Book Reviews / Critique

REVIEWS[1]

Journey to the Shores of the Polar Sea, in the Years 1819-1822

By John Franklin
CD-Academic Book Company
Dartmouth, Nova Scotia
$69.95 (personal), $195 (institutional)
CD-ROM edition, 1998
Distributed by University of Toronto Press

Reviewed by Ashton Embry
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This is not your standard "book" review because it is appraising the medium, not the message. CD-Academic Book Company has committed to putting on CD-ROM many of the now-rare, 19th century books that describe the heroic expeditions of Arctic exploration and discovery. Such books were the blockbusters of their time but are now fragile, touch-only-with-gloves volumes, carefully guarded by watchful librarians. The one at hand describes Sir John Franklin's successful (he came back alive on this one) overland exploration of a large swath of the northwestern Canadian mainland. It is a fine adventure story in its own right but is now much more important as a detailed description of the 19th century culture of both the English explorers and the native North Americans they encountered.

The CD format is an excellent means of allowing widespread access to this and other journals, and I am pleased to say it is very user friendly. The CD comes with Adobe Acrobat Reader, which is easily installed if need be. The table of contents of the book is readily accessed and a simple click takes you to any section of the book or any illustration. Pages are "turned" with the enter key. Notably, the illustrations are provided in both low-resolution (ready viewing) and high-resolution (examining details, printing) formats. The zoom feature is also very handy, especially for the maps.

I expect the CD format will have great appeal for researchers who can quickly find specific subject matter with a search engine and can zoom in on any spot on the maps for easy reading. Passages can be easily copied and pasted to another document. For those who want to read the "book" from "cover to cover," I expect they would be better off printing, and then reading, a chapter or so at a time. I don't think the CD format will ever replace a hardcopy book, which is primarily read for pleasure rather than research. However, the CD format definitely has advantages that hardcopy does not and, in an ideal world, both formats would be available for every important contribution.

More information on this new series is available on the CD-Academia web site: http://www.cd-books.com

A Petrographic Atlas of Canadian Coal Macerals and Dispersed Organic Matter

Edited by Judith Potter, Lavern D. Stasiuk and Alexander R. Cameron
Canadian Society for Coal Science and Organic Petrology
1998, 103 p, C$138.00
Geological Survey of Canada Bookstore
3303 33 Street N.W.
Calgary, Alberta T2L 2A7
ISBN 0-6690-17538-X

Reviewed by Neely H. Bostick
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This atlas is a collection of remarkably bright and high-contrast photomicrographs, both colour and black and white, reproduced in very high resolution on glossy card paper. Photo captions faithfully note some constituents, keyed with letters on each photo, and the geologic formation and location of each sample. With the photo captions, a 10-page introduction including tables of up-to-date terminology, maps of coal basin location, general geologic diagrams of the coal-bearing strata, extensive bibliographies for each section, and the spiral binding, the *Atlas* is a stunning volume. The Society produced the *Atlas* to celebrate 25 years of collaboration between coal geoscientists from the federal and provincial governments, universities, and the coal and petroleum exploration industries in Canada. The bibliographies and the appendix show who the Canadians are and why they are so important in the field which, during this 25 years, has come to be called organic petrology.

[1] Although we expect that book reviews will continue to be the mainstay of this section, we welcome reviews of CD-ROMs such as the following, by Ashton Embry, of an historic book by Sir John Franklin, now available in CD-ROM format. Also welcome are reviews of software and World Wide Web sites relevant to the earth sciences in Canada. Editor.

Organic petrology is the study of solid organic matter in rocks; it may amount to most, or a tiny fraction, of rocks such as coal, oil shale, shale and marl, sandstone, limestone, and rocks of ore deposits. Sediments not yet rock, such as peat, are studied to help understand the genesis of different coal types. Organic petrology is mainly microscopy, although connected historically to coal technology and recently to petroleum geochemistry. The main advantage of microscopy is discrimination and quantitative counting of individual, fairly homogeneous constituents in size down to a few micrometers; coal technology and geochemistry have been limited mainly to analysis of whole samples, often very heterogeneous, on the order of a cubic centimeter or larger. Organic petrography serves commerce and industry especially with respect to coal use, including carbonization, exploration for sources of petroleum and natural gas, and analysis of organic wastes from modern civilization that have spread through air and water.

