

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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Episodes

Introduction to Seismology

THIRD EDITION

Peter M. Shearer

University of California, San Diego



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Brief Contents

Preface	<i>page</i> xv
Acknowledgments	xvii
1 Introduction	1
1.1 A Brief History of Seismology	2
1.2 Exercises	16
2 Stress and Strain	19
2.1 The Stress Tensor	19
2.2 The Strain Tensor	26
2.3 The Linear Stress–Strain Relationship	30
2.4 Exercises	33
3 The Seismic Wave Equation	39
3.1 Introduction: The Wave Equation	39
3.2 The Momentum Equation	40
3.3 The Seismic Wave Equation	42
3.4 Plane Waves	45
3.5 Polarizations of <i>P</i> - and <i>S</i> -Waves	47
3.6 Spherical Waves	50
3.7 Methods for Computing Synthetic Seismograms [†]	50
3.8 Exercises	60
4 Ray Theory: Travel Times	63
4.1 Snell’s Law	63
4.2 Ray Paths for Laterally Homogeneous Models	65
4.3 Travel Time Curves and Delay Times	69
4.4 Summary of 1-D Ray Tracing Equations	75
4.5 Spherical Earth Ray Tracing	77
4.6 Three-Dimensional Ray Tracing [†]	80
4.7 Ray Nomenclature	82
4.8 Global Body Wave Observations	85
4.9 Exercises	94
5 Inversion of Travel Time Data	99
5.1 One-Dimensional Velocity Inversion Theory	99

vi	Brief Contents	
	5.2 Straight-Line Fitting	101
	5.3 $\tau(p)$ Inversion	104
	5.4 Summary: One-Dimensional Velocity Inversion	110
	5.5 Three-Dimensional Velocity Inversion	111
	5.6 Earthquake Location	122
	5.7 Exercises	131
6	Ray Theory: Amplitude and Phase	137
	6.1 Energy in Seismic Waves	137
	6.2 Geometrical Spreading in 1-D Velocity Models	140
	6.3 Reflection and Transmission Coefficients	142
	6.4 Turning Points and Hilbert Transforms	153
	6.5 Propagator Matrix Methods for Modeling Plane Waves [†]	155
	6.6 Attenuation	160
	6.7 Exercises	172
7	Reflection Seismology and Related Topics	175
	7.1 Background	175
	7.2 Zero-Offset Sections	176
	7.3 Common Midpoint Stacking	178
	7.4 Sources and Deconvolution	182
	7.5 Migration	185
	7.6 Velocity Analysis	192
	7.7 Back-projection	197
	7.8 Receiver Functions	200
	7.9 The Language of Reflection Seismology	205
	7.10 Exercises	205
8	Surface Waves and Normal Modes	209
	8.1 Love Waves	209
	8.2 Rayleigh Waves	213
	8.3 Dispersion	218
	8.4 Global Surface Waves	219
	8.5 Observing Surface Waves	222
	8.6 Normal Modes	226
	8.7 Exercises	232
9	Earthquakes and Source Theory	237
	9.1 Green's Functions and the Moment Tensor	237
	9.2 Earthquake Faults	241
	9.3 Radiation Patterns and Beach Balls	246

9.4 Far-Field Pulse Shapes	255
9.5 Stress Drop	264
9.6 Radiated Seismic Energy	270
9.7 Earthquake Magnitude	276
9.8 Finite Slip Modeling	287
9.9 The Heat Flow Paradox	290
9.10 Exercises	293
10 Earthquake Prediction	299
10.1 The Earthquake Cycle	299
10.2 Earthquake Triggering	306
10.3 Searching for Precursors	311
10.4 Are Earthquakes Unpredictable?	313
10.5 Exercises	314
11 Seismometers and Seismographs	319
11.1 Seismometer as Damped Harmonic Oscillator	319
11.2 Short-Period and Long-Period Seismograms	324
11.3 Modern Seismographs	326
11.4 Exercises	329
12 Earth Noise	331
12.1 Earth's Background Noise	331
12.2 Cross-Correlation Analysis of Ambient Noise	333
12.3 Exercises	338
13 Anisotropy	341
13.1 Rays and Wavefronts for Anisotropy	341
13.2 Eigenvalue Equation for Anisotropic Media	342
13.3 Weak Anisotropy	346
13.4 Hexagonal Anisotropy	347
13.5 Shear-Wave Splitting	349
13.6 Mechanisms for Anisotropy	358
13.7 Earth's Anisotropy	361
13.8 Exercises	363
Appendix A The PREM Model	365
Appendix B Math Review	369
Appendix C The Eikonal Equation	377

viii	Brief Contents	
	Appendix D Python Functions	381
	Appendix E Time Series and Fourier Transforms	387
	Appendix F Kirchhoff Theory	393
	Bibliography	403
	Index	419

