Pergamon

PII: S0191-8141(96)00033-8

Journal of Structural Geology, Vol. 18, No. 7, pp. 971 to 973, 1996

0191-8141/96 $15.00+0.00

BOOK REVIEWS

Geology For All

Murck, B. W., Skinner, B. J and Porter, S. C.. 1986. *Environmental Geology*. John Wiley & Sons, Inc, New York. Price (paperback). US$22.95, £19.99, ISBN 0-471-30356-9.

The book was sent to the *Journal of Structural Geology* for review, despite its title covering a subject not commonly investigated in this Journal. It was passed to me for perusal, a geochemist with some environmental experience. The book only touches my environmental interests with one sentence mentioning microbial methylation of mercury, one small paragraph mentioning chlorinated organics, and only one photograph of my research area, titled "Chemically polluted waste water, Merseyside, England". Yet my opinion, an organic geochemist speaking to structural geologists, is: Seriously consider buying it for yourself, definitely make sure the library has sufficient copies, and try to get a few fixed with chains or electronically tagged so that they don't walk away.

The book is not a detailed treatise on the environment. It takes the student and teacher from first principles (e.g. what is a mineral?) to the point at which, with guidance, the student can tackle the journals. There are no references for further reading, leaving the teacher completely free to carry on the education process according to personal taste. The book is not the environmental Gospels of Murck, Skinner and Porter.

There are 5 sections. The introduction starts with a stunning colour infrared satellite of the Nile and Upper Egypt, setting the stage for a discussion of the book's concerns: geology, the environment, earth systems and cycles, resources, waste and human interactions. In Part One, the first section introduces the planet and plate tectonics. The next chapter introduces what are usually termed cycles, plate tectonics, rocks, and uniformitarianism. The following chapter introduces the mantle and core, minerals, and their properties. In Part Two, the reader is introduced to geologic hazards, their assessment, hazard maps, prediction, and the role of geoscientists. The following chapters discuss specific aspects in detail: earthquakes, volcanic eruptions, tsunamis, landslides and mass-wasting, subsidence, floods, ocean and weather, and meteorite impacts. Part Three starts with a discussion of renewable and non-renewable resources. This is followed by chapters on fossil fuels, energy alternatives, mineral resources, soil resources, and water resources. Finally, Part Four considers aspects which might be more usually described as environmental. After an initial discussion on waste management, the remaining chapters consider waste disposal, contaminants in the geologic environment, and atmospheric change.

In reviewing this book, I went through it three times. Initially I progressed as far as the second chapter. The chapter is written in the simplest terms, and I would have no hesitation in using the text to teach to undergraduate earth science majors or majors taking earth science as a subsidary, non-scientists or school children. Innocuously introduced, however, at the start is a fundamental concept in classical thermodynamics, but with no mention of thermodynamics. The text and example is so lucidly written that I am considering using this section in an introductory thermodynamics course. This is then followed by an equally innocuous discussion of fluxes of elements between, for example, the oceans and atmosphere, which I would not hesitate to use for high school children. The two standard text books on fluxes prior to this book, however, I would not recommend to anyone except those some way into their doctorates, or further. In the teaching and writing of a broad context text book aimed at the novice, it is difficult not to sacrifice rigour for the sake of communication ease. I found no evidence of this sacrifice. In my third reading, I looked specifically at chapters whose contents contained my research areas (ore deposits, fossil fuels, and pollution), with the objective of being purposefully critical. I found some points where my and the authors approaches differed, but these were trivial nuances, which increased my respect for what is written.

I was impressed furthermore at the consistent approach in every chapter to help the student learn, in addition to a relaxed text and excellent, thoughtfully chosen, illustrations. At the end of each chapter, there is a summary of key points, followed by a section containing key words (in addition to a glossary at the end of the book). Finally, there is a section of questions and activities. The activities are intelligent, chosen to be suitable for all standards of students, and include simple experiments. There are three appendices, on Units and conversions, the Periodic Table, and the Geologic Time Scale. One aspect which I considered original and probably effective, is the extensive use of graphs. These range from the time scale of processes (sound wave to formation of ore deposits and mountain ranges) to climatic predictions. The flavour is very much that of the Nuffield approach in the U.K.

My enthusiasm for this book arises from my view that communication from the expert to the teacher to the novice is the prime issue. A good teacher can address an issue at almost any level, ranging from kindergarten to postgraduates to mature students in evening classes. A clear understanding of the science, examples from everyday life, and very extensive use of some of the best colour photographs and diagrams that I have encountered, make this book excceptional. By the time I had finished the first chapter, I wished that I had had such a book previously for teaching. In the preface, there is a listing of additional source material, including Instructors' Manuals, Slide sets, and CD-ROM sources. For the teacher who has to address broad issues in the geosciences, whether a structural geologist or organic geochemist, this book should be rewarding to use.