As a field dominated by microscopy, organic petrography especially has needed visual communication and standardization of *what* each person is seeing and analyzing, to give real meaning to quantitative counts, graphs or equations predicting technical properties. Communication and standardization have advanced by means of personal teaching, sample exchanges, and meetings working at the microscope. Photographs in scientific papers, textbooks, and atlases have been very important, so I look at this *Atlas* for its potential as a practical tool for students, experienced petrographers, and other geoscientists.

Section I of the *Atlas* is a compendium of good-quality Canadian coals; the five chapters on coal are each for a coal rank class (plus a chapter illustrating carbonization residues) intended to show microscopic details of coals in relation to rank. Each coal rank class is briefly documented according to individual coal basins and geologic formations containing the coals. On each photo are identified macerals, a term for the various organic constituents: by analogy with the inorganic constituents, the minerals. The analogy is emphasized by maceral names ending in -ite, like many mineral names. Macerals, with some minerals, are accurately and beautifully illustrated. The maceral identification and labelling are authoritative and well worth study. The labels on the photos are a smooth way to key the photos to the captions. Because the plates show the macerals by groups, one can locate examples of a given maceral, although there are no indexes.

The *Atlas* shows Canadian coals of different age and location, but it does not include maceral composition of the coals (nor mention coal lithotypes or microlithotypes, the *kind* of coal in a sample under the microscope, which results from the kind, size and arrangement of the macerals). One may find photos of a particular coal by searching the captions. There is no indication of which coals are good for burning, gasification or carbonization, although a page illustrating carbonization products identifies the four source coals and gives a composition balance index.

Just as the chapters on coal illustrate good (low-mineral) coals that are likely to be mined, the chapters in Section II, on dispersed organic matter (DOM), illustrate macerals from petroleum source rocks and oil shales, the economically important rocks that contain dispersed organic matter. The bulk of solid organic matter is found in ordinary shales, not in coals and oil source rocks. The introduction or captions do not note which macerals might be "good" for petroleum source rocks but the bibliography contains many informative publications. Except for the plate on bitumens, there is no indication of the thermal maturity level of the pictured dispersed organic matter; I would guess that most examples are from immature potential source rocks, comparable in maturity to lignite and subbituminous coal.

The beauty of the *Atlas*, and most of the information, lies in the captioned photos. The high-resolution results from printing all the photos with four half tones (red, yellow, blue-green and black) with slight difference in registry of each. The *Atlas* photos have notable contrast and detail within macerals, some as great as if the sample surface had been etched. Photo magnification is mostly uniform on each plate, with a scale bar, and this makes the size of constituents easy to grasp.

Expanded captions to indicate maceral associations, coal textures and compositions would have made the *Atlas* more petrographic. A technique used in atlases in petrology could have given more feeling for organic petrography with no additional text or terminology: photos at low magnification could show the overall sample, with detail of different parts in the existing photos at higher magnification. Where would the user turn for definitions or discussion of macerals or to delve more into petrography or petrology? *Coal Petrology: Its Principles, Methods, and Applications,* published in 1983 by the Geological Association of Canada as Short Course Notes 3, is a splendid illustrated textbook for both coal and dispersed organic matter. *Introduction to Coal Petrography: Atlas of Petrographic Constituents in the Bituminous Coals of Southern Africa,* published in 1986 as Review Paper 2 by The Geological Society of South Africa is a compact, well-illustrated introduction to coal petrography, technology and technique. *Stach's Textbook of Coal Petrology,* now in several (expensive) editions, is a must. I have not tested *Coal Petrology v. 2* in the *Atlas of Coal Geology* published in 1999 on CD-ROM, with 275 photo sets, by The Society of Organic Petrology to experience how it compares with publications on paper.

