Book Reviews / Critique

REVIEWS

Quin Kola – Tom Payne's Search for Gold

By Alice Payne
Crossfield Publishing
502 Downey Place
Okotoks, Alberta T0L 1T2
2000, 214 p.
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Canadian Society of Petroleum Geologists
160 – 540 5 Avenue S.W.
Calgary, Alberta T2P 0M2
jaime.croft@cspg.org

Reviewed by Ward Neale
5108 Carney Road
Calgary, Alberta T2L 1G2

This is the life story of a colourful adventurer and mine finder in the first half of the 1900s. Late in life, Tom Payne documented many of his experiences in a hand-written memoir, now on file in the National Archives of Canada, Ottawa. His daughter Alice, a well-known Canadian geologist, over the years since his death has corroborated dates and facts, filled in gaps by searching the literature, and interviewed friends and co-workers from various stages of his career. Finally, as she moves towards her own retirement years, she has put his story between very attractive covers that feature geologist Maurice Haycock's painting of Echo Bay, Great Slave Lake. The style is unique: Tom's own notes interspersed with the views and recollections of his associates and family members. Alice's research and memories form the links that help smooth a narrative that in many sections reads at the jerky pace of exciting fiction.

Tom Payne grew up in Essex, England, son of a prominent but rather unpleasant and unloving physician, and was educated at Felsted, a public (*i.e.*, private) English boarding school. His father initially advised the school that Tom was "more fitted for a reformatory school." After completing school, he was employed in various aspects of agriculture, and socially seems to have been a bit of a hell-raiser.

Then, in 1912, like many of his kind, he borrowed money and set out to make his fortune farming in western Canada. Although very fit and strong, he was rejected by the armed forces for service in World War 1 because of an incipient hernia. He worked at a variety of jobs in the Calgary/Medicine Hat area and, later, in central Saskatchewan. Among other talents, he acquired an ability to operate and maintain machinery so that when he decided in the 1920s that farming wasn't for him he became involved in northern transportation. He drove tractors hauling freight for mine construction, and later operated a steam shovel at Flin Flon, Manitoba. With the shovel, he once dug through overburden into an ore zone and had his appetite whetted for gold mining. Next he was involved with tractor trains on an ill-fated expedition prospecting along the west coast of Hudson Bay. Here, as at Flin Flon, he had opportunity to talk with geologists and to read up on ore deposits. Trapping with an Innuit partner filled in the time between jobs.

The Dirty Thirties was the time of staking rushes in the northwest, triggered by Gilbert Labine's discovery of pitchblende at Great Bear Lake. Tom Payne was first involved in driving and maintaining tractors for the Ryan brothers on the portage north of Fort Smith. Then he convinced one of the brothers to grubstake him, and was off to the far north working as a boatman, trapper, mechanic, cook, and whatever. Here he prospected (and starved!), alone or with others, whenever opportunity offered at Great Bear, Hottah Lake, Beaverlodge and, finally, Yellowknife. His big find came in 1936 when he encountered free gold in gossan above a quartz vein in staked ground adjacent to what became the Con Mine. As soon as it became open, he re-staked it, and a small 100-share company was formed (he had 30 shares) and named "Quin Kola Gold Mines" after the Dogrib term for quartz. He was now *en route*, along a rather hazardous trail, to fame and fortune. When it finally came, he set his sights on another target: oil. After the Leduc discovery in 1947, he drove 160,000 miles around Alberta looking for a suitable drill site. He found one and his "Metro" well blew in on 25 May 1950, and produced for 30 years. And that is a barebones account of Tom Payne's career.

The flesh on those bones is an understanding that the reader receives of the hardships, hopes, joys, and skulduggery that was the life of those pioneers to Canada's northwest. Tom Payne's own adventures are almost beyond belief! Trapping along the west shore of Hudson Bay, he found himself adrift on an ice flow and ended up on the east shore where he was rescued by a ship that dropped him off in St. John's, Newfoundland. In the Yellowknife area, following a dispute with a company for which he was working, he was barred from cookhouse and bunkhouse, so he slept outside in -50° weather and ate off the slop pile. Later, when he was working the Quin Kola claims, he fell and ruptured his old hernia. He was flown out to Fort Smith where he languished in great pain for 4 weeks before the famed "Wop" May flew him to Edmonton where gangrenous hernia and phlebitis were not his only

concerns: he was also diagnosed as having scurvy! But from his hospital bed he engineered a deal with Cominco to buy 60% of his prospect for big bucks. It became Rycon Mines, probably the richest gold mine in Canada. The ragged and rugged 47 year old bachelor also became reacquainted with nurse Olga, the assistant night superintendent. She eventually became Mrs. Payne in a very touching and well-told account of their romance.

The change in his fortunes didn't entice him to step up on the social escalator. He described himself as a prospector for the rest of his life. His experiences with large companies had built up a distrust that also stayed with him. When he spurned an offer from Imperial Oil to buy his well, his explanation was "It's not every day you get to say 'No' to Imperial Oil" !

Great names of the north pop up continually throughout the book: pilots Jack Moar and Harry Hayter; miners Bob Armstrong, Joe Rankin and Bill Jewitt; geologists Neil Campbell, Bob Folinsbee and G.S.C. giants "Cap" Kidd, Cliff Lord, and Fred Jolliffe. Some of them and many fascinating lesser lights were interviewed by the author, and their tales are often as exciting as those of our hero, Tom. Jolliffe later became a beloved professor at McGill (one of my favourites!) and later at Queen's. I guarantee that a couple of generations of former students will enjoy Tom Payne's accounts of working with a hoard of untutored assistants in the famous GSC 1935-1936 make-work program. They will also learn of the valuable assistance that Tom and his helpers were able to give to the prospectors in the region.