I have not encountered text books of this calibre before, and hope that it will set the standard for many more. In the preface, the authors claim their reason for writing the book as "We love geology. We love to study, teach and learn about geology". In this case I believe these claims. I have one negative comment for the publisher. The book is paperback, and will erode with heavy use. The price is excellent for students, but for libraries and teachers, the publishers should consider a more durable cover. If you have to teach broad course earth sciences, seriously consider buying it. If you want a book at 1970s prices packed with thoughtfully chosen, qood quality colour photographs and diagrams for personal pleasure or teaching from kindergarten to post graduates, with a text designed for teaching, consider purchasing it. If one simply wants a book to decorate the coffee table, this is it.

Manchester, U.K. *Andy Gize*

Seismic Encyclopaedia

Sheriff, R. E. and Geldart, L. P. 1995. *Exploration Seismology*, 2nd edition, Cambridge University Press, List price £75, US$30 (hardback) £29.95, US$49.95 (paperback).

The (1982) first edition of Sherriff & Geldhart's text has been on my bookshelf since the time I was a PhD student studying to become a structural geologist using geophysics, particularly exploration seismology, as the principal tool of my trade. That two volume encyclopaedia of exploration seismology will be replaced this year by a single volume update. Encyclopaedia is the right description here because this book contains just about anything one might want to know about exploration seismology. It attempts to provide basic descriptive introductions for those unfamiliar or casually interested, detailed explanations for those already working within the field, and substantial theoretical mathematics for those wishing to understand the underpinnings of the techniques used in the developmental, acquisition, processing and interpretational aspects of exploration seismology.

Most, if not all, exploration seismologists will want to have the new second edition. It is more comprehensive than some of its competitors such as Yilmaz (1981), more in depth than some others such as Hatton *et al.* (1986), yet remains accessible. Structural geologists will probably find only a few chapters of relevance to them, just as seismologists would find a comparable text in structural geology selectively useful.

The text is surprisingly readable given the large amount of mathematical formalism. Concepts are well illustrated by figures. However, it is the poor quality of many figures that I find the major drawback of this second edition. In this age of rapidly expanding use and utility of computers, particularly in the processing and interpretation of seismic data, the appearance of blotted, hand-drawn illustrations is a poor advertisement for the wealth of information available here.

Seismic reflection profiling remains the most widely used exploration technique. It also remains a tool that primarily, perhaps exclusively, provides us with geometries. These geometries may represent sedimentary layers, faults, shear zones, igneous intrusives or facies changes, but only lithological changes produce impedance contrasts that reflect seismic energy. Only where acquisition allows sources and receivers to be sited on most sides of a rock volume target, typically shallow targets involving well holes, can comprehensive collections of physical properties such as velocity and density be obtained and used. Sheriff & Geldart clearly reveal their background in economic exploration seismology by the large percentage of text they have again devoted to the often poorly constrained physical properties. Happily for structural geologists whose preoccupation is with structure geometries, these geometries retain the attention of industry as well.

The text is divided logically into 15 chapters that are well cross-referenced. These chapters will likely fall into three types for most structural geologists: useful, interesting and "thank you, but not today, I have a headache". In the first group are: 6. Characteristics of seismic events, and 10. Geologic interpretation of reflection data. These chapters document the usefulness of seismology in providing structural information at depth. In the second group are: 1. Introduction, 2. Theory of seismic waves, 5. Seismic velocity, 9. Data processing. These chapters reveal the possible pitfalls in assuming that a seismic section is a cross-section of the subsurface. The remaining chapters will be read largely by exploration geophysicists: 3. Partitioning at an interface, 4. Geometry of seismic waves, 7. Equipment, 8. Reflection field methods, 11. Reflection methods, 12. 3-D methods, 13. Special techniques, 14. Special applications, and 15. Background mathematics. Discussions of the contents of specific sections from a few of these chapters illustrate the strengths and weaknesses of this book as a whole.