Contents

Preface	<i>page</i> xv
Acknowledgments	xvii
1 Introduction	1
1.1 A Brief History of Seismology	2
1.1.1 Recent Advances	14
1.2 Exercises	16
2 Stress and Strain	19
2.1 The Stress Tensor	19
2.1.1 Example: Computing the Traction Vector	21
2.1.2 Principal Axes of Stress	22
2.1.3 Example: Computing the Principal Axes	23
2.1.4 Deviatoric Stress	24
2.1.5 Values for Stress	25
2.2 The Strain Tensor	26
2.2.1 Values for Strain	29
2.2.2 Example: Computing Strain for a Seismic Wave	29
2.3 The Linear Stress–Strain Relationship	30
2.3.1 Units for Elastic Moduli	33
2.4 Exercises	33
3 The Seismic Wave Equation	39
3.1 Introduction: The Wave Equation	39
3.2 The Momentum Equation	40
3.3 The Seismic Wave Equation	42
3.3.1 Potentials	45
3.4 Plane Waves	45
3.4.1 Example: Harmonic Plane Wave Equation	46
3.5 Polarizations of <i>P</i> - and <i>S</i> -Waves	47
3.6 Spherical Waves	50
3.7 Methods for Computing Synthetic Seismograms [†]	50
3.7.1 Discrete Modeling Methods [†]	53
3.7.2 Equations for 2-D Isotropic Finite Differences [†]	56
3.8 Exercises	60

4	Ray Theory: Travel Times	63
4.1	Snell's Law	63
4.2	Ray Paths for Laterally Homogeneous Models	65
4.2.1	Example: Computing $X(p)$ and $T(p)$	68
4.2.2	Ray Tracing through Velocity Gradients	68
4.3	Travel Time Curves and Delay Times	69
4.3.1	Reduced Velocity	70
4.3.2	The $\tau(p)$ Function	70
4.3.3	Example: Computing $\tau(p)$	73
4.3.4	Low-Velocity Zones	73
4.4	Summary of 1-D Ray Tracing Equations	75
4.5	Spherical Earth Ray Tracing	77
4.5.1	The Earth-Flattening Transformation	78
4.6	Three-Dimensional Ray Tracing [†]	80
4.7	Ray Nomenclature	82
4.7.1	Crustal Phases	82
4.7.2	Whole Earth Phases	83
4.7.3	<i>PKJKP</i> : The Holy Grail of Body Wave Seismology	85
4.8	Global Body Wave Observations	85
4.8.1	Uses of Global Body-Wave Phases	90
4.9	Exercises	94
5	Inversion of Travel Time Data	99
5.1	One-Dimensional Velocity Inversion Theory	99
5.2	Straight-Line Fitting	101
5.2.1	Example: Solving for a Layer Cake Model	102
5.2.2	Other Ways to Fit the $T(X)$ Curve	103
5.3	$\tau(p)$ Inversion	104
5.3.1	Example: The Layer Cake Model Revisited	106
5.3.2	Resolving $\tau(p)$ and the Slant-Stack Method	106
5.3.3	Linear Programming and Regularization Methods	109
5.4	Summary: One-Dimensional Velocity Inversion	110
5.5	Three-Dimensional Velocity Inversion	111
5.5.1	Setting Up the Tomography Problem	112
5.5.2	Example: Toy Tomography Problem	116
5.5.3	Solving the Tomography Problem	117
5.5.4	Tomography Complications	119
5.5.5	Finite Frequency Tomography and Full Waveform Inversion	121
5.6	Earthquake Location	122
5.6.1	Iterative Location Methods	128

	Contents	xi
5.6.2	Relative Event Location Methods	128
5.7	Exercises	131
6	Ray Theory: Amplitude and Phase	137
6.1	Energy in Seismic Waves	137
6.2	Geometrical Spreading in 1-D Velocity Models	140
6.3	Reflection and Transmission Coefficients	142
6.3.1	<i>SH</i> -Wave Reflection and Transmission Coefficients	143
6.3.2	Example: Computing <i>SH</i> Coefficients	146
6.3.3	Vertical Incidence Coefficients	146
6.3.4	Energy-Normalized Coefficients	147
6.3.5	Dependence on Ray Angle	149
6.4	Turning Points and Hilbert Transforms	153
6.5	Propagator Matrix Methods for Modeling Plane Waves [†]	155
6.6	Attenuation	160
6.6.1	Example: Computing Intrinsic Attenuation	161
6.6.2	t^* and Velocity Dispersion	161
6.6.3	The Absorption Band Model [†]	164
6.6.4	The Standard Linear Solid [†]	166
6.6.5	Earth's Attenuation	168
6.6.6	Observing Q	170
6.6.7	Nonlinear Attenuation	171
6.6.8	Seismic Attenuation and Global Politics	172
6.7	Exercises	172
7	Reflection Seismology and Related Topics	175
7.1	Background	175
7.2	Zero-Offset Sections	176
7.3	Common Midpoint Stacking	178
7.3.1	Example: Computing Normal Moveout	180
7.4	Sources and Deconvolution	182
7.5	Migration	185
7.5.1	Huygens's Principle	186
7.5.2	Diffraction Hyperbolas	186
7.5.3	Example: Computing Diffraction Hyperbolas	188
7.5.4	Migration Methods	188
7.6	Velocity Analysis	192
7.6.1	Example: Estimating Layer Velocity and Thickness	195

