# Geophysical Inverse Theory And Regularization Problems

This book is a continuation of 'Acoustic and Elastic Wave Fields in Geophysics, Part I' published in 2000. The second volume is dedicated to propagation of linear plane, spherical and cylindrical acoustic waves in different media. Chapter 1 is devoted to principles of geometric acoustic in plane wave approximation. The eikonal and transport equations are derived. Ray tracing and wavefront construction techniques are explained. Chapter 2 deals with dynamic properties of wave fields. The behavior of pressure and displacements amplitudes in zero approximation is analysed in two ways: using Poynting vector and solving the transport equation. This chapter contains several examples related to shadow zones and caustics. In Chapter 3 using the results of analysis of high-frequency wave kinematics and dynamics some fundamental aspects of Kirchhoff migration are described. Chapters 4 and 5 are devoted to propagation of plane waves in media with flat boundaries in the case of normal and oblique incidence. Special attention is paid to the case when an incident angle exceeds the critical angles. Formation of normal modes in the waveguide is discussed. Chapter 6 deals with a spherical wave reflection and refraction. The steepest descent method is introduced to describe the behavior of reflected, transmitted, head and evanescent waves. In Chapter 7 propagation of stationary and transient waves in a waveguide formed by a flat layer with low velocity are investigated. Normal modes and waves related to the branch points of integrands under consideration are studied. Dispersive properties of normal modes are discussed. Chapter 8 describes wave propagation inside cylinder in acoustic media. Several appendices are added to help the reader understand different aspects of mathematics used in the book.

This book provides an up-to-date presentation of a broad range of contemporary problems in inverse scattering involving acoustic, elastic and electromagnetic waves. Descriptions will be given of traditional (but still in use and subject to on-going improvements) and more recent methods for identifying either: a) the homogenized material parameters of (spatially) unbounded or bounded heterogeneous media, or b) the detailed composition (spatial distribution of the material parameters) of unbounded or bounded heterogeneous media, or c) the location, shape, orientation and material characteristics of an object embedded in a wellcharacterized homogeneous, homogenized or heterogeneous unbounded or bounded medium, by inversion of reflected, transmitted or scattered spatiotemporal recorded waveforms resulting from the propagation of probe radiation within the medium.

This book is devoted to the mathematical theory of regularization methods and gives an account of the currently available results about regularization methods for linear and nonlinear ill-posed problems. Both continuous and iterative regularization methods are considered in detail with special emphasis on the development of parameter choice and stopping rules which lead to optimal convergence rates.

Geophysical Inverse Theory and Applications, Second Edition, brings together fundamental results developed by the Russian mathematical school in regularization theory and combines them with the related research in geophysical inversion carried out in the West. It presents a detailed exposition of the methods of regularized solution of inverse problems based on the ideas of Tikhonov regularization, and shows the different forms of their applications in both linear and nonlinear methods of geophysical inversion. It's

the first book of its kind to treat many kinds of inversion and imaging techniques in a unified mathematical manner. The book is divided in five parts covering the foundations of the inversion theory and its applications to the solution of different geophysical inverse problems, including potential field, electromagnetic, and seismic methods. Unique in its focus on providing a link between the methods used in gravity, electromagnetic, and seismic imaging and inversion, it represents an exhaustive treatise on inversion theory. Written by one of the world's foremost experts, this work is widely recognized as the ultimate researcher's reference on geophysical inverse theory and its practical scientific applications. Presents state-of-the-art geophysical inverse theory developed in modern mathematical terminology—the first to treat many kinds of inversion and imaging techniques in a unified mathematical way. Provides a critical link between the methods used in gravity, electromagnetic, and seismic imaging and inversion, and represents an exhaustive treatise on geophysical inversion theory. Features more than 300 illustrations, figures, charts and graphs to underscore key concepts. Reflects the latest developments in inversion theory and applications and captures the most significant changes in the field over the past decade.

