

*J. T. Fokkema  
and  
P. M. van den Berg*

# Seismic Applications of Acoustic Reciprocity

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# Seismic Applications Of Acoustic Reciprocity

**JE Gale**



## **Seismic Applications Of Acoustic Reciprocity:**

**Seismic Applications of Acoustic Reciprocity** J.T. Fokkema, P.M. van den Berg, 2013-10-22 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 fundamentals 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.

**Electromagnetic Reciprocity in Antenna Theory** Martin Stumpf, 2017-11-08 Provides a self contained account on applications of electromagnetic reciprocity theorems to multiport antenna systems. The reciprocity theorem is among the most intriguing concepts in wave field theory and has become an integral part of almost all standard textbooks on electromagnetic EM theory. This book makes use of the theorem to quantitatively describe EM interactions concerning general multiport antenna systems. It covers a general reciprocity based description of antenna systems their EM scattering properties and further related aspects. Beginning with an

introduction to the subject Electromagnetic Reciprocity in Antenna Theory provides readers first with the basic prerequisites before offering coverage of the equivalent multiport circuit antenna representations EM coupling between multiport antenna systems and their EM interactions with scatterers accompanied with the corresponding EM compensation theorems In addition the text Presents basic prerequisites including the definition of the notation integral transformations and EM reciprocity theorems in their general form Explores multiport antenna forward scattering theorem multiport antenna matching theorem and uniqueness theorem Supplements each chapter with a solved illustrative example Electromagnetic Reciprocity in Antenna Theory is an excellent text for EMC and antenna researchers and students of the subject as well

Seismic Interferometry Deyan Draganov, Johan O. A. Robertsson, 2008 Seismic Interferometry History and Present Status SEG Geophysics Reprint Series No 26 shows that developments in seismic interferometry the methodology of generating new seismic responses by crosscorrelation have taken an enormous flight since the beginning of this century In 2006 the editors of this volume compiled a supplement to Geophysics dedicated to this new branch of science The 22 papers of the well received supplement recognized by one award for best paper and two honorable mentions for best paper in Geophysics and more than 100 citations in the first 20 months form the basis for this reprint volume The editors have added 50 papers from SEG and other journals including Science Physical Review and Geophysical Research Letters The book contains an editors introduction with extensive references and chapters on seismic interferometry without equations highlights of the history of seismic interferometry from 1968 until 2003 and a more detailed overview of the rapid developments since 2004 Seismic Interferometry is an invaluable source for researchers and students interested in the theory and applications of interferometry in geophysical exploration seismic and EM seismology ultrasonics and underwater acoustics *Time-Domain Electromagnetic Reciprocity in Antenna Modeling* Martin Stumpf, 2019-09-02 Describes applications of time domain EM reciprocity and the Cagniard deHoop technique to achieve solutions to fundamental antenna radiation and scattering problems This book offers an account of applications of the time domain electromagnetic TD EM reciprocity theorem for solving selected problems of antenna theory It focuses on the development of both TD numerical schemes and analytical methodologies suitable for analyzing TD EM wave fields associated with fundamental antenna topologies Time Domain Electromagnetic Reciprocity in Antenna Modeling begins by applying the reciprocity theorem to formulate a fundamentally new TD integral equation technique the Cagniard deHoop method of moments CdH MoM regarding the pulsed EM scattering and radiation from a thin wire antenna Subsequent chapters explore the use of TD EM reciprocity to evaluate the impact of a scatterer and a lumped load on the performance of wire antennas and propose a straightforward methodology for incorporating ohmic loss in the introduced solution methodology Other topics covered in the book include the pulsed EM field coupling to transmission lines formulation of the CdH MoM concerning planar antennas and more In addition the book is supplemented with simple MATLAB code implementations so that readers can test EM reciprocity by conducting numerical

experiments In addition this text Applies the thin sheet boundary conditions to incorporate dielectric conductive and plasmonic properties of planar antennas Provides illustrative numerical examples that validates the described methodologies Presents analyzed problems at a fundamental level so that readers can fully grasp the underlying principles of solution methodologies Includes appendices to supplement material in the book Time Domain Electromagnetic Reciprocity in Antenna Modeling is an excellent book for researchers and professors in EM modeling and for applied researchers in the industry

