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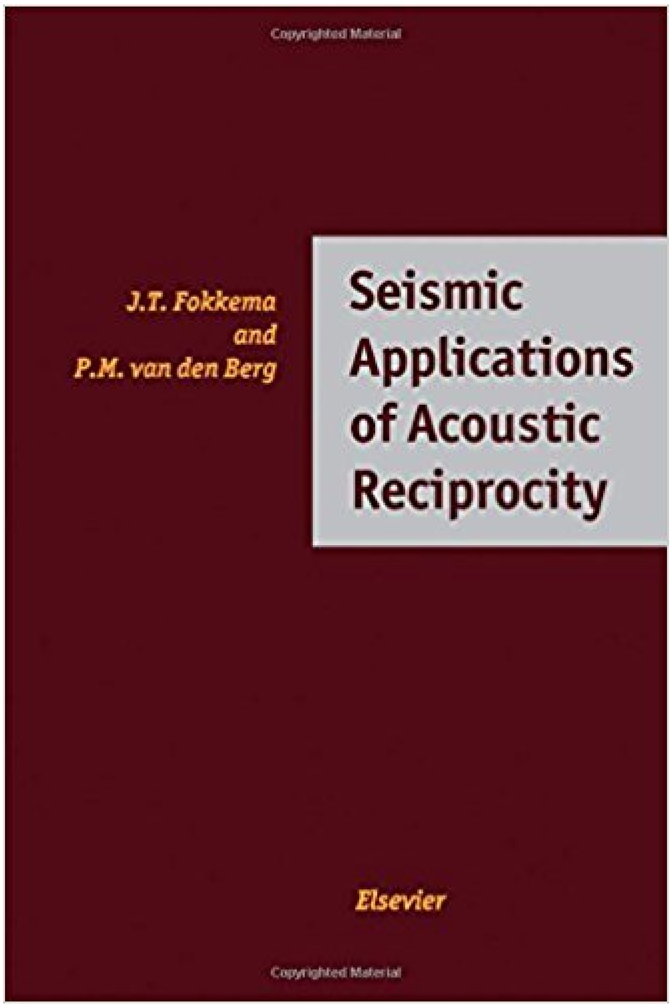
Seismic Applications Of Acoustic Reciprocity



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Synopsis

The seismic applications of the reciprocity theorem developed in this book are partly based on lecture notes and publications from Professor de Hoop. Every student Professor de Hoop has taught knows the egg-shaped figure (affectionately known as "de Hoop's egg") that plays such an important role in his theoretical description of acoustic, electromagnetic and elastodynamic wave phenomena.On the one hand this figure represents the domain for the application of a reciprocity theorem in the analysis of a wavefield and on the other hand it symbolizes the power of a consistent wavefield description of this theorem.The roots of the reciprocity theorem lie in Green's theorem for Laplace's equation and Helmholtz's extension to the wave equation. In 1894, J.W. Strutt, who later became Lord Rayleigh, introduced in his book The Theory of Sound this extension under the name of Helmholtz's theorem. Nowadays it is known as Rayleigh's reciprocity theorem.Progress in seismic data processing requires the knowledge of all the theoretical aspects of the acoustic wave theory. The reciprocity theorem was chosen as the central theme of this book as it constitutes the fundaments of the seismic wave theory. In essence, two states are distinguished in this theorem. These can be completely different, although sharing the same time-invariant domain of application, and they are related via an interaction quantity. The particular choice of the two states determines the acoustic application, in turn making it possible to formulate the seismic experiment in terms of a geological system response to a known source function.In linear system theory, it is well known that the response to a known input function can be written as an integral representation where the impulse response acts as a kernel and operates on the input function. Due to the temporal invariance of the system, this integral representation is of the convolution type. In seismics, the temporal behaviour of the system is dealt with in a similar fashion; however the spatial interaction needs a different approach. The reciprocity theorem handles this interaction by identifying one state with the spatial impulse function, also known as the Green's function, while the other state is connected with the actual source distribution. In general, the resulting integral representation is not a spatial convolution. Moreover, the systematic use of the reciprocity theorem leads to a hierarchical description of the seismic experiment in terms of increasing complexity. Also from an educational point of view this approach provides a hierarchy and the student learns to break down the seismic problem into constituent partial solutions.This book should contribute to the understanding that the reciprocity theorem is a powerful tool in the analysis of the seismic experiment.

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The authors have done a good job of describing increasingly complex wave problems, starting from simple cases and systematically applying the principle of dynamic reciprocity. The book is recommended for libraries and research workers in the field.Pure and Applied Geophysics

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