I would have welcomed mention of the basic maceral concept. Some terms imply that the macerals are genetic/compositional units, whereas they are defined by parameters resulting from microscopic examination: shape, relief, reflectance, colour, fluorescence, texture, resistance to abrasion during polishing, *etc.* They may originate mainly from certain botanical tissues or may have a certain range of technical behaviour or importance in geochemistry, but are defined through microscopy. Nevertheless, the *Atlas* is a splendid and beautiful means to pass on and strengthen the definitions, although one must turn elsewhere for them. I applaud the appearance of this stunning collection of captioned photos, which strengthens the practice of organic petrography and should help to bring it to the attention of non-scientists and other scientists, more than would a textbook.

Terroir. The Role of Geology, Climate and Culture in the Making of French Wines

By James E. Wilson
Mitchell Beazley, London, UK
1998, 336 p., £30
University of California Press
in association with The Wine Appreciation Guild, San Francisco, CA
1999, 336 p., US$50.00
ISBN 0520219368

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"An exceptional amount of fine wines of France grow on the Jurassic ... The Jurassic could be said to be France's 'national rock' ." Such uncompromisingly simple statements are typical of this wonderfully refreshing treatment of the concept of terroir and its relation to the vineyards of France. Rather than using terse scientific language, Wilson has chosen a bold style of writing in order to convince those other than geologists of the effect on the grape, and hence the wine produced, of the underground reactions and interactions of its roots with the subsoil. Threaded into the text, anecdotes of his early life as a geologist in Texas and more recent research experiences in France make for a very readable book for the geological community. Indeed, this is a must-buy book for all earth scientists who enjoy wine and who have pondered the two questions that Wilson sets out to answer: 1. Why do the fine wines of France grow where they do? (or what makes good grapes?), and 2. How is it that one vineyard yields superior wine, while its neighbour, that appears the same, does not?

To answer these questions, the book is divided into two parts. The first part is a 62-page, highly informative overview of the elements of French terroirs. This includes discussion of bedrock geology, soils, clay, plant chemistry, paleoclimate, macro- and microclimate, sugar-acid development, grapevine lineage, history of French wine, the influence of the tiny root louse Phylloxera vastatrix and how American rootstocks are now employed to resist infestation by this insect, and the influence of wine on French culture. In exploring the terroir concept, Wilson notes that geology dictates the overall landscape, rock type, landform, exposure, soil and subsoil, and drainage; whereas climate influences selection and distribution of vines, selection of wine variety, and cultivation by man. France provides an ideal natural laboratory to explore these elements: although the nation is smaller than the state of Texas, it has grape vines growing on the most varied geology and landscapes of any wine country in the world, and it has a 2000-year history of growing wine grapes.

The second part comprises 11 chapters on each of the principal wine districts of France: Champagne, Alsace, Burgundy, Aquitaine, Bordeaux, the Southwest, the Loire, the Kimmeridgian Chain (upper Loire, Chablis), Auvergne-Bourbonnais, the Rhône and the Southeast, and Languedoc-Roussillon. Each of these districts is described in detail in terms of its geology, physiography and climate, and the various subdivisions of these and how they relate to terroir and the quality of the wines produced. Wilson also discusses numerous interesting cultural and historical issues, how these have influenced the concepts of appellations, and how appellations are applied differently in each wine district. Each chapter is about 20 pages long and forms the seminal work on that district. Although there is an earlier geologic guide to the French terroirs published by the Bureau de Recherches Géologiques et Minières (BRGM) under the direction of Charles Pomerol (1984; English version 1989), this book is essentially a field guide of geologic localities in the wine districts. In contrast, Wilson's book also can be used in the field, and has the advantage of being a great read, whether you ever get to France.