One amusing thread woven into the fabric of the book is the strength of the old school tie. For example, Tom was arrested in Calgary after beating up a CPR employee who wouldn't hire Tom because he was an Englishman. But the cop turned out to be a Felsted old boy who allowed him to escape in an alley! When he contacted the colourful Bob Edwards, who published the story in the *Calgary Eye Opener,* the CPR hired Tom the very next week! At the Fort Smith portage he encountered Jack Taylor, a Felsted boy now working on Hudson Bay Company boats and a key figure in the wild parties at that place and time. And they were wild! Recovering from his severe illness and finally having hit the jackpot in Yellowknife, he took a trip to Montreal where another old Felsted grad, John Molson (of brewery fame no less) showed him a good time. His actual school tie, rather threadbare over the years, is itself the subject of a good story, but I shall leave you to discover that when you read the book. Like me, you will probably agree that Arthur Hailey chose well when he used Tom Payne as a model for his prospector in the novel *Hotel.*

Exploration for Metalliferous and Related Minerals in Britain: a Guide 2nd edition

By T. B. Coleman and D. C. Cooper
DTI Minerals Programme Publication 1
2000, 80 p., £20 paperback
British Geological Survey
Keyworth, Nottingham NG12 5G
United Kingdom
www.mineralsUK.com

Reviewed by J.F.H. Thompson
Teck Corporation
200 Burrard Street
Vancouver, British Columbia V6C 3L9

This is a paperback, large-format book produced by the British Geological Survey and the Department of Trade and Industry (DTI) Minerals Program of the United Kingdom. The purpose of the book, like the original edition produced in 1990, is to provide a comprehensive introduction to the mineral potential and mineral exploration in the United Kingdom. The underlying goal clearly is to encourage mineral exploration.

Following a useful Summary, the book has an Introduction, eight sections covering technical, legal, and business aspects of mineral exploration in the United Kingdom, and four appendices with supporting information. Section 2, the Public Sector Role in Mineral Exploration, describes the various government organizations that provide geoscientific data or regulate mineral exploration. Some of this is covered in more detail with additional information in Section 7, Mineral Legislation; Section 8, Sources of Information; and Section 9, Financial Assistance.

Technical data are set out in Sections 3 to 6. Section 3, Geology and Structure, is a succinct description of the major geological subdivisions and events in the British Isles, no mean task given the range of ages and complex geological settings found in Britain. Section 4, Mineral Exploration and Discoveries Since 1965, briefly summarizes some of the exploration programs of the last 35 years. The mid-1960s is selected to start this review because of the technological developments that occurred at this time, resulting in more systematic and effective exploration. Although several of these programs discovered mineralization, only a few mines were developed.

Section 5, Future Prospects for Mineral Exploration, is the most comprehensive section in the book. This section is organized by deposit type with subdivisions based on districts, geological setting, or more detailed deposit types. Although the information in this section is extensive and well presented, the organization is confusing. For example, the subsection on Volcanic Mineralization is further subdivided into Volcanogenic Massive Sulphide (VMS) deposits, Besshi-style deposits, and Caldera-related deposits. In most classifications, Besshi deposits are a type of VMS deposit, whereas calderas are a geological environment that may host a wide range of mineralization, not all of it related to caldera formation. One subsection is devoted to Unconformity-related (Redox) gold mineralization which, although recognized in other parts of the world, is yet to be proven as a setting for major economic deposits. Little data are provided on the gold grade or extent of mineralization found in the British examples. Finally, a subsection on Gemstones occurs between subsections on Epithermal gold mineralization and Granite-related mineralization for no obvious reason: Section 5 is not organized alphabetically. Section 5 is supported to a considerable degree by Appendix I, which covers similar data organized by commodity. These could have been combined into one comprehensive section, and I suspect

that many readers in the mineral exploration business will prefer to start with Appendix I before moving to Section 5.

Section 6, Mineral Exploration Techniques in Britain, describes some of the important approaches for mineral exploration in the context of an extensively populated and cultivated setting such as the British Isles. Most of these techniques are used in similar environments elsewhere in the world, although some of them are considered of limited value and expensive. Some of the potential technical problems facing exploration in the British Isles are set out clearly as a warning to those who overlook the extensive cultural and agricultural history.

Overall the book will be useful to those considering mineral exploration in the British Isles, although many Canadians may consider £20 pricey for a government publication. The book is clearly promotional. For example, many of the statements in the book on the mineral endowment of Britain are, at best, unsubstantiated. When compared to books, pamphlets, and web sites provided by other countries, this book falls short on critical information. For example, tabulated past production, taxation, and costs would be useful comparative data. There is some repetition in the book and, as with many government publications, the book is full of acronyms for agencies, programs, and deposit-types. Although the acronyms are clearly explained and full addresses and explanations are provided for appropriate organizations, the inevitable use of acronyms will frustrate the casual reader. Unfortunately, this book is unlikely to generate a new wave of mineral exploration in Britain given the current state of the exploration business: global competition, limited investor interest, and relatively low exploration budgets.

