

## BOOK REVIEWS

*The Man Who Found Time*. By Jack Repcheck, Perseus Books Group, Cambridge, Massachusetts, U.S.A., 2003. 247 pages, US \$26 (CDN \$40), hardbound, ISBN 0-7382-0692-X.

It is difficult indeed for today's geologist to appreciate the intellectual straight-jacket imposed by adherence to the notion of a young Earth. Yet, prior to James Hutton (1726–1797), various biblical chronologies had “firmly established” the age of the Earth to be about 6000 years. The most detailed chronology was that of James Ussher, Archbishop of Armaugh, Ireland, who declared that Earth was created at noon on Sunday, 23 October, 4004 B.C. The good Archbishop was not alone; dozens (if not hundreds) of chronologists plied the trade from the 4<sup>th</sup> century A.D. well into the 18<sup>th</sup> century. Nor were all chronologists religious figures, their ranks included such august scientists as Johannes Kepler and Isaac Newton.

Let us not be too smug. In the rather recent past, when this reviewer was an undergraduate, geologists were prisoners to the doctrine of the permanence of continents and ocean basins, and slaves to the geosynclinal theory with its mysterious borderlands that emerged and foundered conveniently to leave no traces.

*The Man Who Found Time* opens with an account of history's most important field trip. In June, 1788, James Hutton, already 62 years old, took two skeptical friends, mathematician John Playfair and chemist Sir James Hall, to view the spectacular unconformity at Siccar Point, Scotland, where Old Red Sandstone of Devonian age lies on the bevelled ends of upturned Silurian greywackes. The significance of the exposure was incontestable: The Earth is old, very, very old. Playfair was so struck that he was later to write: “The mind seemed to grow giddy by looking so far into the abyss of time.”

Interestingly, Hutton discovered the exposure at Siccar Point fully three years after the presentation before the Royal Society of Edinburgh of his revolutionary “Concerning the System of the Earth, its Duration, and Stability.” Because his ideas were received with little enthusiasm, Hutton set out to find field evidence to bolster his theory, a quest that led him to Siccar Point as well as to exposures of granitic intrusions in the Scottish Highlands.

Even though now backed by wonderful and convincing exposures, at the time of Hutton's death his ideas were refuted in influential books by Richard Kirwan and Robert Jameson, as well as in the 3<sup>rd</sup> edition of the Encyclopedia Britannica. It came to Hutton's younger friend and colleague, John Playfair (1748–1819) to pick up the gauntlet to become Hutton's champion defender – his bulldog – with the publication in 1802 of *Illustrations of the Huttonian Theory of the Earth*. Upon Playfair's death, the defense was taken up by Charles Lyell (1797–1875), the 19<sup>th</sup> century's most influential geologist and prolific writer of textbooks. His *Principles of Geology*, first out in 1830, went through eleven editions and was the premier geological text of its time and unswervingly championed the Huttonian Earth. Charles Darwin's early catastrophic views of Earth history fell away when, having just set sail aboard the *Beagle* (in 1832), he read Hutton's words in Lyell's text: “In the economy of the world, I can find no traces of a beginning, no prospect of an end.” The rest is history ...

The preceding paragraphs are bits and pieces from Repcheck's compact and nicely written biography of James Hutton, *The Man Who Found Time*. The compactness of the book (10 chapters plus addenda and a solid 13-page index squeezed onto 247 small pages) reflects the limited knowledge that we have of James Hutton's life. We know, for example, that in 1750 Hutton, with friend James Davie, devised and patented a process for making sal ammoniac that made him financially independent for the rest of his days. We know that he was an innovative experimental farmer. He fathered a son, but never married. He studied law and medicine, but never practiced either profession. But so many details are wanting. Repcheck makes up for this void by filling in the historical setting of Hutton's time with focus on the Scottish Enlightenment. The result is an instructive and polished book, recommended reading for all Earth scientists with the curiosity to ask: Wherefrom the roots of our discipline?