Field testing did bring out some minor flaws. The two-colour illustrations (brown and black on white) are sometimes miscoloured or confusing: in several figures two colours are given for Tertiary clastics without explanation. The labelling in several brown and white photographs is difficult to read. Perhaps a more important criticism (at least for earth scientists) is the omission of any detailed description in the text and figures of seismic and electrical resistivity data acquired by the author and colleagues. As this is the first use of geophysics that I am aware of in any publication on terroir, it deserves more, but details may be left out because the book is aimed at the general public. I found the lack of geophysical data and discussion of same for geological modelling of the Grand Crus of Vosne Romanée and Montrachet frustrating, as this is important proof of a geological base for Burgundian terroirs, and the techniques likely have relevance to understanding our Canadian terroirs. It is to be hoped that future editions will include more geophysical data and interpretation.

How well Wilson's book will succeed with non-geologists, particularly non-scientists, is less certain. My group of three non-scientists, with whom I field tested the book in Champagne and Burgundy last summer, found the book interesting, informative and readable, but they had difficulty understanding the geological terminology. The small but useful glossary of geologic, geographic and wineland terms at the end of part one does not cover all of the geological terms used in the book, so at least a first-year course in earth science seems needed to appreciate this book.

This book received major awards in 1999 from the wine industry and the wine media: the Veuve Clicquot (the famous champagne house) wine book of the year; Decanter Magazine wine book of the year finalist; and the Andre Simon wine book of the year. This is truly impressive, expecially for a geologist with no formal training in oenology and biticulture, so at about C$77 and 336 pages, with 58 excellent colour photographs, it is a bargain. As no other book has ever had such an immediate and expensive effect on me, readers should be aware that this is a dangerous book, which might be required in Canada to have a warning on the cover such as: "Reading this may be hazardous to your bank balance." I received an early copy of the book from the UK in March 1999, and by late April had arranged a costly (but rewarding!) August trip to Champagne, Burgundy and Normandy. Expensive or

not, geology and wine make for an excellent marriage and enjoyable times, whether at home or abroad.

Wilson's book provides a signal example of the importance of geology to the making of wine, a relationship we will be exploring further in the new *Geoscience Canada* series "Geology and Wine" which began in v. 26, n. 4 (1999).

Introduction to Seismology

By Peter M. Shearer
Cambridge University Press
Cambridge, UK CB2 2RU
1999, 260 p., US$29.95 paperback
US$74.95 hardcover

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This publication provides a lucid and concise introduction to seismology. The book evolved from a series of lecture notes developed for geophysics graduate students at the University of California, San Diego and it contains numerous illustrations, heuristic mathematics, and clear explanations.

Introductory chapters include a brief history of seismology and descriptions of the Earth and its seismic activity. The concepts of stress and strain are defined and are used in the derivation of the fundamental elastic wave equations. The derivations are developed in understandable mathematical steps, and the mathematics is coupled with FORTRAN computer codes and useful exercises.

Following introductory wave theory, the book then describes ray tracing in terms of both travel times and amplitudes. Travel time inversion discussions are coupled with tomography and optimization techniques. The reader is supplied with practical tools for seismic velocity estimation. Recent computational examples are included in discussions of seismic travel times.

In this book, there is a nice blend of earthquake (global) seismology and exploration seismology. Topics in earthquake prediction, earthquake magnitudes, and source mechanisms will interest earthquake seismologists. Reflection seismic methods are accurately described in an exploration seismology context. In terms of cited references, the book does a better job of providing detailed references in earthquake seismology than in exploration seismology. The book discusses instruments, Earth noise, and anisotropy in a chapter entitled "Miscellaneous," which is a somewhat unusual treatment.

Nevertheless, *Introduction to Seismology* by Shearer does an excellent job of integrating many aspects of seismology. It provides a superb introduction to the subject and gives a number of practical exercises. Its price is very reasonable (less than US$30 for the paperback version), and is a bargain for anyone wishing to learn about seismology. The book will have considerable value for both undergraduate and graduate students in geophysics, and it will serve as a very worthwhile reference publication for many years to come.

