Introduction to Seismology

Third Edition

The Third Edition provides a concise yet approachable introduction to seismic theory, designed as a first course for graduate students or advanced undergraduate students. It clearly explains the fundamental concepts, emphasizing intuitive understanding over lengthy derivations, and outlines the different types of seismic waves and how they can be used to resolve Earth structure and understand earthquakes.

New material and updates have been added throughout, including ambient noise methods, shear-wave splitting, back-projection, migration and velocity analysis in reflection seismology, earthquake rupture directivity, and fault weakening mechanisms. A wealth of both reworked and new examples, review questions and computer-based exercises in MATLAB/Python gives students the opportunity to apply the techniques they have learned to compute results of interest and to illustrate Earth's seismic properties. More advanced sections, which are not needed to understand the other material, are flagged so that instructors or students pressed for time can skip them.

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Peter M. Shearer
University of California, San Diego

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Preface

Since the first edition of *Introduction to Seismology* appeared in 1999, there have been many advances in the field, and a number of other seismology texts have been published. However, there remains a need for a readable, concise introduction to the quantitative aspects of seismology that is designed specifically for classroom instruction, and I hope my book continues to fill this niche.

Over the last 10 years, I have continued teaching the beginning seismology class at University of California, San Diego and have received feedback from my students, as well as other instructors who have been using the book. The third edition is my attempt to expand on some subjects, clarify parts of the book that have proven confusing, and update the discussion of current research results. Major changes and additions from the second edition include the following:

- section describing waveform cross-correlation of ambient noise
- expanded discussion of seismic migration, including its relation to back-projection and adjoint inversion
- reworked and expanded anisotropy section, including shear-wave splitting analysis methods
- updates to the source chapter, including greater discussion of directivity and fault weakening mechanisms
- more worked examples throughout the text
- computer code examples now in Python rather than Fortran

To quicken the pace, many results are described without detailed proofs or derivations of equations. In these cases, the reader is usually referred to other sources for more complete explanations. Generally, I have attempted to provide practical descriptions of the main concepts and how they are used to study Earth structure. Some knowledge of physics and vector calculus is assumed, but in an effort to make the book self-contained, most of the key concepts are reviewed in the appendices. Although some current research results are presented, I have concentrated more on fundamental principles and key data sets in an effort to avoid rapid obsolescence after this book goes to press.

The emphasis in the student exercises is not on deriving equations (which few seismologists spend much time doing anyway) but on using techniques explained in the text to compute results of interest and to illustrate some of Earth's seismic properties. Since computer programming skills are often a necessity for performing seismology research, I have included a number of computer-based assignments. These are designed to give a taste of real research problems, while requiring only a moderate level of programming ability. Subroutines to assist in the exercises are listed in Appendix D.

As in the second edition, sections flagged with a † are suggestions for possible areas to skip without much compromise in understanding of the remaining subjects. Supplemental web material and computer code examples continue to be available at www.cambridge.org/Shearer3e, which also contains a link to a website with a list of known typos and other errors.

Acknowledgments

This book began as a series of lecture notes that I developed while teaching the beginning seismology class to first-year graduate students in geophysics at U.C. San Diego. Some of the material in Chapters 4–5 and the section on the eikonal equation is derived from notes that John Orcutt wrote for a similar class. The stacked images in Chapter 4 were produced in collaboration with Janine Buehler. I am grateful to Steve Day, Dick Hilt, Youshun Sun, and Ruedi Widmer-Schnidrig for alerting me to some mistakes in the first edition; to Heidi Houston, Cliff Thurber, Bob Nowack, and Arthur Snoke for their suggestions for the second edition; to Emily Brodsky, Heidi Houston, Heiner Igel, and John Vidale for their comments on drafts of the second edition; and to Ian Bastow, Robin Matoza, and Daniel Trugman for their suggestions and comments for the third edition.

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