A few minor criticisms. The idyllic scene from the Isle of Arran on the dust jacket might better be replaced by a sketch of the unconformity at Siccar Point. In fact, an illustration of that unconformity in the text would be beneficial. The only illustration, a map (p. 12), could be enhanced by placing exclusive emphasis on Scotland. “Geologists now call an exposure of intruded magma either a dike or a sill” (p. 46) leaves little ground for

practically all igneous rocks. Hutton noticed that soil at Slighhouses, his experimental farm, was “leeching away” (p. 115). Was it being carried off by slimy little beasties that normally live in ponds? And, it is Ecuador (not Equador, p. 193).

To conclude this review, I would like to come back to the Young Earth *versus* Old Earth argument. Should James Hutton reappear amongst us now at the dawn of the 21<sup>st</sup> century, what would he find? I dare say he would not be overly pleased. He would discover that perhaps as many as four out of ten Americans “do not accept scientific evidence that differs with biblical accounts of creation” (*American Scientist*, v. 92, p. 203). Canadians, though, fare better. Should Hutton fire up his computer and go on-line to surf “creation science” sites, he would read (and these are direct quotes): 1) The six days of Genesis are 24 hours each; 2) the Earth is between 6,000 and 15,000 years old, and was rapidly made ready for its purpose as a home for man; 3) individual “kinds” of plants and animals were created directly by God in a mature state; 4) the flood of Noah’s time was violent, covered the entire Earth, and largely formed the geological column. The nonsense is endless, the outlook discouraging. Clearly, as scientists, geologists have done poorly in conveying Hutton’s elegant and straightforward message. I would propose that a group of the most ardent spokesmen of the Young Earth view be taken to Siccar Point there to debate their dogma on the outcrop, one-on-one, with contemporary Earth scientists. The message of the rocks is eloquent, explicit, and unambiguous. Two centuries ago at the site Hutton convinced two skeptics that Earth is very, very old. Can today’s geologists do as well?

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*Geologic Map of North America*. Geological Society of America, DNAG Continent-Scale Map 001. Scale: 1:5,000,000 (2005). Compiled by John C. Reed, Jr., John O. Wheeler, and Brian E. Tucholke. US\$150 (US\$120 to members of GSA). Available from Geological Society of America, P.O. Box 9140, Boulder, Colo. 80301, U.S.A. See also [www.geosociety.org](http://www.geosociety.org)

The *Geologic Map of North America* is the first (but last-issued!) of six continent-scale maps in the DNAG series. It was compiled by John C. Reed, Jr., John O. Wheeler, and Brian E. Tucholke, and is printed on three sheets; the map itself is on two sheets, one to the north of the other, with generous overlap along a trim line for mounting. Joined, the map is nearly square, measuring 1.75 by 1.70 m. The title of the map is perhaps a bit misleading because the geology of the surrounding

oceans is also depicted. In places, this complicates decoding and interpretation of the marine portion of the map, about 50 per cent of the whole, although a thin colorless border along shorelines does help the reader. On land, geology is depicted under most lakes. Exceptions are chiefly Canadian: Great Bear, Great Slave...

The explanation (legend) sheet, 1.40 by 1.04 m, features a staggering ~900 units arranged in four columns (sedimentary, volcanic, plutonic, and metamorphic + undivided crystalline rocks), plus special seafloor units. Formation names are not conferred, but lithologic indicators are given by suffixes (examples: e, evaporite; vf, felsic rocks; a, anorthosite; gn, orthogneiss), as is some metamorphic information by selected overprinted patterns. A few units are so tiny that their approximate locations are cited on the legend to aid the reader. One that I sought out, Wyn, a late Archean syenite gneiss according to the letters, and found in “S.E. Greenland”, is a spot only 1 mm in diameter that drove me to my hand lens. This is but one example of the fine detail portrayed on the *Geologic Map of North America*. Other information printed on the explanation sheet includes a summary of map symbols (including special submarine features), an index map and list of impact structures, an index map of geological provinces in the Canadian Shield, and a compilation of dyke swarms, which are depicted schematically by thin lines on the geological map. Unfortunately, with few exceptions, color contrasts between swarms are trivial and masked by the colors of enclosing rock units.