Fine-grained Turbidite Systems

Edited by A.H. Bouma and C.G. Stone
American Association of Petroleum Geologists Memoir 72
Society for Sedimentary Geology Special Publication 68
2000, 342 p. plus CD, US$103 hardcover
ISBN 0-89181-353-5

Reviewed by A.P. Hamblin
Geological Survey of Canada, Calgary
3303 33 Street N.W.
Calgary, Alberta T2L 2A7

Following the golden years of the 1960s and 1970s, research on turbidite systems slumped into a consolidation/application phase, accumulating more examples of the main principles and using them in exploration programs. Recently, however, there has been a resurgence of interest in all aspects of the subject, fuelled by the discovery of large hydrocarbon accumulations in fine-grained turbidite systems in passive margin settings, such as along the coasts of the North Sea, Brazil, and Nigeria. The lack of a comprehensive text on fine-grained turbidite systems emphasizing the architecture and reservoir characteristics, combined with confusion on some commonly used terms, provided the impetus for a field trip associated with the joint AAPG/SEPM conference in Dallas in 1997. Subsequently, this volume detailing and summarizing the expert participants' ideas was generated. This volume represents the first joint publication of SEPM and AAPG, and bodes well for the future of this co-operative relationship.

Based on this work, there are significant differences between the classical, well-studied sand/conglomerate-rich systems and the fine-grained systems treated here. Fine-grained mud-rich turbidite systems clearly represent one end-member of the turbidite continuum. Typically they occur on passive margins seaward of major deltas, with long terrestrial transport distances and large fluvial/deltaic inputs. The resulting deposits are dominated by large volumes of mud (>70%). The overall point of the book is that there is more than one type of submarine fan/turbidite system, and, therefore, more than one depositional model is required to adequately represent the systems encountered in nature.

A total of 28 contributions from some of the most active researchers in the field of fine-grained turbidites (representing industry, government, and academia) present a broad spectrum of case studies (both outcrop and subsurface) from many geographic locations and geologic ages. There are a few theoretical and modelling papers as well, for those readers so inclined. The first editor, co-author on several papers, and prime mover in the initiation of the volume, is none other than Arnold H. Bouma himself.

Although it is not immediately obvious from the Table of Contents, the 28 chapters are actually arranged into topical sets dealing first with larger-scale aspects such as general principles (papers 1-7), seismic studies (8-12), stratigraphy (13-16), and secondly with more detailed aspects such as reservoir characterization (17, 18), sedimentology (19-26), and downhole logging (27, 28). To this end there is an innovative chart on the front flyleaf listing various topics and the chapter in which they figure to a greater or lesser degree, a useful aid to finding the information you really want. Another interesting innovation is that all papers are included on a CD, with full text and illustrations as .pdf files. More than half the case study examples are based on outcrop studies, the most important source of information regarding reservoir geometries, architecture, and continuity. Interestingly, examples are concentrated primarily in only a few areas of the world: Upper Paleozoic of the Ouachitas in the southern United States, Upper Paleozoic of the Karoo Basin in South Africa, and modern submarine fans of the Gulf Of Mexico, all settings subject to known glacio-eustatic/climatic effects. The editors briefly acknowledge this factor at the end of their introductory paper. But, how crucial is this point to the application of the emerging principles?

Overall, I find this book to be a fund of information, primarily because of the organizational approach from larger-scale to smaller-scale topics, the innovative Topics Chart indexed to chapter numbers, the extensive use of real examples to illustrate principles, the emphasis in many papers on integrated, multidis-

ciplinary analysis using sequence stratigraphic concepts and seismic data interpretation, and the CD. My two quibbles are the lack of a good summarizing paper to put all this in perspective, beyond the 4-page Introduction (although, this tome should be viewed as a workshop result, acting as a springboard to launch continuing research, rather than the final word), and the inordinate influence of a single researcher (albeit one of Bouma's stature) on so much of the content. In addition, the Table of Contents should have been subdivided to better reflect the actual organization of Chapters into topical sets. Text, illustrations (including some colour), and editing are of uniformly high quality, as we have come to expect from the special volumes published by these organizations. The complete text and illustrations on CD will be attractive to many users. Mindful that this is still a work in progress, I recommend this volume as a fine detailed reference for stratigraphers, sedimentologists, seismic stratigraphers and explorationists familiar with, and working directly in, these important deposits. Others may find it difficult to extract the main principles from the local specifics in each case study.

Inland Flood Hazards: Human, Riparian, and Aquatic Communities

Edited by Ellen E. Wohl
Cambridge University Press
40 West 20 Street
New York, NY 1001-4211, USA
2000, 498 p., US$110
ISBN 0-521-62419-3

Reviewed by William M. Last
Department of Geological Sciences
University of Manitoba
Winnipeg, Canada R3T 2N2

Living in Winnipeg and regularly witnessing the rebirth of Lake Agassiz in southern Manitoba associated with periodic flooding of the Red River, I eagerly approached the opportunity to examine this new monograph on flood hazards. I was not disappointed. *Inland Flood Hazards: Human, Riparian, and Aquatic Communities* is an attractive, 500-page hardcover book consisting of 19 papers (chapters) that deal with nearly every aspect of the topic.

The material is organized into seven major sections, plus introduction and conclusions chapters. Each of the chapters is written by a recognized expert(s) in the particular area and is intended to provide a general overview of the subject understandable to a multidisciplinary scientific audience. The use of case studies, as well as an effort by the editor to encourage use of three drainage regions as examples throughout the volume — the Colorado River basin of western United States and Mexico, the Tone River basin of Japan, and the Ganges and Brahmaputra rivers in Bangladesh — help to illustrate many of the theoretical concepts and discussions. Following an informative and reasonably comprehensive introduction to inland flood hazards by Dr. Ellen Wohl, the editor of the volume, the first and largest section of the book comprises three chapters that deal with physical controls on flooding. Hirschboeck *et al.* review the hydroclimatology of meteorologic floods. Floods arising from dam failures are discussed by Cenderelli. Wohl provides a summary assessment of how human activities, such as drainage basin and channel modification, affect flood hazards.