7.6.2	Statics Corrections	196
7.7	Back-projection	197
7.7.1	The Adjoint Operator as an Inversion Method [†]	199
7.8	Receiver Functions	200
7.9	The Language of Reflection Seismology	205
7.10	Exercises	205
8	Surface Waves and Normal Modes	209
8.1	Love Waves	209
8.1.1	Solution for a Single Layer	212
8.1.2	Example: Computing Love Wave Dispersion	213
8.2	Rayleigh Waves	213
8.3	Dispersion	218
8.4	Global Surface Waves	219
8.5	Observing Surface Waves	222
8.5.1	Example: Measuring Group and Phase Velocity	223
8.6	Normal Modes	226
8.7	Exercises	232
9	Earthquakes and Source Theory	237
9.1	Green's Functions and the Moment Tensor	237
9.2	Earthquake Faults	241
9.2.1	Non-Double-Couple Sources	244
9.3	Radiation Patterns and Beach Balls	246
9.3.1	Example: Plotting a Focal Mechanism	253
9.4	Far-Field Pulse Shapes	255
9.4.1	Directivity	257
9.4.2	Example: 2004 Sumatra Earthquake Directivity	259
9.4.3	Source Spectra	260
9.4.4	Empirical Green's Functions	263
9.5	Stress Drop	264
9.5.1	Example: Estimating Stress Drop	267
9.5.2	Self-Similar Earthquake Scaling	268
9.6	Radiated Seismic Energy	270
9.6.1	Earthquake Energy Partitioning [†]	273
9.7	Earthquake Magnitude	276
9.7.1	The b -Value	282
9.7.2	Example: Use of b -Value	284
9.7.3	The Intensity Scale	285
9.8	Finite Slip Modeling	287
9.9	The Heat Flow Paradox	290

	Contents	xiii
9.9.1 Why Are Faults Weak?	292	
9.10 Exercises	293	
10 Earthquake Prediction	299	
10.1 The Earthquake Cycle	299	
10.2 Earthquake Triggering	306	
10.3 Searching for Precursors	311	
10.4 Are Earthquakes Unpredictable?	313	
10.5 Exercises	314	
11 Seismometers and Seismographs	319	
11.1 Seismometer as Damped Harmonic Oscillator	319	
11.2 Short-Period and Long-Period Seismograms	324	
11.3 Modern Seismographs	326	
11.4 Exercises	329	
12 Earth Noise	331	
12.1 Earth's Background Noise	331	
12.2 Cross-Correlation Analysis of Ambient Noise	333	
12.3 Exercises	338	
13 Anisotropy	341	
13.1 Rays and Wavefronts for Anisotropy	341	
13.2 Eigenvalue Equation for Anisotropic Media	342	
13.2.1 Slowness Surfaces	344	
13.2.2 Snell's Law at an Interface	345	
13.3 Weak Anisotropy	346	
13.4 Hexagonal Anisotropy	347	
13.5 Shear-Wave Splitting	349	
13.5.1 Linear Polarization Analysis	350	
13.5.2 Estimating Shear-Wave Splitting Parameters	351	
13.5.3 Example: Shear-Wave Splitting Observed at RSON	353	
13.5.4 SKS Splitting	354	
13.5.5 Example: SKS Splitting Analysis for RSON	356	
13.5.6 Shear-Wave Splitting Observations	356	
13.6 Mechanisms for Anisotropy	358	
13.7 Earth's Anisotropy	361	
13.8 Exercises	363	

Appendix A	The PREM Model	365
Appendix B	Math Review	369
	B.1 Vector Calculus	369
	B.2 Complex Numbers	373
Appendix C	The Eikonal Equation	377
Appendix D	Python Functions	381
Appendix E	Time Series and Fourier Transforms	387
	E.1 Convolution	387
	E.2 Fourier Transform	388
	E.3 Hilbert Transform	389
Appendix F	Kirchhoff Theory	393
	F.1 Kirchhoff Applications	398
	F.2 How to Write a Kirchhoff Program	399
	F.3 Kirchhoff Migration	400
	Bibliography	403
	Index	419

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-Schmidrig 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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