The map and explanation are accompanied by a 28-page brochure written by the compilers, with contributions from W.R. Stettner and D.R. Soller. The brochure treats the history of continent-scale geological maps from 1752 to the present, the complexity of the explanation sheet, and the confection of the map itself. Keeping pace with the rapid advances of digital technology was a particular challenge. Also discussed are the potential uses of the map and plans for future revisions and additions. Acknowledgments and 124 references are given on the final four pages of the brochure.

The compilation of a continental-scale map is a delicate balance between, on the left, the inclusion of not enough *versus* on the right, an excess of geological data. Deviation to either side of the central pivot renders the map progressively less useful. To the left, it becomes inadequate. To the right, it becomes illegible. The map here under review comes close to being centrist, with a slight tendency to the right, that of excess. With some 900 units, complex letter symbols, and dun-colored dykes, legibility is compromised. A hand lens is *de rigueur* over most of the Canadian Cordillera, the Shield, parts of the Appalachians, and much of Mexico.

The *Geologic Map of North America* is the most up-to-date geological panorama of the whole northern half of the western hemisphere, land and sea. It is a cartographic *tour de force* that at a distance allows a coherent overview of the architecture of North America and its bordering oceans and continental scraps. Close-up, the map offers abundant detail for more local analysis. Certainly no university-level department of geology or exploration division of a mining company should be without this map. It is an invaluable source of data and a visual inspiration.

Sadly, the *Geologic Map of North America* is priced far beyond the reach of students and most academics. Why is it so expensive? The 1932 *Geologic Map of the United States* at 1:2,500,000, still in print when I bought my copy in 1956, was \$2.50. The later edition, also at 1:2,500,000 and published in 1974, was \$5.00, and for an additional \$1.25, a 40-page explanatory text (*U.S. Geological Survey, Professional Paper 901*) was furnished. Perhaps the high price is to pay for the Geological Society of America's silly new logo.

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*Kovdor*. By G.Yu. Ivanyuk, V.N. Yakovenchuk and Ya.A. Pakhomovsky. Laplandia Minerals, Apatity, Russia, 2002 (English/Russian). 326 pages, hardbound (in dust jacket), \$110.00. ISBN 5-900395-41-3. Available from Lapis Onlinebuchladen at <http://www.lapis.de/shop> (catalogue #912077).

“Gem of the Kola Land” – that is how Kovdor is referred to in this book, and that is what, given the choice, I would have included in its title. The Kovdor intrusive complex in the Kola Alkaline Province, in northwestern Russia, is in every sense of that word, a gem. It is a place where some 400 million years ago, various types of exotic magmas from the Earth's mantle stalled in the crust, forming a fantastic kaleidoscope of ultramafic, alkaline, carbonatitic and “cross-bred” metasomatic rocks. This petrographic assemblage is so well endowed with mineral resources that, at one time, five different types of these resources (magnetite, apatite, baddeleyite, phlogopite and vermiculite) were mined here simultaneously. The phlogopite deposit, rated no. 1 in the world in terms of its tonnage, has produced phlogopite crystals up to 15 m in diameter! The Kovdor complex is the indisputable leader among similar carbonatite-bearing intrusions in terms of the total number of minerals and the number of new species reported from this locality over the past 70 years. It is the type locality for 16 minerals, 12 of which (including

kovdorskite) are not known to occur anywhere else in the world. For comparison, the Oka carbonatite complex in Québec has so far produced only two new species. Last, but not least, the Kovdor mines are a source of some of the most valued and sought-after specimens of carbonatitic minerals, including magnetite, forsterite, phlogopite, tetra-ferriphlogopite, bobierrite, collinsite, zircon, diopside, apatite and, of course, kovdorskite. Well, enough of the introduction, let us turn over the title page...