The second and third sections of the book deal with physical, geochemical, and biological processes of floods. Mertes' chapter is a fascinating overview of inundation hydrology, and also includes all of the book's colour plates/figures. Wohl reviews the effect that floods exert on channel geometry and, in turn, the impact of these changes on sediment transport. The role that floods play in contaminant transport and the basic geochemical principles controlling mobilization of contaminants are summarized by Finley. For many geoscientists, the two overview chapters discussing biological processes of floods — Floods, Flood Control, and Bottomland Vegetation by Friedman and Auble and Flooding and Aquatic Ecosystems by Wydoski and Wick — will be new and exciting territory.

A single paper by Merritts, The Effects of Variable River Flow on Human Communities, comprises the next section and sets the stage for much of the second half of the book. From a personal perspective as a geologist, it is the material in these final three sections that I found most enlightening because the papers offer excellent starting points on topics in which I had only rudimentary knowledge. In the first chapter of the Responses to Flooding section, Ramírez offers a very digestible overview of flood prediction and modelling concepts. Most environmental earth scientists will have at least a passing knowledge of the predictive statistical methods used by hydrologists, but Stedinger's chapter, Flood Frequency Analysis and Statistical Estimation of Flood Risk, is one of the better summaries of this important topic that I have read. Baker provides a succinct review of the rapidly developing field of paleoflood hydrology.

The sixth section of the book, Flood Hazard Mitigation Strategies, leads off with a short but informative chapter by Watson and Biedenharn comparing the evolution of management strategies used in the lower Mississippi River with the efforts on Japan's Tone River. Nonstructural mitigation approaches are reviewed by Gruntfest, followed by an interesting discussion of the necessity of stream flow planning and flow requirements relative to sustaining native riverine biota by Stalnaker and Wick.

The final section, Societal Controls on Human Responses to Flood Hazards, contains two chapters that I feel are "must read" papers for any practitioner or student engaged in flood hazard environmental science. Laituri explores the various and often exceedingly complex relationships between human culture and flooding. Hamilton and Joaquin summarize the immense topic of urban planning as a way of reducing flood risk and vulnerability.

The editor concludes the book with a short 4-page glimpse at future challenges facing the scientific community in attempting to reverse the well-established 20th century trend of increasing flood damages and losses. A 4-page topic index follows.

Overall, Dr. Wohl has successfully accomplished her daunting objective,

namely to provide a comprehensive and interdisciplinary review of the topic of inland flood hazards. I am impressed with the breadth of coverage, overall high quality of writing, tight editing, and generally clear, "professional" illustrative material. Although the volume is not a textbook, with its 6.5 cm page margins and boxed chapter summaries (abstracts?), it does have a textbook look and feel to it. I am certain many of the chapters will be on required reading lists in undergraduate and graduate environmental geoscience courses.

The book is not without shortcomings, however. Fortunately, these are relatively minor and do not significantly detract from the overall quality or value of the monograph. For example, the editor's effort to use the three drainage systems — Colorado, Tone, and Ganges/Brahmaputra river basins — throughout the entire volume falls flat. In fact, the Ganges/Brahmaputra system is mentioned in only five of the 19 chapters, and the Tone River basin is used as an example in only three chapters. Indeed, after reading the entire volume, I feel I still have only a cursory understanding of both of these systems despite the editor's contention in the Preface that they would be "used throughout the volume to exemplify the various aspects of inland flood hazards."

I feel the book would have benefitted greatly from a glossary and list of acronyms. Clearly, in a volume directed at a multidisciplinary audience such as this one is, it is nearly impossible to assume any reasonable level of common knowledge. This is not to imply that the terminology is inadequately defined within each chapter, but rather that the inclusion of a glossary would greatly assist the reader.

I found it interesting that all 22 contributors to the book are from the United States, and most from the western USA. Although this has not obviously curtailed the breadth of topic covered in the volume, I wonder if a somewhat more international contributor list might have been beneficial in terms of examples and case studies. For example, Canadian readers will be surprised to find no listing of any Canadian river or flood in the index, and only scant reference to Canadian examples within the text and tables of a few chapters.

There are a few other unfortunate lapses. It is tempting by authors of overview papers such as these to make use of internet and web page resources. Extreme caution should be exercised in citing these resources, however. For example, I was able to access only about a third of the 19 web addresses listed in Chapter 15! Furthermore, several of these web pages had evidently not been updated for several years. I dislike the practice of citing other chapters in the book simply as "author, this volume" and not supplying the complete reference in the references cited list. Obviously, a person reading a reprint or xerox copy of one of the chapters will have no idea what the title or length of the other chapter might be. The use of gray background in otherwise simple line drawings was often distracting and always unnecessary. Some of the tabular information seemed a bit out of date. For example, surely the tables in Chapter 3 summarizing dam failure mechanisms in the 20th century could have been updated for the purpose of this volume rather than stopping at 1965. It is not clear to me why Chapter 15 does not have a summary or abstract "box" like the other chapters do. Equations and formulae in the text are sequentially numbered in all chapters except Chapter 7. Finally, although a list of contributors and their affiliations appears immediately after the preface, at no place in the volume are we given complete addresses for the contributors. In most cases, this does not present an overwhelming problem. I am sure I could find the city, state and postal code of, for example, Franklin and Marshall College if I wanted to contact Dr. Merritts. But I am not confident I could search out the contact information for Dr. Finley, whose affiliation is simply Shepherd Miller, Inc. or Dr. Wick at TETRA TECH, Inc.

