Handbook of Poststack Seismic Attributes

Arthur E. Barnes

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Elizabeth Lorenzetti Harvey, volume editor
Rebecca Latimer, managing editor
Dedication

To Irene
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About the Author

Arthur E. Barnes received a BS (1974) in physics from Denison University, an MS (1980) in geophysics from the University of Arizona, and a PhD (1990) in geophysics from Cornell University. His experience includes seismic data acquisition and processing, software development, software pre-sales, and research. His employers have included Western Geophysical, Conoco, Ecole Polytechnique de Montreal, Landmark (Halliburton), Paradigm, and PETRONAS Research. He has applied and developed seismic attributes throughout his career. Currently a consultant in seismic software development and services, his professional interests include seismic attributes, interpretive processing, and seismic pattern recognition. He is a member of SEG, EAGE, and AAPG.
Preface

The Handbook of Poststack Seismic Attributes is a general reference for poststack seismic attributes intended for reflection seismologists in petroleum exploration. The goal of the book is to bring greater understanding and order to the important and rapidly evolving science of seismic attributes, so that geophysicists can apply attributes more effectively to interpret seismic data. To this end, I emphasize what all attributes have in common, what they mean, and what they measure, arguing that the meaning of an attribute should guide both its implementation and its application. I freely judge certain attributes to be useful and others to be useless, and I consider the advantages as well as the shortcomings of attribute analysis. I provide sufficient mathematics to implement the attributes, favoring clarity and simplicity over mathematical rigor. In the manner of a handbook, I cover methods and ideas that are more likely to be encountered in practice, but I make no pretense of being comprehensive. Indeed, ponderous books can be written on topics that are treated here only cursorily, such as spectral decomposition and seismic pattern recognition.

I begin the book by introducing the fundamental ideas that underlie all seismic attribute analysis and reviewing the history of seismic attributes from their origins to current developments. I describe the characteristics of key and familiar poststack attributes, starting with attribute maps and interval statistics, and progressing through to complex trace attributes, 3D attributes that quantify aspects of geologic structure and stratigraphy, seismic discontinuity attributes, spectral decomposition, thin-bed analysis, waveform classification, recursive inversion for relative acoustic impedance, and spectral ratioing for Q estimation. I discuss how attributes are usefully combined through multiattribute analysis through volume blending, cross-plotting, principal component analysis, and unsupervised classification. I end the book with a brief overview of how seismic attributes aid data interpretation, with a look at bright spots, frequency shadows, faults, channels, diapirs, and data reconnaissance. A glossary provides definitions of seismic attributes and methods, and appendices provide necessary background mathematics.

It is my sincere hope that this book instills a greater appreciation for seismic attributes, moderated by a clearer awareness of their limitations.
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Acknowledgments

This book is a product of several decades spent studying seismic attributes. I thank the many colleagues who have influenced my thinking, particularly Larry Fink, Kenny Laughlin, Boshara Arshin, and the late Turhan Taner. I am sincerely grateful to Nigel Anstey for a long and lively letter detailing his early development of seismic attributes, as well as for copies of his famous but rare reports on attributes from 1972 and 1973. I especially thank Tracy Stark and Jeffrey Thurston for many stimulating discussions and for openly sharing ideas and insights.

I acknowledge Crown Minerals and the New Zealand Ministry of Economic Development for permission to show images of their data from the Taranaki Basin, offshore New Zealand, from which most of the data examples are taken.

I warmly thank the editors who have devoted many hours in helping put this book together, namely Rebecca Latimer, Elizabeth Lorenzetti Harvey, Sergey Fomel, Marilyn Perlberg, and Susan Stamm. Their valuable suggestions and many corrections have improved the book significantly. However, errors and shortcomings are inevitable, and I encourage interested readers to point them out and to offer their comments.

Finally, I thank my wife, Irene, for her constant support and encouragement over the many years during which this book gradually took form.