Methods and Applications in Reservoir Geophysics, David H. Johnston, ed., ISBN 978-0-931830-46-4, SEG, Investigations in Geophysics no. 15, 2010, 672 pp., US $149, $119 (member), $95.20 student.

This book updates the technology in reservoir geophysics since its original debut in 1992. This compilation consists of 40 reprinted papers from recent journal articles and 13 new articles. Each chapter focuses on a different stage of field life from appraisal through development.

The first two chapters describe the life cycle of an oil field and the supporting technologies to geophysics for field development. Reservoir management plans should be implemented using multidisciplinary teams utilizing reservoir engineering, rock physics, geology, and geophysics.

The 35 papers in the next three chapters cover aspects of major phases in oil field development: appraisal, development, and production. Seismic methodologies, as well as nonseismic technologies (electromagnetics and gravity) are illustrated. There are case histories from the Gulf of Mexico, Malaysia, China, Bolivia, Alaska, and the North Sea. The production geophysics chapter contains papers on 4D (or time-lapse) seismic, VSP, and passive seismic methods. I was surprised that the issue of depth conversion was not addressed. It was good to see that the issue of reserve bookings was covered.

The last chapter is on the road ahead with ten papers discussing coming technologies for production geophysics. There is a relationship to the technologies that were originally discussed in the 1992 edition of the book. Some of the technologies discussed as future technologies in 1992 (e.g., microseismic, microgravity, and electromagnetics) are now more commonly used technologies in development geophysics. New technologies discussed in the 2010 edition are multiazimuth seismic, life of field seismic, elastic seismic stratigraphy, virtual sources, CO_2 monitoring, and hydrates. Given the dynamic state of current seismic acquisition, these papers could be the quickest to move from the road ahead to common practice.

Methods and Applications in Reservoir Geophysics is a book not to simply demonstrate the value of reservoir geophysics, but also to illustrate effective ways to apply geophysics in reservoir management. David Johnston has put together a good collection of papers to cover the full gambit of reservoir geophysics. Geophysicists involved in reservoir development should find the book a useful addition to their library.

—*DAVID BARTEL*
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Plates vs. Plumes: A Geological Controversy by Gillian R. Foulger, ISBN 978-1-40510-6148-0, Wiley-Blackwell, 2010, 364 pp., US $99.95.

The concept of mantle plumes was first proposed by Jason Morgan in 1971 as a mechanism for the "hot spots" such as the Hawaiian Island chain that were a key piece of evidence for acceptance of the new plate tectonic theory in the 1960s. A substantial theory quickly developed in support of the idea, and there was considerable debate as to whether plumes could also be a driving force for plate motions. Like many newly adopted theories in science, the seemingly clear and unambiguous picture presented by the first versions quickly became more complex as the concept was extended to more physical examples, and the related phenomena were studied in ever-increasing detail.

In the past decade, the debate on plumes has become whether they actually exist, as more and more of the proposed plumes exhibit such different characteristics that they each may be viewed as a special case. As a side note, even the "hot spot" concept is in question, as it cannot be clearly demonstrated the mantle beneath "hot" spots is significantly warmer than the norm. The preferred terminology is now "melting anomaly," meaning areas with high levels of crustal and upper-mantle melting and the resultant large volumes of volcanic rocks, flood basalts, etc. An alternate theory is being developed, with the rather unfortunate label of the "plate theory," which essentially attributes all melting to plate tectonic processes in the crust and upper mantle, dispensing with the plume model which assumes an origin in the lower mantle.

As described by the publisher, this book is intended as a review of both theories and the current state of the debate between the proponents on each side. The approach is to lay out the fundamentals of each theory in terms of the major geological features to be explained (e.g., Hawaii and other volcanic island/seamount chains, Iceland, continental flood basalts, and rift zones). The bulk of the book looks at several major categories of geological and geophysical evidence related to melting anomalies, and how well the two theories match the evidence.

The first of these is "vertical motions"; the plume model suggests that a substantial period of crustal uplift occurs well before rifting or any visible volcanic activity. The fundamental problem that arises here is that the methods to differentiate the models are indirect, the data incomplete and often unreliable, and the interpretations subject to a large degree of nonuniqueness. Estimating the amount of uplift that may have preceded a continental flood basalt event 65 million years ago is far from a simple task. (The same issues apply to most of the other categories as well.) In the following two chapters, the author takes a detailed look at the great variety of volcanic features associated with melting anomalies and the time progression of volcanic events, in part to attempt to define whether the events have a "fixed" location relative to the upper mantle. Next she examines the evidence from seismology; unfortunately, the lower mantle cannot be clearly mapped by this (or any other) method. Following from the original "hot spot" concept, the heat flow and temperature evidence are examined next. The final section on "evidence" concerns petrology and geochemistry, and what compositional information can tell us about the origin of igneous rocks (the fundamental question again is, are they from the lower mantle?). The final chapter is a "Synthesis" which sums up all the evidence to conclude that the "plate" model is correct.