In summary, I recommend this book for all who are interested in or actively working in flood hazard environmental science, and it is a definite high-priority acquisition item for university science libraries. The volume is packed with informative and well-written overviews covering a very wide range of flood hazard topics. I am sure the book will be a well-used item on my bookshelf.

Earth Systems: Processes and Issues

Edited by W.G. Ernst
Cambridge University Press
Cambridge, England and New York, NY
2000, 566 p.
US$100 hardcover, ISBN 0-521-47323-3
US$44.95 paperback, ISBN 0-521-47895-2

Reviewed by Alan V. Morgan
Department of Earth Sciencess
University of Waterloo
Waterloo, Ontario N2L 3G1
avmorgan@uwaterloo.ca

Earth Systems: Processes and Issues is a fairly massive tome of 566 pages in 33 chapters and involving 28 different authors. In many ways this is a remarkable book since it transgresses from traditional earth sciences across the bordering areas of geography, biology, soils and weathering processes, atmospheric chemistry, and physics, as well as oceanography and even social sciences. This is as it should be in an earth systems approach. My feeling is that most of the book is eminently "readable," in fact it encouraged me to take it to bed several times. I can assure you that this is not a normal practice, at least for me!

The book is divided into four main sections. The Introduction addresses the question "Why Study Earth Systems Science" and also deals with physical geography and different time scales. Part 2 covers Natural Processes and includes the Geosphere, the Hydrosphere, the Atmosphere and the Biosphere. The Geosphere deals with all the goodies that we are familiar with: our planet's place in the solar system; the internal makeup of Earth; plate tectonics; fluvial landforms; chemical weathering of soils; and the interfaces between geo-hydro-atmos- and bio-spheres. The Hydrosphere covers the hydrological cycle; atmosphere-ocean coupling; the deep-sea and surface circulation of the oceans; and chemical oceanography. The Atmosphere describes composition, mixing and ozone destruction; motions; and the greenhouse effect; and covers the questions of climate prediction and accuracy of prediction. The Biosphere section deals with biodiversity; evolution (adaptation and

environmental change); C, S and N in global bio-geochemical cycles; the terrestrial carbon cycle with specific reference to Jasper Ridge; and the ecological implications of rapid global change.

Part 3 goes on to consider societal and policy implications in two main sections. These cover Resource Use and Environmental Technology and Society, and Environment and Public Policy. The first section has chapters on population and the environment; mineral resources (assets and liabilities); energy resources; and natural hazards. The second section moves into the realm of how society reacts to change. Chapters here include steps from environmental science to effective policy; carbon taxes and other domestic policy options; land use and local changes; agriculture and global change; water allocation and protection (from a United States' perspective); valuing nature and life support system — toward Earth sense. The final section is a one-chapter synthesis of Earth Systems and Global Change.

Ernst has brought together an interesting group of authors to explain the various interactions, including such notables as Paul Ehrlich and Bill Fyfe. The book suffers somewhat because of overlap, however: sections are repetitious, there are several duplications of the same figures in different chapters, and there are a number of typographic and factual errors. Better proofreading should have caught these: airborn, Chicxilub, largesty, montaine, and visable are a few that I noted. Similarly, ocean crust with an specific gravity of 30 rather than 3.0; one English ton at 2000 lbs rather than 2240 lbs; the Precambrian/Cambrian boundary at 570 my, rather than the more recently accepted 543 my. These are minor but annoying factual errors that are distracting and unacceptable.

After being picky I would still recommend the book if you, and/or your students, want to have an overall look at many of the interactive elements that an earth systems approach demands. The price at US$100 for the hardcover text is a little steep for the average student (or professor), but the paperback version at US$44.95 is less than half the price. At about C$70.00 you will get a comprehensive text that certainly can be used at several levels and in various departments in the university system; or, if you just want to be better informed, will provide you with a readable overview of what few of us truly appreciate.

Geology Underfoot in Central Nevada

By Richard L. Orndorff, Robert W. Weider and Harry F. Filkorn
Mountain Press Publishing Co.
Missoula, Montana
2001, 295 p., US$16

Reviewed by William A.S. Sarjeant
114 Science Place
Department of Geological Sciences
University of Saskatchewan
Saskatoon, Saskatchewan S7N 5E2
william.sarjeant@usask.ca

For several years Mountain Press has been producing an excellent series of regional guides to the rocks of the United States. The "Roadside Geology" series, each treating with a particular state or a particular region of a state, now includes 20 handsome large-format paperback volumes, each of them well illustrated and written for persons with only a limited technical knowledge. The second series, "Geology Underfoot" (of which this is the fifth volume), takes one beyond roads, in regions of especial geological interest.

Nevada's cities attract many geological conferences, in large part, no doubt, because of the other attractions of Reno and Las Vegas. However, there is no question that the geology of that state *is* spectacular and, whenever visitors can tear themselves away from those other attractions, they will find this volume of great service. It treats with a region occupying the midriff of the state of Nevada, from Reno and Carson City in the west to the Great Basin National Park in the east; the bare midriff, one might call it, for the greater part is desert, with rocks amply exposed.

