Book Review

A STUDENT'S GUIDE TO GEOPHYSICAL EQUATIONS by William Lowrie (2011) Cambridge University Press, U.K., 296 pp. Paperback (ISBN-13: 9780521183772) $29.99; Hardback (ISBN: 9781107005846) $80.00; E-formats available $24.00.

William Lowrie is Professor of Geophysics at ETH Zürich (currently Emeritus following his retirement after 30 years in that post), and is a very well-respected name in the field of geophysics (particularly palaeomagnetism). He has held senior posts at both the European Geosciences and American Geophysical Unions, and is a Fellow of the AGU and a member of the Academia Europaea.

A Student's Guide to Geophysical Equations is not Lowrie's first foray into book publishing; his *Fundamentals of Geophysics* (the second edition of which was published in 2007) is a well-regarded general introductory textbook to geophysics. Lowrie's stated aim for this latest textbook is that it should act as a supplemental work, filling in the gaps often left by other textbooks (including *Fundamentals of Geophysics*) in the derivations of the fundamental equations of geophysics. It is based on a set of his lecture notes produced for this purpose. He also notes the need in the age of sophisticated geophysical software for the continuation of a solid understanding of the theoretical basis (and limitations) of the underlying equations.

The book's 8 main chapters over 281 pages cover a range of subjects in geophysics. The first chapter provides an introduction to the mathematics required to understand the geophysical theory, which he later introduces. This ranges from coordinates and vectors to spherical harmonics and Fourier series. This chapter serves best as a handy reference for later chapters; a student for whom most of the contained mathematics is new would probably be advised to refer to a more extended work on the subject. The next two chapters cover "Gravitation" and "Gravity" (the distinction in the book approximately being that the latter is the application of the former specifically to the Earth). "Gravitation" covers the derivation of the equations describing gravitational acceleration and potential. "Gravity" explains the fundamentals underlying gravity measurements on the Earth, and the geoid. Following on from this, the large-scale motion of the solid Earth is covered in two chapters entitled "The Tides" and "Earth's Rotation". Topics addressed in these include, for example, lunar tidal potential and Chandler Wobble. Next up is "Earth's Heat", which starts with the basic laws of thermodynamics, covers the thermal properties of the core, and finishes with example derivations of solar heat penetration and lithosphere cooling. Geomagnetism—the subject closest to the author's heart—forms the penultimate chapter. This includes the derivations of the equations describing properties of the Earth's magnetic field, and the equations governing its cause: the geodynamo. Related to this chapter are the book's two appendices, which detail the derivation of the laws governing magnetic and electromagnetic phenomena. The final chapter is entitled the "Foundations of Seismology". As the author himself notes in the preface, theoretical seismology is a large topic, and there are several well-regarded textbooks that cover this subject in much greater detail (for example, *Introduction to Seismology*, by Shearer; and *Quantitative Seismology* by Aki and Richards). Thus, Prof. Lowrie restricts himself to presenting the derivation of elastodynamics and the seismic wave equation, and its P- and S-wave solutions in homogeneous, isotropic media. Since these subjects are covered more fully in other textbooks this chapter serves better as supplemental material to a general geophysics textbook than an introduction to a seismology textbook proper.

Throughout the book the focus is on the derivation of the fundamental equations of geophysics, covering this in detail, including noting assumptions made and mathematical techniques applied. It does not cover advanced subject matter in the subjects tackled, instead ending each chapter with a short, well-thought-out list of further reading (generally more specialized textbooks). It also largely avoids much discussion of the application of the subjects it covers, sticking to being an introduction to the theory rather than the practice of geophysics. This is an advantage; it allows the book to remain concise and avoid reproducing material better gleaned from other sources.

In terms of writing style, the book indeed reads (presumably as intended) very much like a companion work: it is easier to dip into than to read cover to cover. Thus, the chapters (and indeed the sections within them) stand fairly independently from each other. The text is clear and certainly no-nonsense, arguably bordering on a little terse in places, but this means that the main content of the book—the eponymous geophysical equations—are not obscured. Here, the author has put considerable effort into making sure that derivations are clearly described, filling in the detailed mathematics that a primary textbook is forced to omit. Figures are small, simple, and clear, and largely devoted to illustrating dimensions or coordinate systems relating to the equations under discussion.

Overall, *A Student's Guide to Geophysical Equations* succeeds as a supplemental work to either a more general introductory textbook (most naturally Lowrie's own *Fundamentals of Geophysics*, which maintains continuity in mathematical notation) or as an introduction to several more advanced, subject-specific works. As such, it is a worthy addition to the shelf (or eBook reader) of serious students of geophysics, or indeed faculty preparing lecture courses on related subjects.

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