Regularization of Inverse Problems

Parameter Identification and Inverse Problems in Hydrology, Geology and Ecology

Optimization and Regularization for Computational Inverse Problems and Applications

Inversion of Geophysical Data

Insight and Algorithms

*Geophysical Potential Fields: Geological and Environmental Applications, Volume Two, investigates the similarities and differences of potential geophysical fields, including gravity, magnetics, temperature, resistivity and self-potential, along with the influence of noise on these fields. As part of the Computational Geophysics series, this volume provides computational examples and methods for effectively solving geophysical problems in a full cycle manner. Including both quantitative and qualitative analysis, the book offers different filtering and transformation procedures, integrated analysis, and special interpretation methodologies, also presenting a developed 3D algorithm for combined modeling of gravity and magnetic fields in complex environments. The book also includes applications of the unified potential field system, such as studying deep structure, searching hydrocarbon and ore deposits, localizing buried water horizons and rockslide areas, tectono-structural mapping of water basins, and classifying archaeological targets. It is an ideal and unique resource for geophysicists, exploration geologists, archaeologists and environmental scientists. Clearly demonstrates the successive stages of geophysical field analysis for different geological and environmental targets Provides a unified system for potential geophysical field analysis that is demonstrated by numerous examples of system application Demonstrates the possibilities for rapidly and effectively interpreting anomalies, receiving some knowledge of modern wavelet, diffusion maps and informational approach applications in geophysics, and combined gravity-magnetic methodology of 3D modeling Includes text of the Geological Space Field Calculation (GSFC) software intended for 3D combined modeling of gravity and magnetic fields in complex environments*

*Geophysical inversion is an ill-posed problem. Classical local search method for inversion is depend on initial guess and*

*easy to be trapped in local optimum. The global optimization is a group of novel methods to deal with the problems mentioned above. The book introduces the geophysical inversion theory, including the classical solving approaches firstly. Then, it introduces several typical global inversion approaches including particle swarm optimization (PSO), differential evolution (DE), and multiobjective optimization methods, as well as some examples to inverse the geophysical data, such as gravity, MT sounding, well logging, self-potential, seismic data, using these global optimization approaches.*

*The past few decades have witnessed the growth of the Earth Sciences in the pursuit of knowledge and understanding of the planet that we live on. This development addresses the challenging endeavor to enrich human lives with the bounties of Nature as well as to preserve the planet for the generations to come. Solid Earth Geophysics aspires to define and quantify the internal structure and processes of the Earth in terms of the principles of physics and forms the intrinsic framework, which other allied disciplines utilize for more specific investigations. The first edition of the Encyclopedia of Solid Earth Geophysics was published in 1989 by Van Nostrand Reinhold publishing company. More than two decades later, this new volume, edited by Prof. Harsh K. Gupta, represents a thoroughly revised and expanded reference work. It brings together more than 200 articles covering established and new concepts of Geophysics across the various sub-disciplines such as Gravity, Geodesy, Geomagnetism, Seismology, Seismics, Deep Earth Processes, Plate Tectonics, Thermal Domains, Computational Methods, etc. in a systematic and consistent format and standard. It is an authoritative and current reference source with extraordinary width of scope. It draws its unique strength from the expert contributions of editors and authors across the globe. It is designed to serve as a valuable and cherished source of information for current and future generations of professionals.*

*Geophysical Inverse Theory and Regularization ProblemsElsevier*
*Global Optimization Methods in Geophysical Inversion*
*Encyclopedia of Solid Earth Geophysics*
*Discrete Inverse Problems*
*Geological and Environmental Applications*
*Inverse and Ill-Posed Problems*

Following Keller [119] we call two problems inverse to each other if the for mulation of each of them requires full or partial knowledge of the other. By this definition, it is obviously arbitrary which of the two problems we call the direct and which we call the inverse problem. But usually, one of the problems has been studied earlier and, perhaps, in more detail. This one is usually called the direct problem, whereas the other is the inverse problem. However, there is often another, more important difference between these two problems. Hadamard (see [91]) introduced the concept of a well-posed problem, originating from the philosophy that the mathematical model of a physical problem has to have the properties of uniqueness, existence, and stability of the solution. If one of the properties fails to hold, he called the problem ill-posed. It turns out that many interesting and important inverse in science lead to ill-posed problems, while the corresponding di problems rect problems are well-posed. Often, existence and uniqueness can be forced by enlarging or reducing the solution space (the space of "models"). For restoring stability, however, one has to change the topology of the spaces, which is in many cases impossible because of the presence of