The chapter describing characteristics of seismic events contains concepts important to anyone using seismic data to study structures. It states that the basic task is threefold: selecting those seismic events that represent primary reflections, converting travel times into depths and dips correctly, and mapping resultant coherent or continuous features. Recognition of a seismic event is based on its coherence, distinctive amplitude, phase (wave shape) characteristics, dip move out behaviour and normal move out behaviour. These criteria are explained by interspersing the discussion with important concepts such as spatial aliasing, convolved source wavelets, composite wavelets that represent a summation of reflectivity from numerous boundaries too closely spaced for full resolution, and focusing by lens-shaped structures. Characteristics of diffractions, multiples, out-of-plane reflections, refractions and surface waves are discussed so as to emphasize both the disadvantages posed by their presence in records as well as the additional information available in each if used properly. Resolution and wavelet shape receive much attention in the text, but continue to demand more coverage in my opinion. Recent work has shown that sedimentary processes, faulting, shearing and intrusive processes all occur in a self-affine (fractal) manner in nature, and therefore produce exponential distributions in the size of a particular feature. This implies that no matter what resolution is available to a particular seismic study, it can never resolve the finest-scale structure. Instead these structures will appear in seismic data as composite wavelets, phase incoherence along a particular reflector, scattered energy or anisotropy. This is currently an active field of research that can produce few certain conclusions at present, but it undoubtedly represents much potential information to structural geologists who study scale-invariant deformation in particular.

Within the chapter on data processing is a section about processes that reposition data, more commonly call data migration. It is central to making seismic reflection geometries useful to structural geologists. Developing good migration techniques has engaged geophysicists for decades and continues to do so. This text concisely summarizes the four main methods used for migrations today and discusses their relative merits and limitations. Migration is a computationally intensive process and improved computer hardware has led to ever-improving migration techniques. Better resolution and definition of the velocity field has led to improved migrated sections. The text understates recent advances in velocity field definition due to improved modelling of long-offset ("refraction") observations involving diving waves and wide-angle reflections. These models provide the continuous, average bulk velocities required for successful migrations and avoid interpolation and sampling problems associated with extrapolating detailed logs between randomly located wells. Several recent studies have shown that velocity fields determined from modelling of refraction observations are consistent with those determined from iterative depth migrations; it is only the truncation of diffraction hyperbolae by acquisition and progressing limitations that result in the traditional discrepancy between reflection stacking velocities and average bulk velocities. With enough effort, accurate velocity fields can be obtained and correct structural geometries reliably estimated.

The chapter on the geologic interpretation of reflection data will undoubtedly be the favourite of structural geologists. Its 70+ pages start off very slowly with summaries of plate tectonic concepts, but eventually become a very useful series of interpreted seismic sections that illustrate a broad range of common sedimentary structures including salt domes, reefs, unconformities, faults, folds. The last few examples include synthetic seismic sections that illustrate behaviour of rays within velocity models and show inexperienced interpreters just how much noise and spurious energy exists on typical seismic sections. As with the entire book, this chapter attempts to cover everything. It again fails, but unlike any other book I have encountered, it does achieve a balance between the generalized description of geological structures, the specific illustration of the structures with seismic sections, and the common discrepancies found between the two. Large format atlases of seismic data (e.g. the Bally atlases, the BIRPS Atlas) provide more complete examples. Many recent structural geology texts provide better descriptions of balancing cross-sections, folding and faulting but invariably shy away from the necessary illustration of these structures *in situ* because seismic sections require a thorough introduction.

It is this last point that leads me to highly recommend this book to both neophyte and well-seasoned structural geologists alike. The name of the game is understanding and describing geological features in three dimensions. No better tool exists than reflection seismic sections supported by good velocity models. This text tells those using such sections everything they will probably need to know to avoid pitfalls and feel confident in their interpretations. In the interpretation chapter it gives a few examples with which to practice; more challenging examples are available in published journal articles and atlases. Keep this text near-to-hand when interpreting the deterministic geometries of large-scale structures observed in the crust. Remain vigilant for a topic that is not included here: the stochastic properties of rocks at sub-resolution scale for most seismic studies, in other words, the effect of penetrative structures at scales below seismic resolution. Properties related to foliation and other aspects of structural geology that are studied at single outcrops and with thin sections may some day also be included in a text on exploration seismology, perhaps the third edition of Sheriff & Geldart.

REFERENCES

Hatton, L., Worthington, M. H. & Makin, J. 1986. *Seismic Data Processing, Theory & Practice.* Blackwell Scientific Publications, Oxford.

Yilmaz, O. 1987. Seismic Data Processing. Society of Exploration Geophysicists, Investigations in Geophysics.

Cambridge, U.K. *David B. Snyder*

Mapping Again

Barnes, John W. 1995. *Basic Geological Mapping, 3rd Edition.* John Wiley & Sons, Chichester, U.K. Price (paperback) £10.99.

This is a welcome new edition of this excellent little book in the Geological Field Guide Series. It is essentially aimed at a British undergraduate audience with a new valuable chapter on writing geological reports for our final year mapping projects. However, its information is universal and, indeed, it has advice for mapping in climates warmer than our own.

There does not appear to be a lot of new material, but for those not familiar with the previous editions, it is a thorough and well-thought-out treatment of all aspects of *basic* mapping, complemented by the other books in the series for more advance techniques. The principal chapters deal with: Instruments and equipment; Geological maps and