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978-0-521-19910-0 - Practical Seismic Data Analysis
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Practical Seismic Data Analysis

This modern introduction to seismic data processing in both exploration and global geophysics demonstrates practical applications through real data and tutorial examples. The underlying physics and mathematics of the various seismic analysis methods are presented, giving students an appreciation of their limitations and potential for creating models of the subsurface. Designed for a one-semester course, this textbook discusses key techniques within the context of the world's ever-increasing need for petroleum and mineral resources – equipping upper undergraduate and graduate students with the tools they need for a career in industry.

Key features

- Examples throughout the texts allow students to compare different data analysis methods and can be demonstrated using the instructor's software of choice.
- Exercises at the end of sections allow the students to check their understanding and put the theory into practice.
- Further reading lists encourage exploration of more advanced and detailed literature relating to topics covered in the book.

Hua-Wei Zhou is Professor and Robert Sheriff Endowed Chair of Applied Seismology at the University of Houston, and has held the position of "Lv-Ka" Scholar at Ocean University of China in Qingdao since 2010. He is one of the few experts in seismic imaging to have done extensive research in both exploration geophysics and solid Earth geophysics, having worked for Exxon Production Research Company as well as having 20 years' academic teaching experience. He has taught the materials for this book in graduate classes as well as in industry short courses, given in the USA, South Africa, and China.

"This book is a valuable reference for senior undergraduates and graduates in exploration geophysics and seismology. It covers all the common methods and steps of seismic data processing, using clearly presented mathematics. In particular, helpful Boxes in the text enable readers to better understand both basic and crucial information, supported well by the Exercises and Further Reading lists also provided."
– Jingyi Chen, *Decker Dawson Assistant Professor of Geophysics, University of Tulsa*

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PREFACE

Seismic data analysis transfers seismic records measured at the surface or along wellbores into imagery, estimates, and models of subsurface structures and properties. It covers the topics of digital seismic data processing, seismic migration, and subsurface model building that are useful in both exploration geophysics and solid Earth geophysics. Although several excellent books have covered these topics either from the viewpoint of exploration geophysics or that of solid Earth geophysics, I was motivated to write this book to deal with common seismic analysis methods for both aspects of geophysics. This book is intended as an introductory text on common and practical methods in seismic data analysis.

Most of the materials for this book originated as lecture notes for graduate courses in geophysics at University of Houston and Texas Tech University. Students on these courses usually have a variety of backgrounds: many are recent graduates from geophysics, geology, engineering, computer sciences, or other physical science disciplines, and others are employees in the petroleum industry. They intend to apply seismic data analysis skills to problems in exploration geophysics, solid Earth geophysics, and engineering and environmental sciences. Although they may have access to some commercial or free software in seismic processing, most of these students have not gone through a systematic review of common approaches to seismic data analysis and the practical limitations of each method. Hence, an effort has been made in this book to emphasize the concepts and practicality of common seismic analysis methods using tutorial and case examples or schematic plots.

The first six chapters of the book prepare the background and deal mostly with time processing. Chapter 1 introduces seismic data and issues of sampling, amplitude, and phase. Chapter 2 addresses pre-processing of reflection seismic data using examples on normal moveout (NMO) analysis, noise suppression, and near-surface statics. The topics of discrete Fourier transform and wavelet transfer are both discussed in Chapter 3 in terms of the law of decomposition and superposition. Chapter 4 is devoted to the meaning and assessment of seismic resolution and fidelity. Chapter 5 discusses filtering of time series using z-transform and Fourier transform methods. Chapter 6 covers several common deconvolution methods.

Each of the final four chapters may be studied independently: Chapters 7 to 9 are on three main branches of seismic data analysis, and Chapter 10 covers several special topics. Chapter 7 introduces several seismic migration methods that have served as the main subsurface seismic imaging tools in exploration geophysics. Chapter 8 is on seismic velocity analysis using semblance, migration, and tomography. Chapter 9 discusses the basic issues and relationship between seismic modeling and inversion. Chapter 10 addresses processing issues in topics of seismic data acquisition, suppressing of multiple reflections, seismic velocity anisotropy, multi-component seismic data, and seismic attributes.

Each chapter starts with an overview paragraph describing the sections to follow. Terms defined are indicated by bold font. For students, it is especially important to comprehend the meaning of common terms and concepts in the field because this often reflects the depth of their understanding. A large number of figures are given that illustrate concepts or

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applications. Several boxes are provided in each chapter to examine specific case studies or ideas. There is an exercise at the end of each main section. Each chapter ends with a summary of key concepts, and a list of further reading. All serious learners should read several technical papers from the suggested reading lists, to draw connections between the issues covered by the chapter and the reference papers.

The mathematical content has been kept to a minimum, although I assume that readers are comfortable with basic calculus and linear algebra including matrices. Most parts of the book should be readable by those with an undergraduate degree in physical science or engineering. Readers without much mathematical training should focus on the main concepts and physical meanings.

This book could not have been completed without the encouragement of Dr. Robert E. Sheriff, my colleague and mentor. I would like to thank my fellow geophysicists for granting permission to reproduce figures from their publications. I acknowledge the assistance of many people in the preparation of this book, especially those students who provided feedback. I particularly thank Kurt Marfurt, Oong Youn, Mike Thornton, Zhihui Zou, Fang Yuan, and Wendy Zhang. This book is dedicated to my parents.

Hua-Wei Zhou

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