“Kovdor” was put together (perhaps, the word “crafted” would be more appropriate here) by three researchers from the Geological Institute in Apatity, known to many professional and amateur mineralogists for their popular publications on Kola (*e.g.*, Britvin *et al.* 1996, Pakhomovsky *et al.* 2001) and for the outstanding specimens of Kola minerals that their company (Laplandia Minerals) has been offering at European shows. (The druse of kovdorskite crystals gracing the dust jacket will give you some idea about the caliber of specimens that have passed through their hands). Alkaline-rock connoisseurs will likely connect the names of Ivanyuk, Yakovenchuk and Pakhomovsky to chlorbartonite, kukisvumite and several other tongue-twisters that have been discovered by this group at Kovdor and Khibiny in the past decade or so. In addition to his impressive academic achievements, the senior author has been also recognized for his artistic talents (Robinson 2001), showcased most recently in de Fourestier (1999). As acknowledged in the preface to the book, some of its chapters were written in collaboration with other geologists and engineers having close professional ties to Kovdor.

As with other publications in that genre, the structure of “Kovdor” largely follows the traditional geography – history – geology – mineralogy format. Unlike its many predecessors, however, this book's coverage of geology is very thorough (53 pages), and the historic section is quite appropriately followed by a comprehensive review of the contemporary mining activities at Kovdor. Again, unlike most other essays on topomineralogy, this one is bilingual, and the English text reads as smoothly as the original Russian version (thanks, primarily, to Frances Wall of the Natural History Museum, who meticulously proofread the entire translation). The book is well researched, proportionate and beautifully illustrated. I would have thought the scenery and some of the mineral specimens (see, *e.g.*, magnetite on pp. 146-147, or page-sized bobierrite on p. 238) were photographed professionally, had I not known that the senior author is as skillful with a camera as he is with a drawing pen. The quality of paper, printing and binding is very high, and the color reproduction is exceptional (this is coming from someone who has seen “*en vivo*” many of the mineral and rock specimens shown in the book).

Following a foreword from the Governor of the Murmansk Region, reflecting on the place of Kovdor in the regional economic landscape and on the significance of the present publication, and a preface, acknowledging those who helped put this monograph together, "Kovdor" opens with a ten-page overview of the local geography. This overview features breathtaking imagery of northern landscapes and details on the climate, vegetation, wildlife and even... water quality.

The next chapter, entitled *How Kovdor Began*, is twenty pages long and provides a detailed account of the history of exploration and mining in the Kovdor area. This section is full of curious and, generally, little-known facts. I, for one, had no idea that the first mining operations in the area were run by the local Lapp population already in the 1700s, or that the Kovdor carbonatites, discovered in 1934, were initially mistaken for limestone. The narrative is augmented with some 30 historical photographs and views of the Kovdor mines and ore-dressing facilities over the years.

I greatly enjoyed reading the chapter on the economics of Kovdor. It begins with a retrospective of the Kovdor Mining and Ore-Dressing Plant (Kovdorskii GOK joint-stock company) that went into production in 1962, grew into one of the leading mining centers in the Russian Arctic, suffered (like so many, if not all, similar enterprises across the former USSR) from uncertainty and cutbacks in the 1990s, but pulled through the tough times and eventually found its niche on the mineral-commodity market. Since 1996, the GOK has consistently rated among Russia's top 200 companies. I have found this story of survival very captivating. The last half of this chapter (nine pages) is concerned with the principal mineral resources (magnetite, apatite and baddeleyite), their tonnages, grades and production volumes, as well as with those economic challenges that the company currently faces or will have to deal with in the coming years. There are some 25 illustrations in this chapter, including production charts, views of the mines and plant, Kovdor cityscapes, and several portraits of the GOK executives.

One of the highlights of this book is a comprehensive description of the geology and petrology of the Kovdor pluton. This section, entitled *Summary of the Geology of the Kovdor Massif*, opens with a brief overview of its geological setting and structure. It is followed by descriptions of the various igneous and metasomatic rocks that make up the pluton and associated mineral deposits. The descriptions vary in length from ten lines (tinguaite) to over ten pages (phoscorites), depending on how common and economically important the rock under consideration is. If you are not familiar with the nomenclature of alkaline and carbonatitic rocks, you might need Le Maitre (2002) to navigate through the