Mid-Ocean Ridges: Dynamics of Processes Associated with Creation of New Ocean Crust

Edited by J.R. Cann, H. Elderfield and A. Laughton
Cambridge University Press
United Kingdom
1999, 301 p., C$85.00 hardcover

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Like all symposia volumes, *Mid-Ocean Ridges* is an eclectic collection of papers, ranging from theoretical considerations of melt productivity to discussions of hot vent ecosystems. However, this volume is more coherent than most and provides a valuable summary of the tectonic, magmatic and hydrothermal processes occurring on the mid-ocean ridges. All of the papers in this volume were presented at a Royal Society Discussion meeting held in London, England on 5 and 7 March 1996. Twelve of the 13 papers in the volume were published previously in the Philosophical Transactions of the Royal Society (a. 355, 1997) and one wonders why the editors felt it necessary to produce a separate volume.

The papers were grouped into four sessions at the symposium, a grouping reflected in the current volume. Group 1 includes three papers focussed on melt production beneath mid-ocean ridges and imaging of melt bodies in the upper crust. The next three papers deal with the production of ocean crust, and this section is followed by four chapters dealing with submarine hydrothermal fluids and their deposits. The final three chapters discuss the biological consequences of hydrothermal activity.

Determining the amount and location of melt beneath spreading axes by geophysical techniques has long been a challenge. In the first group of papers, Blackman and Kendall review the effect of melt on seismic properties of crystalline rocks and show that travel time delays produced by melt are low (0.4 sec or less for P waves) and heavily dependent on the geometry of the melt bodies. Because the best-documented examples of subrift magma chambers have all come from relatively fast-spreading ridges in the Pacific Ocean, many workers have concluded that such chambers are small and ephemeral or even non-existent on slow-spreading ridges. However, Sinha *et al.* provide convincing evidence of accumulated melt beneath the slow-spreading Reykjanes Ridge segment of the Mid-Atlantic Ridge. They argue that although the Reykjanes Ridge is relatively close to the Iceland plume, melt production there is not unusually high and that similar chambers should be a normal feature of slow-spreading ridges. Chapter 3 by Asimov *et al.* is a highly theoretical discussion of variations in isentropic melt productivity (the amount of melt generated per unit pressure drop). They predict that melt productivity in peridotite will increase with increasing melt fraction in the batch melting case, but that this overall increase in productivity will be punctuated by significant drops upon the disappearance of each phase in the residue.

Once melting of peridotite begins

beneath a spreading ridge, the melts must somehow coalesce and migrate upward to collect in some type of magma chamber where crustal accretion takes place. Kelemen *et al.* provide a comprehensive review of melt migration processes, drawing heavily on evidence from ophiolites, where mantle sections are well exposed. Although the organization of this chapter leaves much to be desired, the paper deals with all aspects of the problem. The authors conclude that most melt is extracted from the mantle by focussed flow in dunite conduits, the dunite being formed by melt-rock reaction. Smaller amounts of melt migrate by reactive porous flow though intergranular space.

Most mantle plumes are intraplate features that form oceanic islands and seamounts and are not considered important in normal crustal accretion. However, Iceland is an anomalous region where the plume lies beneath a ridge axis. In a stimulating paper White examines the morphology of the North Atlantic seafloor and uses it to interpret rift-plume interaction since the initial breakup of the basin. The first formed ocean crust in this region was nearly twice normal thickness, reflecting the high mantle temperatures associated with the plume. This early crust is easily recognized because it is marked by an absence of fracture zones. During the last 25 m.y. the plume has been migrating eastward and the neovolcanic zone in Iceland has been jumping eastward to keep up with it.