**Reciprocity in Elastodynamics** J. D. Achenbach, 2003 The reciprocity theorem has been used for over 100 years to establish interesting and useful relations between different loading states of a body This book discusses current and novel uses of reciprocity relations for the determination of elastodynamic fields The author who is internationally distinguished for his contributions to theoretical and applied mechanics presents a novel method to solve for wave fields shedding new light on the use of reciprocity relations for dynamic fields in an elastic body The material presented in the book is relevant to several fields in engineering and applied physics Examples are ultrasonics for medical imaging and non destructive evaluation acoustic microscopy seismology exploratory geophysics structural acoustics and the response of structures to high rate loads and the determination of material properties by ultrasonic techniques [Introduction to Petroleum Seismology, second edition](#) Luc T. Ikelle ,Lasse Amundsen, 2018-03-26 Introduction to Petroleum Seismology second edition SEG Investigations in Geophysics Series No 12 provides the theoretical and practical foundation for tackling present and future challenges of petroleum seismology especially those related to seismic survey designs seismic data acquisition seismic and EM modeling seismic imaging microseismicity and reservoir characterization and monitoring All of the chapters from the first edition have been improved and or expanded In addition twelve new chapters have been added These new chapters expand topics which were only alluded to in the first edition sparsity representation sparsity and nonlinear optimization near simultaneous multiple shooting acquisition and processing nonuniform wavefield sampling automated modeling elastic electromagnetic mathematical equivalences and microseismicity in the context of hydraulic fracturing Another major modification in this edition is that each chapter contains analytical problems as well as computational problems These problems include MatLab codes which may help readers improve their understanding of and intuition about these materials The comprehensiveness of this book makes it a suitable text for undergraduate and graduate courses that target geophysicists and engineers as well as a guide and reference work for researchers and professionals in academia and in the petroleum industry **Materials and Acoustics Handbook** Michel Bruneau, Catherine Potel, 2013-05-10 Written by a group of acoustics and vibration specialists this book studies the acoustic and vibrating phenomena that occur in diverse materials used for all kinds of purposes The first part studies the fundamental aspects of propagation analytical numerical and experimental The second part outlines industrial and medical applications Covering a wide range of topics that associate materials science with acoustics this will be of invaluable use to researchers engineers or practitioners in this field as well as students in acoustics physics and

mechanics     *3D Seismic Survey Design* Gijs J. O. Vermeer, 2012 Since the first edition of 3D Seismic Survey Design appeared in 2002 seismic data acquisition has seen many changes most of which have been captured in this second edition This book by Gijs Vermeer describes in detail the properties of 3D acquisition geometries and shows how these properties naturally lead to the 3D symmetric sampling approach to 3D survey design Many examples from the literature are used to illustrate good and less good choices of acquisition parameters The link between survey parameters and noise suppression as well as imaging is an intrinsic part of the contents This book should be of great interest to the designer of 3D seismic surveys but also to every geophysicist who uses 3D seismic data to retrieve accurate information on the properties of the subsurface

*Acoustical Imaging* Leonardo Marotti, 1996 Contains 131 papers presented at the September 1995 symposium Arrangement is in sections on the mathematics and physics of acoustical imaging novel approaches in biomedical imaging tissue characterization flow imaging transducers and arrays imaging systems and techniques underwater and industrial     **The State-of-Art Techniques of Seismic Imaging for the Deep and Ultra-deep Hydrocarbon Reservoirs** Jianping Huang, George Mcmechan, Jidong Yang, Hua-Wei Zhou, Keyu Liu, Yong Zheng, Wei Zhang, 2022-11-11     **A Guided Tour of Mathematical Methods** Roel Snieder, 2004-09-23 Mathematical methods are essential tools for all physical scientists This second edition provides a comprehensive tour of the mathematical knowledge and techniques that are needed by students in this area In contrast to more traditional textbooks all the material is presented in the form of problems Within these problems the basic mathematical theory and its physical applications are well integrated The mathematical insights that the student acquires are therefore driven by their physical insight Topics that are covered include vector calculus linear algebra Fourier analysis scale analysis complex integration Green's functions normal modes tensor calculus and perturbation theory The second edition contains new chapters on dimensional analysis variational calculus and the asymptotic evaluation of integrals This book can be used by undergraduates and lower level graduate students in the physical sciences It can serve as a stand alone text or as a source of problems and examples to complement other textbooks     *Acoustical Imaging* L. Masotti, P. Tortoli, 2012-12-06 This volume contains 131 of the papers presented at the 22nd International Symposium on Acoustical Imaging This meeting which was held for the first time in Florence Italy on September 3-6 1995 allowed an intense and friendly exchange of ideas between over 150 researchers from 26 different countries of Europe 70% America 20% Asia and Australia 10% The Symposium started on Sunday September 3 with the opening Session held in the magnificent Salone dei 500 in Palazzo Vecchio this included invited talks by Peter Wehls and Hua Lee who reviewed the State of the Art in Acoustical Imaging research One hundred and forty papers selected from the nearly 200 submitted Abstracts were presented in 11 non parallel oral Sessions and one Poster Session This year a Best Poster award was introduced which was won by V Miette M Fink and F Wu Also a special session on Acoustical Microscopy was organized by Walter Arnold in which invited speakers Ioie Iones Oleg Kolosov Andrew Briggs and Ute Rabe reviewed the capabilities of this emerging topic