terminological maze. The descriptions are augmented with four geological maps (Kola Peninsula, Kovdor complex, magnetite and "staffelite" deposits), one block diagram (phlogopite deposit), 12 views of outcrops and mine workings, 17 photographs of hand specimens, and 62 thin-section shots. The latter are properly labeled, scaled and, for the most part, assembled into matching pairs of plane- and cross-polarized-light images. All of the imagery in this chapter is in full color, which adds greatly to the educational value of the book, given that most readers will have probably never seen an ijolite or turjaite. I think you will also appreciate the care with which the photographer selected his objects. In addition to showing textures and petrographic trivia, these images carry a wealth of information on how the Kovdor rocks formed and transformed. Two examples include metasomatic fringes at the contact of carbonatite with urtite (p. 60), and replacement of biotite by aegirine-augite in fenitized gneiss (p. 63).

Approximately 60% of book's volume is taken up by mineral descriptions, which are arranged systematically and, within individual chemical classes, alphabetically. The descriptions, covering all 175 mineral species known at Kovdor, were compiled using both published and the authors' own data. Every description (even those of native gold and pyrite) contains results of electron-microprobe and, in some instances, "wet" chemical analyses. The identity of the majority of minerals was confirmed by X-ray powder diffraction, and these data are included in the book. Both chemical and diffraction data are accompanied by detailed information on provenance (*e.g.*, "harmotome from a chabazite veinlet in fenite", "catapleiite from a dolomite carbonatite in ijolite", *etc.*). This chapter is richly illustrated, but the authors did not limit the scope of these illustrations to aesthetic specimens (as is often the case with books in that genre), although there is a plenty of "eye-candies" among the 146 full-color photographs accompanying the descriptions. Here, again, many of the specimens were obviously chosen to depict a specific mineral-forming process or processes. Examples are numerous, but my personal favorites are a phlogopite crystal rimmed by vermiculite on page 170, and replacement of forsterite by fibrous richterite on page 207. For a real treat, flip to the description of kovdorskite, complete with 11 photographs of the blue, pink and colorless varieties of Kovdor's "hallmark" mineral. In addition, there are photographs of thin sections (11), opaque minerals in reflected light (11), 55 scanning-electron-microscopy images, and 15 indexed crystal drawings in this chapter. All figure captions are exhaustively detailed; *e.g.*, "Druse of quintinite-2H crystals from a phlogopite – calcite – magnetite rock, the Anomalous Zone. From the collection of N.M. Manaev. (5 × 3 cm)." The final nine pages of the mineralogy section contain brief descriptions of the 42 minerals that require

further studies, and those that had been reported from Kovdor in the older literature, but were not confirmed by the authors of this book.

The subject index contains the mineral names of both confirmed and inadequately characterized mineral species with the corresponding page numbers. It is followed by an extensive list of references and three pages of short biographic sketches for the three principal authors and their colleagues who contributed to the book.

Keeping in mind that “Kovdor” was written and translated in Russia, edited in England and printed in Finland, there are surprisingly few typos and even fewer mistranslations (“Imperia” instead of “Empire” on p. 16, “trachytic” in place of “trachytoidal” on p. 62, “tetragonal trioctahedral” instead of “trapezohedral” on p. 164, and “massifs and its ores” on p. 317). Apart from minor editorial nitpicks, I have only three things to criticize. The formulae of pseudobrookite, zirconolite, nontronite and monazite-(Ce), given in the descriptive section, are not charge-balanced if one takes into account variations in charge among the cations enclosed in parentheses. Secondly, I personally would have preferred to see a more extensive subject index, *i.e.*, one that includes rocks, locality names, *etc.* Finally, some of the published work on Kovdor, unfortunately, seems to have escaped the authors’ attention. For example, Zlatkind (1945) described a new type of plutonic melilitic rocks, which she dubbed “kovdorite”. Although that name did not stick, the rock “kovdorite” actually preceded the mineral kovdorskite by 35 years! The recent publications by Verhulst *et al.* (2000) on the petrology of Kovdor, and by Williams (1996) and Subbotin & Subbotina (2000) on pyrochlore from the Kovdor phoscorites and carbonatites should also have been cited.