**measurement errors. At first glance, it seems to be impossible to compute the solution of a problem numerically if the solution of the problem does not depend continuously on the data, i. e. , for the case of ill-posed problems.**

**This book provides a thorough introduction to the challenge of applying mathematics in real-world scenarios. Modelling tasks rarely involve well-defined categories, and they often require multidisciplinary input from mathematics, physics, computer sciences, or engineering. In keeping with this spirit of modelling, the book includes a wealth of cross-references between the chapters and frequently points to the real-world context. The book combines classical approaches to modelling with novel areas such as soft computing methods, inverse problems, and model uncertainty. Attention is also paid to the interaction between models, data and the use of mathematical software. The reader will find a broad selection of theoretical tools for practicing industrial mathematics, including the analysis of continuum models, probabilistic and discrete phenomena, and asymptotic and sensitivity analysis.**

**This collection of papers on geophysical inversion contains research and survey articles on where the field has been and where it's going, and what is practical and what is not. Topics covered include seismic tomography, migration and inverse scattering.**

**A comprehensive text on resistivity and induced polarization covering theory and practice for the near-surface Earth supported by modelling software.**

**Offset-dependent Reflectivity**

**Inverse Methods for Atmospheric Sounding**

**Time Series Analysis and Inverse Theory for Geophysicists**

**Geophysics Today**

**Wavefield Inversion**

Foundations of Geophysical Electromagnetic Theory and Methods, Second Edition, builds on the strength of the first edition to offer a systematic exposition of geophysical electromagnetic theory and methods. This new edition highlights progress made over the last decade, with a special focus on recent advances in marine and airborne electromagnetic methods. Also included are recent case histories on practical applications in tectonic studies, mineral exploration, environmental studies and off-shore hydrocarbon exploration. The book is ideal for geoscientists working in all areas of geophysics, including exploration geophysics and applied physics, as well as graduate students and researchers working in the field of electromagnetic theory and methods. Presents theoretical and methodological foundations of geophysical field theory Synthesizes fundamental theory and the most recent achievements of electromagnetic (EM) geophysical methods in the framework of a unified systematic exposition Offers a unique breadth and completeness in providing a general picture of the current state-of-the-art in EM geophysical technology Discusses practical aspects of EM exploration for mineral and energy resources

While the prediction of observations is a forward problem, the use of actual observations to infer the properties of a model is an inverse problem. Inverse problems are difficult because they may not have a unique solution. The description of uncertainties plays a central role in the theory, which is based on probability theory. This book proposes a general approach that is valid for linear as well as for nonlinear problems. The philosophy is essentially probabilistic and allows the reader to

understand the basic difficulties appearing in the resolution of inverse problems. The book attempts to explain how a method of acquisition of information can be applied to actual real-world problems, and many of the arguments are heuristic. Annotation Rodgers (U. of Oxford) provides graduate students and other researchers a background to the inverse problem and its solution, with applications relating to atmospheric measurements. He introduces the stages in the reverse order than the usual approach in order to develop the learner's intuition about the nature of the inverse problem. Annotation copyrighted by Book News, Inc., Portland, OR.

In many physical sciences, the most natural description of a system is with a function of position or time. In principle, infinitely many numbers are needed to specify that function, but in practice only finitely many measurements can be made. Inverse theory concerns the mathematical techniques that enable researchers to use the available information to build a model of the unknown system or to determine its essential properties. In Geophysical Inverse Theory, Robert Parker provides a systematic development of inverse theory at the graduate and professional level that emphasizes a rigorous yet practical solution of inverse problems, with examples from experimental observations in geomagnetism, seismology, gravity, electromagnetic sounding, and interpolation. Although illustrated with examples from geophysics, this book has broad implications for researchers in applied disciplines from materials science and engineering to astrophysics, oceanography, and meteorology. Parker's approach is to avoid artificial statistical constructs and to emphasize instead the reasonable assumptions researchers must make to reduce the ambiguity that inevitably arises in complex problems. The structure of the book follows a natural division in the subject into linear theory, in which the measured quantities are linear functionals of the unknown models, and nonlinear theory, which covers all other systems but is not nearly so well understood. The book covers model selection as well as techniques for drawing firm conclusions about the earth independent of any particular model.

