

## Fundamentals of Geophysics Second Edition

This second edition of *Fundamentals of Geophysics* has been completely revised and updated, and is the ideal geophysics textbook for undergraduate students of geoscience with only an introductory level of knowledge in physics and mathematics.

Presenting a comprehensive overview of the fundamental principles of each major branch of geophysics (gravity, seismology, geochronology, thermodynamics, geoelectricity, and geomagnetism), this text also considers geophysics within the wider context of plate tectonics, geodynamics, and planetary science. Basic principles are explained with the aid of numerous figures, and important geophysical results are illustrated with examples from scientific literature. Step-by-step mathematical treatments are given where necessary, allowing students to easily follow the derivations. Text boxes highlight topics of interest for more advanced students.

Each chapter contains a short historical summary and ends with a reading list that directs students to a range of simpler, alternative, or more advanced, resources. This new edition also includes review questions to help evaluate the reader's understanding of the topics covered, and quantitative exercises at the end of each chapter. Solutions to the exercises are available to instructors.

WILLIAM LOWRIE is Professor Emeritus of Geophysics at the Institute of Geophysics at the Swiss Federal Institute of Technology (ETH), Zürich, where he has taught and carried out research for over 30 years. His research interests include rock magnetism, magnetostratigraphy, and tectonic applications of paleomagnetic methods.

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# Fundamentals of Geophysics

Second Edition

WILLIAM LOWRIE  
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## Preface to the second edition

In the ten years that have passed since the publication of the first edition of this textbook exciting advances have taken place in every discipline of geophysics. Computer-based improvements in technology have led the way, allowing more sophistication in the acquisition and processing of geophysical data. Advances in mass spectrometry have made it possible to analyze minute samples of matter in exquisite detail and have contributed to an improved understanding of the origin of our planet and the evolution of the solar system. Space research has led to better knowledge of the other planets in the solar system, and has revealed distant objects in orbit around the Sun. As a result, the definition of a planet has been changed. Satellite-based technology has provided more refined measurement of the gravity and magnetic fields of the Earth, and has enabled direct observation from space of minute surface changes related to volcanic and tectonic events. The structure, composition and dynamic behavior of the deep interior of the Earth have become better understood owing to refinements in seismic tomography. Fast computers and sophisticated algorithms have allowed scientists to construct plausible models of slow geodynamic behavior in the Earth's mantle and core, and to elucidate the processes giving rise to the Earth's magnetic field. The application of advanced computer analysis in high-resolution seismic reflection and ground-penetrating radar investigations has made it possible to describe subtle features of environmental interest in near-surface structures. Rock magnetic techniques applied to sediments have helped us to understand slow natural processes as well as more rapid anthropological changes that affect our environment, and to evaluate climates in the distant geological past. Climatic history in the more recent past can now be deduced from the analysis of temperature in boreholes.

Although the many advances in geophysical research depend strongly on the aid of computer science, the fundamental principles of geophysical methods remain the same; they constitute the foundation on which progress is based. In revising this textbook, I have heeded the advice of teachers who have used it and who recommended that I change as little as possible and only as much as necessary (to paraphrase medical advice on the use of medication). The reviews of the first edition, the feedback from numerous students and teachers, and the advice of friends and colleagues helped me greatly in deciding what to do.

The structure of the book has been changed slightly compared to the first edition. The final chapter on geodynamics has been removed and its contents integrated into the earlier chapters, where they fit better. Text-boxes have been introduced to handle material that merited further explanation, or more extensive treatment than seemed appropriate for the body of the text. Two appendices have been added to handle more adequately the three-dimensional wave equation and the cooling of a half-space, respectively. At the end of each chapter is a list of review questions that should help students to evaluate their knowledge of what they have read. Each chapter is also accompanied by a set of exercises. They are intended to provide practice in handling some of the numerical aspects of the topics discussed

in the chapter. They should help the student to become more familiar with geophysical techniques and to develop a better understanding of the fundamental principles.

The first edition was mostly free of errata, in large measure because of the patient, accurate and meticulous proofreading by my wife Marcia, whom I sincerely thank. Some mistakes still occurred, mostly in the more than 350 equations, and were spotted and communicated to me by colleagues and students in time to be corrected in the second printing of the first edition. Regarding the students, this did not improve (or harm) their grades, but I was impressed and pleased that they were reading the book so carefully. Among the colleagues, I especially thank Bob Carmichael for painstakingly listing many corrections and Ray Brown for posing important questions. Constructive criticisms and useful suggestions for additions and changes to the individual revised chapters in this edition were made by Mark Bukowski, Clark Wilson, Doug Christensen, Jim Dewey, Henry Pollack, Ladislaus Rybach, Chris Heinrich, Hans-Ruedi Maurer and Mike Fuller. I am very grateful to these colleagues for the time they expended and their unselfish efforts to help me. If errors persist in this edition, it is not their fault but due to my negligence.

The publisher of this textbook, Cambridge University Press, is a not-for-profit charitable institution. One of their activities is to promote academic literature in the “third world.” With my agreement, they decided to publish a separate low-cost version of the first edition, for sale only in developing countries. This version accounted for about one-third of the sales of the first edition. As a result, earth science students in developing countries could be helped in their studies of geophysics; several sent me appreciative messages, which I treasure.

The bulk of this edition has been written following my retirement two years ago, after 30 years as professor of geophysics at ETH Zürich. My new emeritus status should have provided lots of time for the project, but somehow it took longer than I expected. My wife Marcia exhibited her usual forbearance and understanding for my obsession. I thank her for her support, encouragement and practical suggestions, which have been as important for this as for the first edition. This edition is dedicated to her, as well as to my late parents.

William Lowrie  
*Zürich*  
*August, 2006*

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