To summarize, the value of this book is difficult to overestimate. Intrusions of alkaline-ultramafic rocks and associated carbonatites (like Kovdor) are significantly more common than nepheline syenite plutons (like Mont Saint-Hilaire). It is in the former type of igneous formations in which many new kinds of rocks (*e.g.*, uncomphgrite, okaite, melteigite and phoscorite) and numerous new minerals (*e.g.*, carbocernaite, cebolite, niocalite and zirconolite) have been recognized. Yet, museum curators, serious mineral collectors and “hard-rock” Earth scientists outside of the alkaline domain will most likely know about Mont Saint-Hilaire or Ilimaussaq, but have not necessarily heard of Kovdor, Oka or Iron Hill. This recently published monograph will be an excellent (and, given the quality and volume, reasonably priced) introduction to the world of carbonatites, phoscorites and associated silicate rocks for all those who have learnt about the existence of the word “phoscorite” from this review. In my opinion, readers with a more advanced understanding of such rocks

will also find this book useful as a comprehensive synthesis of the previously published and new data on the geology, economics, petrology, mineralogy, and the history of exploration of the Kovdor complex. I most certainly have.

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*Quantitative Seismic Interpretation: Applying Rock Physics Tools to Reduce Interpretation Risk*. By Per Avseth, Tapan Mukerji and Gary Mavko. Cambridge University Press, 2005, 359 pages, hardbound, US\$140 (ISBN 13 978-0-521-81601-7).

This is undoubtedly one of the most exciting seismic reference texts to have been written for the practicing petroleum geophysicist in some time. It is not just a dry mix of text and equations; the use of insightful



quotations, excellent graphics and a dynamic writing style make for a stimulating *tour de force* of applied quantitative techniques for seismic interpreters.

The importance of improving the success rate for discovery and the proper exploitation of hydrocarbons cannot be overstated. Witness the recent business debacle of a major multinational oil company having to reclassify downward by 20% its booked petroleum reserves in 2004; this sort of write-down has been and remains an ongoing occurrence for many other oil and gas companies. This is an ironic turn of events, petroleum reserves write-downs at a time of globally high prices, as observed by Mathew Simmons of Simmons & Company International, a leading petroleum investment bank. Ultimately, the most accurate assessment of a petroleum reservoir is the drill hole. With the cost of offshore drilling usually in the tens of millions of dollars, the petroleum industry must have a reliable way of assessing its holdings without testing every single location by the drill bit. This is where quantitative seismic methods offer the greatest promise as well as the greatest risk to proper evaluation of these multi-million dollar prospects that may develop into multi-billion dollar projects, such as the contentious Ormen Lange field offshore Norway. The development of this project will cost almost \$10 billion USD by 2006, yet recoverable reserve estimates have varied by 40%, all of these being downward revisions. Obviously, this presents a very significant risk to all parties involved; trying to reduce this type of risk by the enlightened use of digital seismic data is the focus of this volume.

The volume starts with a thorough introduction in rock physics; the interaction of P and S waves with density changes in rocks and the derivation of the fundamental relationships between seismic velocities, rock parameters such as density, porosity and pore fluids. The additional complexities of lithological and diagenetic factors are added to this analysis matrix using many of the model-based approaches that have been developed over the past thirty years. The pitfalls arising from these model applications are instructive; they also suffer from a common factor of all forms of analysis that are based on models; misuse by the user due to misinterpretation of the data. This is neatly summed up by the author's observation that "All models are wrong... some are useful". This really applies to more than just rock physics; it should be regarded as a paradigm for the Earth sciences.

The changing interplay of geological reality *versus* seismic expression is graphically illustrated by examples presented from a modern 3-D seismic survey over a submarine fan system. The familiar seismic "bright spot" amplitude analysis, which dates from the 1970s, is a ubiquitous approach for interpreting gas-charged sands in clastic depositional systems based on the

high-amplitude seismic reflections generated by these sands compared to their surrounding shales. This type of interpretation was a direct result of the rapid evolution that digital seismic recording and processing were able to achieve for more accurate seismic images with relative amplitude information.

