Seismic Imaging and Inversion: Application of Linear Inverse Theory, by R. H. Stolt and A. B. Weglein, ISBN 978-1-107-01490-9, Cambridge University Press, 2012, 404 pp., US $125.

This book, the first of a proposed two-volume series, presents the basic concepts and relationships between wave-equation migration and inversion technologies. Migration or seismic imaging techniques are concerned with the determination and restoration of the proper geometric locations of reflections caused by spatial variations in rock properties. Inversion methods quantify the magnitude and sign changes of those same rock properties from seismic data. Migration and inversion technologies play a central role in exploration geophysics as both are required to accurately determine the location and quantity of hydrocarbons in the subsurface. The prevailing view of imaging and inversion technologies is that they are separate and unrelated. A key contribution of this new volume is to demonstrate the relationship that exists between the two through inverse scattering theory.

In this first volume, the focus is on migration algorithms that map recorded seismic data into seismic images and inversion methodologies that transfer the seismic images into rock properties. The physics of seismic imaging and inversion requires complex and largely nonlinear equations to describe the dynamics of the processes. Linearization of these equations into simpler forms is routinely performed to implement solutions as computer processing modules. The primary motivation for linearization is driven by practical constraints of computer speed and memory. The inevitable, negative consequence of linearization is a reduction in accuracy of the computer processing results. Today, most leading-edge seismic processing algorithms incorporate some degree of linearity in their implementations. The second volume of this series will move forward into the more complex nonlinear methods that will overcome the current limitations of processing software.

Volume 1 begins with an overview of modeling, migration, imaging and inversion, and the interrelationships between these technologies. This sets the foundation for subsequent chapters discussing linear inverse scattering theory that puts seismic imaging and inversion on a single, equal footing. This development allows the merging of the two fields because each is now based on a common inverse scattering theory.

The authors introduce the concept of scattering potential from which the seismic reflectivity function can be derived. Viewing the scattering potential as the generator of seismic reflection data allows imaging of surfaces and diffractors without the need for interpreter intervention or separate imaging methods/models.

Each chapter in the book ends with a set of exercises for the reader that challenges them to apply the concepts covered in that chapter to a practical problem. This makes the volume suitable for use as a textbook for a graduate-level geophysics course. The authors of this series, each having large and long-term bodies of creative research in these technologies, are well known and respected by the worldwide geophysics community. I believe this series represents an important contribution to geophysical literature. The novel methods and conceptualization of seismic imaging and inversion methodologies will significantly impact research and development in our industry for decades.

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