While this is an impressive review of a large and complex subject, and will be an essential volume for anyone working in the field, I have some serious reservations about it. The primary problem is that while posing as a review, it clearly endorses one view (the "plate" model) over the other. The evidence as presented seems quite favorable to this view but, given the many ambiguities involved it's likely that an advocate for the plume model could produce an equally compelling book. The author's bias is clear throughout, but comes to the fore in the summary chapter, where she suggests that people still supporting the plume theory are dogmatic and are not even following the scientific method.

Lesser problems are related to the organization of the book. There is considerable overlap in the evidence related to the different categories, and thus the material often seems repetitious. It might have been more effective to present the arguments by location/type of melting anomaly, rather than by type of evidence. For example, have chapters on island chains, rift events, flood basalts, etc.; and summarize all of the evidence to conclude whether the plume or plate model is more appropriate. For me at least this would have made the conclusions more obvious, and would have reduced the repetition. It was also difficult at times to keep track of the many locations around the world cited as examples (names often appear without maps or reference to the first discussion).

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A Student's Guide to Geophysical Equations, W. Lowrie, ISBN 978-1-107-00584-6, Cambridge University Press, 2011, 281 pp., US $80 (hardback), $29.99 (paperback).

This text is a standalone study supplement; in other words, it can accompany many different textbooks. As stated in the preface, it is "a supplementary text to help students understand mathematical steps in deriving important equations in classical geophysics. It is not intended to be a primary textbook, nor is it intended to be an introduction to modern research in any of the topics it covers." To put the last phrase in a specific context: the material presented is but an initial step for the background required to study such texts as Aki and Richards' *Quantitative Seismology*.

The book is divided into eight chapters. The first chapter addresses familiarity with such mathematical concepts as coordinates, vector calculus theorems, spherical harmonics and Fourier transforms. As stated by the author, this chapter is to provide geophysicists whose background is Earth sciences, rather than physics, sufficient knowledge to examine the following chapters. It is a noble but difficult task for students lacking the required mathematical background. Perhaps such readers should view this chapter as an introduction to, and inspiration for, further study, not as a quick fix for their lacunar background because the material contained therein cannot provide mathematical understanding required for quantitative geophysics. For instance, there is no room to discuss curvilinear coordinates, which a reader is likely to find in many advanced treatises.

The next two chapters are titled "Gravitation" and "Gravity"—nomenclature that explains the contents of either chapter: gravitation is the attractive force existing between any two masses and gravity is the force between the Earth and other bodies that results from gravitation and the centrifugal force due to Earth's rotation. Perhaps naturally, these chapters are followed by "The tides" and "Earth's rotation." In the former chapter, the author explains the effects of gravitational forces due to the Sun and the Moon on the Earth's tides; notably, there is an examination of tidal friction resulting in Moon's orbit around the Earth being synchronous with its rotation. In the latter, he examines the same gravitational effects on rotation of the Earth. The last three chapters are "Earth's heat", "Geomagnetism" and "Foundations of seismology." In the final chapter, the author gives a brief introduction to the mathematical foundations of seismological concepts, such as stress and strain. Also, he derives equations of motion in an isotropic Hookean solid, and their decomposition into P- and S-waves. Neither anisotropy nor anelasticity are discussed.

At the end of each chapter are suggestions for "further reading" containing several well-chosen books. The reader might be encouraged to consider these lists as a beginning of further investigations.

A Student's Guide to Geophysical Equations contains two appendices: "Magnetic poles, the dipole field, and current loops" and "Maxwell's equations of electromagnetism", which supplement Chapter 7.

The book is concise (281 pages), yet it contains derivations of many geophysical equations that allow the reader to examine underlying physical assumptions and subsequent mathematical simplifications. As stated by Professor Lowrie, "Computer technology is an essential ingredient of progress (...) but a well-trained aspiring geophysicist must be able to do more than apply advanced software packages".

The usefulness of the book as a reference might be increased by a more complete index, which in the present edition covers fewer than four pages. An ebook, with a possibility of word searching, partially solves this inconvenience.

All in all, *A Student's Guide to Geophysical Equations* is a good introduction to books dealing with foundations of quantitative geophysics.

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