The maps are simple and clear (that of Lake Tahoe, with its surrounding roads, strikingly like a woman's face seen in right profile!). Photographic illustration is ample, the labelled aerial views being especially helpful in comprehending structural patterns. Although including the Berlin-Ichthyosaur State Park with its bones of *Shonisaurus*, this is mostly a region in which to study igneous rocks and physical geology, with its quite recently active volcanoes and spectacular caves. The numerous old mining camps, some well-preserved and others almost vanished, will also afford interest to historians.

This is a good addition to an excellent series, recommended without hesitation to any Canadian geologist planning to visit Nevada, provided only that geology truly *is* the reason for the visit!

Groundwater in Geologic Processes

By Steven E. Ingbritsen and Ward E. Sanford
Cambridge University Press
40 West 20 Street
New York, NY 10011-4211 USA
1998, 341p., US$32.95 paperback
ISBN 0-521-6640-4

Reviewed by Dave Morrow
Geological Survey of Canada, Calgary
3303 33 Street N.W.
Calgary, Alberta T2L 2A7

This volume was motivated by the desire to capture recent advances in our understanding of the role of subsurface fluids in large-scale geologic processes during the development of cratons and sedimentary basins. The authors point out that consideration of groundwater, up to the last decade, was restricted to issues that were more "applied" in nature, such as in studies dealing with water quality and supply issues, mine dewatering issues, and hydrocarbon reservoir hydrodynamics. A number of post-1990 Penrose Conferences (*e.g.*, Basin-Scale Flow and Transport, 1991), symposia at meetings of the American Geophysical Union and of the Geological Society of America, the annual, informal, "Hubbard Quorum" meetings on groundwater and geological processes, and recent reprint volumes (*e.g.*, *The Role of Fluids in Crustal Processes*, Bredehoeft and Norton, 1990) provided the basis for the comprehensive, broad-based

synthesis that this volume represents.

The 10 chapter titles give the reader a good idea of the volume content. In order of presentation, these include: Groundwater Flow, Solute Transport, Heat Transport, Regional-scale Flow and Transport, Ore Deposits, Hydrocarbons, Geothermal Processes, Earthquakes, Evaporites, Diagenesis and Metamorphism. The Preface gives an overview of the material presented in these chapters, and the authors suggest here that this volume could serve as an adjunct text for university courses in hydrology or geohydrology.

There is a logical progression of presented material beginning with general principles and fundamental equations. The fundamental equation of groundwater movement has a clear derivation from Darcy's Law for groundwater movement in water-saturated strata. Concepts, such as hydraulic head, specific storage and storativity are introduced with respect to confined and unconfined aquifers. Several forms of the fundamental groundwater equation are derived and the very important assumption of constant specific volume, or density, that underlies classical groundwater theory of groundwater is discussed.

The authors proceed to discuss examples of crustal or basin-scale flow systems, such as in Mid-Ocean Ridge hydrothermal flow systems or groundwater flow adjacent to salt domes, in which there are significant temperature or solute concentration variations and variable fluid densities, (*i.e.,* specific volume). Flow systems such as these require a more general treatment than the more typical, "classical" groundwater studies, and equations are developed that explicitly allow for groundwater density variation.

Variability of fluid physicochemical parameters is typical of crustal-scale flow systems. A wealth of background information concerning the crustal-scale variability of physical parameters is provided. Perhaps the most important of these is permeability, which varies by 16 orders of magnitude in nature. Variations in permeability strongly influence flow velocities, and influence the relative contributions of the advective components of heat and solute transport with respect to the total fluxes of heat and solute. Equally important in influencing crustal-scale flow systems are the changes in physical parameters of groundwater over wide ranges of temperature and solute concentrations that occur over crustal depth ranges. Aqueous liquids, for example, decrease approximately 600% in fluid kinematic viscosity when heated from earth surface temperature to the critical temperature. This might explain the evidence for very rapid fluid flow and solution-collapse in some hot hydrothermal systems that developed within well-lithified carbonate strata that originally had low effective permeability.

Chapters 1-3 develop concepts and mathematical derivations important for modelling crustal-scale processes. One example of these developments is the advent of computer programs that treat the flow of water and heat in terms of pressure and enthalpy (*i.e.,* heat content), rather than by the more conventional combination of pressure and temperature variables. This is because the pressure-enthalpy state of the fluid corresponds to a unique point, or single vapour/liquid ratio, anywhere in pressure-enthalpy space, whereas at the critical temperature and pressure a fluid can have a wide range of vapour/liquid ratios. The authors suggest that formulations based solely upon the pressure-temperature state of the fluid should be restricted to systems at subcritical temperatures.

Overpressuring and hydraulic fracturing are discussed in Chapter 4 in the contexts of fluid sources and sinks and of rock permeability, as well as with respect to the ambient stress field (*e.g.,* subvertical fracturing in extensional stress regimes). Accretionary prisms associated with subduction zones are cited as examples of "virtual," tectonic compaction-related, fluid sources that have caused near-lithostatic fluid pressures. These fluid overpressures contribute to imbricate thrust faulting within accretionary prisms. This tectonic setting is also a premier example of one of the main themes of the volume, the importance of feedback mechanisms at work in crustal-scale flow systems. Modelling of accretionary prism flow systems must incorporate links between groundwater solute composition and groundwater temperature, as well as deal with the fact that the solid matrix deforms at rates comparable to groundwater flow. The assumption of a solid matrix fixed in space is inherent in almost all groundwater studies.