In this submarine channel example, the technique is shown to work well in the up-dip portion of the survey area and then fail completely in the down-dip section, as confirmed by drilling results. This failure is not due to the data but the increasing depth of the plunging channel system, the increased pressure due to greater depth of burial completely reverses the seismic impedance of the zone of interest, causing the opposite seismic response to that observed in the shallower section.

The observation that rocks are neither linear nor elastic nor isotropic in their response to seismic waves is resolutely shown in theory and practice. A consistent effort is made to present these rock physics parameters in a geological context, to tie these many pristine equations and models back to the messy reality of sedimentary geological systems.

The second chapter starts with a differentiation of qualitative *versus* quantitative seismic interpretation. The extraction of seismic amplitudes and other derived seismic attributes are the heart of quantitative interpretation as opposed to the conventional picking of seismic reflection time values and recognition of stratigraphic patterns in the visible data.

Arguably the text could have started with this chapter, showing how the qualitative geological interpretation can constrain the use of the rock physics tools, but the aim here is clearly to show that both approaches must be integrated. At this point the reader is taken from the macro scale of the seismic events to the micro scale of sedimentary structures and textures, where the mathematical description of the geology is explained. This is developed into a robust set of tools they define as rock physics templates. The specific geological criteria of any given sedimentary basin, *e.g.*, age, depth, lithology and facies types, are used to tailor and specifically constrain these rock physics templates so that the appropriate modeling scenarios are employed. The overall intent here is that an integrated approach is essential, there is no "magic bullet" solution, and literally every aspect of the geological system must be accounted for in some way.

By the third chapter, the need for some serious statistical work should be an obvious necessity with regards to the great volumes of data that have previously been referred to. The next 56 pages range from statistical philosophy, "the flaw of averages", to a good overview of working methods that include geostatistics (kriging),

Monte Carlo methods, pattern recognition, discriminant methods and Bayesian techniques. This chapter alone could stand as a survey course in advanced practical statistics and mathematical geology.

The fourth chapter gives a quick review of seismic interpretation fundamentals, with an overview of amplitude interpretation that moves from its historical roots into modern amplitude *versus* offset (AVO) theory and use, impedance inversion and forward seismic modeling. This chapter's opening quote, Nietzsche's "There are no facts, only interpretations", is a maxim that should always be remembered by geoscientists. The many ways in which a plethora of digital log and seismic data can be interpreted using these techniques is clearly presented with this statement in mind.

The next two chapters are focused on actual case-studies and practical workflows. Given the huge amount of information in the preceding text, it is highly instructive to have some guided tutorial approaches available. All too often, technical articles of this ilk tend to leave many readers dazzled with the science and almost completely at a loss as to how one would do the work. The last chapter presents a directed series of problems that focus onto a full project-style evaluation using log and seismic data. An extremely large volume of data must be used for this task of winnowing out all the needed information that can be had from contemporary seismic and petrophysical log datasets; this requires a good facility with modern computers. To their credit, the authors provide downloading of both types of data with all the requisite handling information on their website; these data can then be manipulated by standard software packages such as Matlab, for which they also provide programming, or Excel for the geological data. However, access to a seismic workstation is required for the 3-D seismic datasets to be addressed. This access to hundreds of megabytes of data for the purpose of these exercises makes for a remarkable learning experience that previously could only be had in either an industry or high-level academic setting.

These last three chapters along with the very complete bibliography are by themselves well worth the cost of the entire book for any geoscientist who needs a solid reference on understanding and actually using these developing technologies. The book is very well illustrated, with numerous clear diagrams and 32 pages of color plates. Owing to printing costs, these are gathered in the center of the book. This requires a lot of page flipping, but in view of the wealth of information offered, it's a minor inconvenience.

With the new reality of ever-increasing petroleum demand and the threat of shrinking supply, the application of various technologies to predict successfully the fluid content of hydrocarbon prospects is absolutely essential. This text will go a long way in providing a fundamental understanding of how to effectively use seismic data with rock physics and geology in the quest for hydrocarbons. Finally, it must be said that this is not a light read, but requires patient study and review that will also require a good many hours of computer work to maximize the learning. Given that, this book represents excellent value for the professional petroleum geoscientist and will make an excellent text for graduate studies in petroleum geophysics.