Detailed surveys of mid-ocean ridges during the last 20 years have revealed a fascinating pattern of ridge segmentation by transform faults, overlapping spreading centres, and a variety of other features. The scale of ridge segmentation is of particular importance because it is used to interpret the nature of magmatic processes at the ridge axis. In Chapter 6, Cormier examines the instability of features on the northern East Pacific Rise and their implications for crustal accretion processes. She concludes that along-axis magma transport is typical of ridge systems and that it should occur at rates between 2 and 25 $m \cdot a^{-1}$, depending on the size of the conduit. She favours a model in which the mantle upwells everywhere beneath the ridge axis, but that the intensity of upwelling and melt production vary significantly along strike.

The next two papers deal with the evolution of seafloor hydrothermal vents and the factors that control hydrothermal circulation. Butterfield *et al.* discuss the response of hydrothermal systems to the underlying volcanic events. From studies of the Juan de Fuca Ridge and East Pacific Rise, they show that the composition of high-temperature fluids is controlled largely by the P-T conditions, reaction kinetics, and rock compositions within the system. Phase separation and volatile flux follow from volcanic eruptions, and the fluids evolve from vapor-dominated to brine-dominated with time. Schultz and Elderfield show that low-temperature, diffuse hydrothermal circulation is an important component of axial ridge systems and that such flow persists in crust up to approximately 65 Ma. Time series measurements at one of the best-known diffuse fields (TAG) show tidal and biweekly variations in both water temperature and flow volume, as well as a secular shift in the locus of heating.

Since their initial discovery in 1977, black smokers have been recognized as a source of massive sulphide deposits. However, only 15 of the more than 100 known deposits are large enough to be considered orebodies if they occurred on land and Fouquet asks the question "where are the large hydrothermal sulphide deposits in the oceans?" He suggests that on slow-spreading ridges the most promising areas for large deposits are on bathymetric highs within ridge segments and at the base and top of the rift valley walls. On fast-spreading ridges, off-axis seamounts are likely locations of large deposits because these are more stable systems than the summit calderas. Factors that control the size of deposits include the presence or absence of a cap rock, the boiling water depth, the stability of the hydrothermal system, degree of permeability, and extent of mixing. Fortier concludes that back-arc basins are the closest analogue for the setting of major deposits on land and that such areas represent the best exploration targets.

It was originally thought that hydrothermal mounds were formed solely from hydrothermal fluids but it is now apparent that abundant seawater is entrained in these systems. Using evidence from anhydrite, Mills and Tivey in Chapter 10 demonstrate extensive mixing of seawater and hydrothermal fluids in the TAG system and suggest that the approximately 20,000 m^3 of anhydrite in the mound could have been precipitated in 80-800 years.

Volcanic eruptions on the seafloor introduce large amounts of heat into the water column and have a major environmental impact on the deep ocean environment. The question naturally arises whether thermal plumes generated in this fashion can penetrate the thermocline and modify surface temperatures. Spear examines some of the factors controlling plume buoyancy and concludes that the very large amounts of heat needed to generate a thermocline-penetrating plume must make them very rare events.

The ecosystems associated with hot vents on the seafloor are unique and pose some interesting questions, such as how do species migrate to new vent sites, what is the stability of these systems, and what factors control the distribution and longevity of the systems? Juniper and Tunnicliffe discuss some of these questions in a stimulating paper titled "Crustal accretion and the hot vent ecosystem" and relate both habitat abundance and stability to spreading rate.

The final paper in the volume by H. Jannasch deals with the basic process that supports hot vent ecosystems, a highly effective microbial chemosynthetic biocatalytic transformation of hydrothermal fluids. He discusses both aerobic and anaerobic chemosynthesis and concludes that about 3% of all organic carbon in the deep-sea environment is formed by chemosynthesis at hydrothermal vents. As a fitting final note, he accepts the notion that the first appearance of life on Earth might have resulted from the oxidation of pyrrhotite to pyrite.

Overall, this is a stimulating and useful collection of papers that provides broad insights into mid-ocean ridge processes. It is well edited and free of typographical errors. By today's standards, the price ($85.00) is reasonable. I recommend it to anyone who would like a broad overview of the dynamic processes taking place at mid-ocean ridges.