoff migration is generally favoured in the balance between quality and cost. Migration from topography, as opposed to from a (conventional) flat datum, results in remarkably improved resolution in the shallow portion of the section, allowing substantial improvements in the velocity model and hence imaging of deeper targets. Migration velocity models that account for velocity anisotropies are shown to significantly improve resolution of synthetic and physical analogue models, with clear implications for Foothills structures.

Lines, Gray and Lawton have organized 28 contributions into 6 chapters: 1) Introduction, 2) Prestack Migration Concepts, 3) Migration in Structurally Complex Areas, 4) Case Histories, 5) Anisotropic Migration, and 6) Conclusions and Future Work. Each chapter comprises brief introductory remarks by the editors, and two or more papers. Of these 28 contributions, 13 are reprints from peer-reviewed journals (eight from *Geophysics*, three from the *Canadian Journal of Exploration Geophysicists*, one from the *Journal of Seismic Exploration*, and one from the CSEG *Recorder*), one is reprinted from a Society of Exploration Geophysicists volume, one appeared as an article in *The Leading Edge*, four are expanded abstracts from CSPG and CSEG meetings, four are reprints from CREWES and FRP research reports (two each), and five are previously unpublished manuscripts. An enclosed compact disc includes files to perform reverse-time depth migration of a synthetic Foothills seismogram data set. These include Fortran77 source code and executable files, data files, and instructions for users. The files are intended for use on a UNIX-based machine.

Although the editorial comments that lead off each chapter are perhaps too brief (the entire contents of Chapter 6 consist of a mere eight sentences), the contributions are well organized, and encompass the range of topics intended. One could quibble that the few previously unpublished contributions could have been more tightly edited, that the year of publication appears nowhere in