The second half of the volume, beginning with Chapter 5 on ore deposits, deals with the role of large-scale groundwater systems with respect to a variety of specific, but regional geological phenomena. Mississippi Valley-type lead-zinc deposits are attributed to regional-scale brine migration as inferred from fluid inclusion data. The authors mention a "salt problem" in that there is little evidence for the former presence of evaporites that might have contributed to the elevated mineralizing brine salinities. In a rare lapse, however, the authors overlooked perhaps an even more significant "problem" with respect to the topographic recharge circulation model that is commonly cited as the driving mechanism for the regional brine migration that formed MVT deposits. Other studies have indicated that saline brines would be rapidly flushed from the system during topographic recharge before ore bodies could form. These caveats are less important for the Irish MVT deposits, which may have formed during deep crustal convection of saline fluids. In a short, but fascinating, section, the authors outline the non-igneous origin of Columbian emerald deposits by hypersaline brine-mediated reactions in organic-rich shales.

Issues covered in Chapter 6 concern the migration of oil, including capillary effects, primary and secondary flow mechanisms, and immiscible multiphase flow. The consistency of oil compositions between reservoirs and their probable source rock argues for primary immiscible flow during phase separation as the dominant migration mechanism, and several case examples are offered to document this (*e.g.,* oil in the Los Angeles Basin). The relationship between magmatic emplacement and epithermal hydrothermal systems is considered under geothermal processes in Chapter 7. As one might expect, fluid pressures can reach lithostatic levels inducing wallrock fracturing during magma emplacement within a radial convection flow system that rapidly advects heat away from an intrusion. The interplay between fluid pressures and rock mechanics is further explored in Chapter 8 on earthquakes,

where the emphasis is on the role of fluid pressures on fault-related movements, or earthquakes, such as along the San Andreas Fault.

The following chapter on evaporites, Chapter 9, departs somewhat from the main groundwater theme of the volume. Here, the origin of evaporite basins and the reaction chemistries that may have led to deposition of bedded evaporites are outlined. This chapter is linked to groundwater processes by the authors' discussion of the relationship between marine-derived evaporite basins and the chemistry of groundwater associated with these basins, such as the tendency of $CaCl_2$-rich continental groundwater to promote deposition of evaporites anomalously depleted in magnesium salts.

The final chapter on diagenesis and metamorphism, Chapter 10, brings together many concepts discussed in earlier chapters. Diagenetic processes are described in terms of "reaction-flow coupling," which is commonly manifested as a progressive accentuation of the original porosity-permeability distribution during groundwater-mediated mineral dissolution and precipitation (*e.g.*, limestone karstification). Mineralogical and isotopic evidence for the participation of meteoric fluids, even in deep crustal metamorphic environments, is described here.

It is abundantly clear that the authors have succeeded in their attempt to encapsulate and synthesize recent developments concerning groundwater in crustal-scale geologic processes. It is also evident that this book represents much more than a simple synthesis. More than in most geologically related volumes I have read, this book gives the reader a feeling akin to standing at the summit of a large iceberg. The reader is uncomfortably aware of the tremendous sweep of knowledge and understanding that underlies this volume and the inability to come to grips with most of this. It is a great strength of this synthesis that it gives the general geological public a basis for at least some understanding of the many aspects of the subject material, and gives the informed reader the means to pursue further investigations using the well-chosen references.

The paperback version is about 9 inches by 6 inches and close to .75 inches thick. A list of problems is given at the end of each chapter to highlight concepts. This volume could indeed be used as a supplementary text for groundwater courses but this would require working out the answers to the problems first, as no problem solutions (intentional pun) are given. Considering what the authors have given us in this volume, they would be justified in assessing a small additional gratuity to supply the answers.

Biotic Response to Global Change: the Last 145 Million Years

Edited by S.J. Culver and P.F. Rawson
Cambridge University Press
Cambridge, UK and New York, NY
2000, 501 p., US$95 hardcover

Reviewed by James M. White
Geological Survey of Canada, Calgary
3303 33 Street N.W.
Calgary, Alberta T2L 2A7

Geology and paleontology, in documenting time and evolution, have initiated a revolution in our understanding of our relationship with the natural world. A volume such as this is a timely attempt for geology to lend some perspective to the "global change" question by discussing, over a broad span of geological time, the response of various organisms to external forcing factors. For professional geologists, it is a worthwhile opportunity to reflect on the consequences of environmental change.

The chapters of the book cover a broad spectrum of late Mesozoic and Cenozoic marine and continental fossils, and are written with an eye to defining and identifying extrinsic (*e.g.*, climate, land bridges, seaways) and intrinsic (*e.g.*, evolutionary innovation) causes of change. The scope of the book is well summarized by a list of its chapters:

1. Introduction, S.J. Culver and P.F. Rawson
2. The Cretaceous World, A.S. Gale
3. The Cenozoic World, K.T. Pickering
4. Calcareous Nannoplankton and Global Climate Change, J.A. Burnett, J.R.Young and P.R. Bown
5. Phenotypic Response of Foraminifera to Episodes of Global Environmental Change, D. Macleod, N. Ortiz, N Fefferman, W. Clyde, C. Schulter and J. Maclean.
6. The Response of Planktonic Foraminifera to the Late Pliocene Intensification of Northern Hemisphere Glaciation, M.R. Chapman
7. The Response of Cretaceous Cephalopods to Global Change, P.F. Rawson
8. Global Change and the Fossil Fish Record: the Relevance of Systematics, P. Forey
9. Response of Shallow Water Foraminiferal Palaeocommunities to Global and Regional Environmental Change, S.J. Culver and M.A. Buzas
10. Intrinsic and Extrinsic Controls on the Diversification of the Bivalvia, J.A. Crame
11. Global Events and Biotic Interaction as Controls on the Evolution of Gastropods, N. Morris and J. Taylor
12. Algal Symbiosis, and the Collapse and Recovery of Reef Communities: Lazarus Corals Across the K-T Boundary, B.R. Rosen
13. Changes in the Diversity, Taxic Composition andLife-history Patterns of Echinoids over the Past 145 Million Years, A.B. Smith and C.H. Jeffery
14. Origin of the Modern Bryozoan Fauna, P.D. Taylor
15. Angiosperm Diversification and Cretaceous Environmental Change, R. Lupia, P.R. Crane, and S. Lidgard
16. Cenozoic Evolution of Modern Plant Communities and Vegetation, M.E. Collinson
17. Leaf Physiognomy and Climate Change, R.A. Spicer
18. Biotic Response to Late Quaternary Global Change – the Pollen Record: a Case Study from the Upper Thames Valley, England, A.G. Parker
19. The Cretaceous and Cenozoic Record of Insects (Hexapoda) with Regard to Global Change, A.J. Ross, E. A. Jarzembowski and S.J. Brooks
20. The Palaeoclimatological Significance of Late Cenozoic Coleoptera: familiar Species in Very Unfamiliar Circum-

stances, G.R. Coope
21. Amphibians, Reptiles and Birds: a Biogeographical Review, A.C. Milner, A.R. Milner and S.E. Evans
22. Paleogene Mammals: crises and Ecological Change, J.J. Hooker
23.Response of Old World Terrestrial Vertebrate Biotas to Neogene Climatic Change, P.J. Whybrow and P. Andrews
24. Mammalian Response to Global Change in the Later Quaternary of the British Isles, A. Currant
25. Human Evolution: how an African Primate Became Global, C. Stringer
26. The Biotic Response to Global Change: a Summary, S.J. Culver and P.F. Rawson.

The volume is an excellent, relatively current summary of the state of the art of many fossil groups. As a Mesozoic/Cenozoic palynologist, I read Chapters 15, 16 and 17 with particular interest. All were well written, credible treatments of their topics.

However, the title Biotic Response to Global Change implies that one can clearly separate evidence of the cause from evidence of the consequences. A key problem is that changes observed in the fossil record have been usually the prime indicators of environmental change. The editors have attempted to remedy this in the first two chapters by Gale and Pickering. They describe, respectively, the main features of Cretaceous and Cenozoic environments, under the headings of plate tectonics and paleogeography, igneous activity, bolide impacts, paleoceanography and Cretaceous climates. This is quite well carried off, but the discussion of Cretaceous climate draws heavily on paleobotanical evidence of high latitude vegetation. Underlying the whole discussion is the geological Epoch/Age structure, defined by paleontological evidence. It is truly difficult to separate the independent and dependent variables for such a discussion.

Several authors point out that changes to which extinct species responded may have been changes in other biota, for example, Lupia *et al.*(Chapter 15) conclude that the decline of diversity of ferns in the mid and Late Cretaceous was likely a response to the rise of angiosperms. Neither change can be directly attributed to climatic or other physical environmental change. However, Lupia *et al.* suggest that the parallel increase in diversity of angiosperms and ephedroids may indicate a common environmental factor. (We may ask if the non-parallel diversity changes in angiosperms and ephedroids in the late Cretaceous suggests a biotic factor).

If I have a major quibble with this book, it is that it has not overcome a fundamental problem, that of bringing a meaningful, geological-scale perspective to issues of concern on a human time scale. The title, Biotic Response to Global Change, plays to the current theme of global climatic change, but because of this underlying problem, the volume falls short of expectations to a significant degree. The environmental changes contemplated in this book comprise more than climatic change, but if they are climatic change, they are large events, such as the onset of Plio-Pleistocene glaciation. Several authors consider the question of how past evidence elucidates the future, and of course conclude that the past is no direct guide to the future. This problem of a large-scale geological perspective, a perspective that is also not predictive, makes it difficult to relate geological insights to short-term human problems, significant on a decadal time scale. This conundrum is not unique to this book: it underlies geologists' communication with a broader, public audience. However, it is important for the public to know — on any scale — that the world is not fixed and immutable. This book is a contribution in the right direction, but it is unlikely to reach the public audience targeted by the title. Thus, laudable as is the attempt, the real strength of the book is not as an ecological morality play, but as a comprehensive treatment of diverse fossil groups, all written with an eye to defining intrinsic and extrinsic environmental factors and the organisms' response. Accordingly, this volume will be of most use to paleontologists and geologists, rather than such groups as politicians and environmental planners.

I particularly enjoyed the earthy writing style of the British Quaternary mammals chapter by Andrew Currant. Here is an excerpt from his introduction:

> An eastwards glance down the Strand past Charing Cross Station would probably show nothing but a mottled red and black scene of buses and taxis, yet beneath the buildings all around lie the bones and teeth of mammoth, reindeer and woolly rhinoceros....the all too obvious message is that things have not always been as they appear today. (p. 367)

From Currant, then, we may extract a succinct conclusion:

> The interplay of orbital variables and the influence of essentially local factors come together to form a board on which a very complex game is played ... At the present stage of knowledge, all we can do with any confidence is record the moves in the game as accurately as we possibly can and attempt to get them in the right order, because as yet we don't really know the rules. (p. 378)