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*Fleischer's Glossary of Mineral Species 2004*. By Joseph A. Mandarino & Malcolm Back. Reviewed in *The Canadian Mineralogist* **43**, 1436-1437 (2005) by Peter Bayliss. A reviewer's assessment of the merits of a recently published book is by its very nature a subjective call. Negative reviews do not normally give rise to a rebuttal. However, in this case, Dr. Bayliss raised several questions of scientific nature that do invite a reply, in the editor's opinion. Here is the response supplied by the authors, printed here so that readers can learn from the interchange.

We were surprised and very disappointed to read the negative review of *Fleischer's Glossary of Mineral Species 2004*. When the senior author questioned the editor about the review and certain inaccuracies in it, he received the reply that book review section is considered an "open forum". Book reviews do not enjoy the same peer-review process as articles. Thus, although we have much more important things to do, we felt it important to reply to some points of Dr. Bayliss' review, so we now enter this "open forum". A colleague who has no connection with the "*Fleischer*" sent us some specific responses with regard to the review. These comments are so well-presented that we decided to reproduce them here with his permission. They are followed by some of our comments.

"The *Glossary of Mineral Species* is arguably the most widely used single-volume reference for mineral species, and one of the most useful books in the field of mineralogy. I would have hoped that the reviewer

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\* Earth Sciences Sector Contribution No. 2005212.

would appreciate and mention the widespread utility of the *Glossary*.”

“The International Union of Pure and Applied Chemistry (IUPAC) adopted *aluminium* as the standard international name for the element in 1990, but three years later recognized *aluminum* as an acceptable variant: [http://www.iupac.org/reports/periodic\\_table/index.html](http://www.iupac.org/reports/periodic_table/index.html)”

“Alabandite does not have significant metallic bonding(!): Mn is coordinated by six sulfur atoms at a distance of 2.61 ångströms. The shortest Mn–Mn distance is 3.69 ångströms, inconsistent with significant metallic bonding in the structure.”

“By definition, all rhombohedral space-groups are members of the trigonal crystal system (and of the hexagonal crystal family); see the International Tables for Crystallography, Volume 1.”

“Amorphous is the most commonly used term for non-crystalline material in the 1998 IMA procedures and guidelines. Furthermore, the second definition in the Oxford English Dictionary is: 2. Min. & Chem. Not composed of crystals in physical structure.”

“In closing, may I remark that one of the prices of success is the criticism with which it comes. I trust that you and Malcolm will weather through, and the *Glossary* will continue to new heights of popularity.”

Our comments:

Yes, there are some typographical errors and mistakes in formatting, which we will endeavor to fix in the next edition. Such errors are inevitable in a book such as this.

The fact that no ISBN number is given does not affect the usefulness of the “*Fleischer*” to the mineralogical community.

The reason for deleting the section on mineral groups is clearly explained on page vi.

Allanite-(La) is “missing” for a very good reason; at the time the “*Fleischer*” went to press, its description had not been published, although the species was approved. It is presently “in press” in *The Canadian Mineralogist* and is scheduled for publication in the February 2006 issue. There are about 200 IMA-approved new species whose descriptions have not been published yet.

Actinolite is NOT a varietal name. It is an approved name for an amphibole species belonging to the Calcic Subgroup of the Amphibole Group.

Regarding the “many exceptions” to the title of “Mineral Species”, we welcome a list of these exceptions from anybody who can provide them.

Dr. Bayliss states: “Only a few examples of errors, omissions and inconsistencies (sic) have been given; however, there are about a thousand. My recommendation for the professional mineralogist is to use *Fleischer’s Glossary of Mineral Species 2004* with caution.” We welcome the list of “about a thousand errors, omissions and inconsistencies” that Dr. Bayliss has compiled and will be pleased to acknowledge his assistance in the next edition.

We have received some corrections from professionals and amateurs who have purchased *Fleischer’s Glossary of Mineral Species 2004*, and we welcome all constructive suggestions. We are compiling these for the next edition.

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