Scattering, Two-Volume Set E. R. Pike, Pierre C. Sabatier, 2002 Part 1 SCATTERING OF WAVES BY MACROSCOPIC TARGET Interdisciplinary aspects of wave scattering Acoustic scattering Acoustic scattering approximate methods Electromagnetic wave scattering theory Electromagnetic wave scattering approximate and numerical methods Electromagnetic wave scattering applications Elastodynamic wave scattering theory Elastodynamic wave scattering Applications Scattering in Oceans Part 2 SCATTERING IN MICROSCOPIC PHYSICS AND CHEMICAL PHYSICS Introduction to direct potential scattering Introduction to Inverse Potential Scattering Visible and Near visible Light Scattering Practical Aspects of Visible and Near visible Light Scattering Nonlinear Light Scattering Atomic and Molecular Scattering Introduction to Scattering in Chemical X ray Scattering Neutron Scattering Electron Diffraction and Scattering Part 3 SCATTERING IN NUCLEAR PHYSICS Nuclear Physics Part 4 PARTICLE SCATTERING State of the Art of Perturbative Methods Scattering Through Electro weak Interactions the Fermi Scale Scattering Through Strong Interactions the Hadronic or QCD Scale Part 5 SCATTERING AT EXTREME PHYSICAL SCALES Scattering at Extreme Physical Scales Part 6 SCATTERING IN MATHEMATICS AND NON PHYSICAL SCIENCES Relations with Other Mathematical Theories Inverse Scattering Transform and Non linear Partial Differential Equations Scattering of Mathematical Objects A Guided Tour of Mathematical Methods for the Physical Sciences Roel Snieder, Kasper van Wijk, 2015-03-05 Mathematical methods are essential tools for all physical scientists This book provides a comprehensive tour of the mathematical knowledge and techniques that are needed by students across the physical sciences In contrast to more traditional textbooks all the material is presented in the form of exercises Within these exercises basic mathematical theory and its applications in the physical sciences are well integrated In this way the mathematical insights that readers acquire are driven by their physical science insight This third edition has been completely revised new material has been added to most chapters and two completely new chapters on probability and statistics and on inverse problems have been added This guided tour of mathematical techniques is instructive applied and fun This book is targeted for all students of the physical sciences It can serve as a stand alone text or as a source of exercises and examples to complement other textbooks **Forward and Inverse Scattering Algorithms Based on Contrast Source Integral Equations** Peter M. van den Berg, 2021-02-26 A guide to wave field computational methods based on contrast source type of integral equations Forward and Inverse Scattering Algorithms Based on Contrast Source Integral Equations presents a text that examines wave field computational methods based on contrast source type of integral equations and the computational implementation in wave field based imaging methods Written by a noted expert on the topic the book provides a guide to efficient methods for calculating wave fields in a known inhomogeneous medium The author provides a link between the fundamental scattering theory and its discrete counterpart and discusses the forward scattering problem based on the contrast source integral equations The book fully describes the calculation of wave fields inside and outside a scattering object with general shape and material property and reviews the inverse scattering problem in which

material properties are resolved from wave field measurements outside the scattering object The theoretical approach is the inverse of the forward scattering problem that determines how radiation is scattered based on the scattering object This important book Provides a guide to the effects of scalar waves acoustic waves and electromagnetic waves Describes computer modeling in 1D 2D and 3D models Includes an online site for computer codes with adjustable configurations Written for students researchers and professionals Forward and Inverse Scattering Algorithms Based on Contrast Source Integral Equations offers a guide to wave field computational methods based on contrast source type of integral equations and the computational implementation in wave field based imaging methods Theoretical And Computational Acoustics '97 Er-chang Shang, Martin H Schultz, Allan D Pierce, Yu-chiung Teng, Yih-hsing Pao, 1999-05-11 This volume is dedicated to Dr Ding Lee for his untiring efforts in promoting the advancement of theoretical and computational acoustics This proceedings volume provides a forum for active researchers to discuss the state of the art developments and results in theoretical and computational acoustics covering aero seismo and ocean acoustics and related topics It discusses multidimensional wave propagation modeling methods of computational acoustics wave propagation in rocks fluid solid interfaces nonlinear acoustics neural networks real applications and experimental results **Extended Abstracts Book: Oral presentations** European Association of Geoscientists and Engineers. Meeting, 2000 *Biomedical Applications of Vibration and Acoustics for Imaging and Characterisations* Mostafa Fatemi, Ahmed Al-Jumaily, 2008 The primary objective of this book is to compile the research topics on biomedical imaging and tissue characterisation techniques that utilise vibration and acoustics Applied Mechanics Reviews ,1986 **Acquiring Better Seismic Data** W.C. Pritchett, 1989-11-30 Written as a reference for geophysicists seismic surveyors and engineers in the mining hydrocarbon and water industries this book attempts to recommend solutions to problems commonly experienced in the field It recommends careful planning and executions of operations at this stage of resources exploration results in large cost and time saving



## Decoding **Seismic Applications Of Acoustic Reciprocity**: Revealing the Captivating Potential of Verbal Expression

In an era characterized by interconnectedness and an insatiable thirst for knowledge, the captivating potential of verbal expression has emerged as a formidable force. Its capability to evoke sentiments, stimulate introspection, and incite profound transformations is genuinely awe-inspiring. Within the pages of "**Seismic Applications Of Acoustic Reciprocity**," a mesmerizing literary creation penned by a celebrated wordsmith, readers set about an enlightening odyssey, unraveling the intricate significance of language and its enduring effect on our lives. In this appraisal, we shall explore the book's central themes, evaluate its distinctive writing style, and gauge its pervasive influence on the hearts and minds of its readership.

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