Theory and Applications
Handbook of Mathematical Methods in Imaging
Computational Methods in Geophysical Electromagnetics
Geophysical Potential Fields
Geophysical Inversion Theory and Global Optimization Methods

This monograph provides a framework for students and practitioners who are working on the solution of electromagnetic imaging in geophysics. Bridging the gap between theory and practical applied material (for example, inverse and forward problems), it provides a simple explanation of finite volume discretization, basic concepts in solving inverse problems through optimization, a summary of applied electromagnetics methods, and MATLAB?÷ code for efficient computation.

This presents practical techniques for interpolation and estimation problems when analysing data from field observations.

In this book the author presents the state-of-the-art electromagnetic (EM) theories and methods employed in EM geophysical exploration. The book brings together the fundamental theory of EM fields and the practical aspects of EM exploration for mineral and energy resources. This text is unique in its breadth and completeness in providing an overview of EM geophysical exploration technology. The book is divided into four parts covering the foundations of EM field theory and its applications, and emerging geophysical methods. Part I is an introduction to the field theory required for baseline understanding. Part II is an overview of all the basic elements of geophysical EM theory, from Maxwell's fundamental equations to modern methods of modeling the EM field in complex 3-D geoelectrical formations. Part III deals with the regularized solution of ill-posed inverse electromagnetic problems, the multidimensional migration and imaging of electromagnetic data, and general interpretation techniques. Part IV describes major geophysical electromagnetic methods—direct current (DC), induced polarization (IP), magnetotelluric (MT), and controlled-source electromagnetic (CSEM) methods—and covers different applications of EM methods in exploration geophysics, including minerals and HC exploration, environmental study, and crustal study. * Presents theoretical and methodological findings, as well as examples of applications of recently developed algorithms and software in solving practical problems * Describes the practical importance of electromagnetic data through enabling discussions on a construction of a closed technological cycle, processing, analysis and three-dimensional interpretation * Updates current findings in the field, especially with MT, magnetovariational and seismo-electrical methods and the practice of 3D interpretations

The Handbook of Mathematical Methods in Imaging provides a comprehensive treatment of the mathematical techniques used in imaging science. The material is grouped into two central themes, namely, Inverse Problems (Algorithmic Reconstruction) and Signal and Image Processing. Each section within the themes covers applications (modeling), mathematics, numerical methods (using a case example) and open questions. Written by experts in the area, the presentation is mathematically rigorous. The entries are cross-referenced for easy navigation through connected topics. Available in both print and electronic forms, the handbook is enhanced by more than 150 illustrations and an extended bibliography. It will benefit students, scientists and researchers in applied mathematics. Engineers and computer scientists working in imaging will also find this handbook useful.

Geophysical Data Analysis: Discrete Inverse Theory

Theory and Applications to the Near-Surface Earth

An Introduction to the Mathematical Theory of Inverse Problems

Resistivity and Induced Polarization

*Recognizing the need for education and further research in AVO, the editors have compiled an all-encompassing treatment of this versatile technology. In addition to providing a general introduction to the subject and a review of the current state of the art, this unique volume provides useful reference materials and data plus original contributions at the leading edge of AVO technologies.*

*This book focuses on essential theories, methods and techniques in the field of environmental and engineering geophysics that can contribute to resource detection and environmental protection. Geophysics has been playing an important role in exploring the earth, locating vital resources and promoting the development of society. This book covers a range of topics including the exploration of modern resources, such as ore deposits, coal mines, shale gas and geothermal power, and the monitoring of geological disasters, including the rock-soil body, ground deformation, mines, specific rock-soil engineering disasters, desertification of land and environmental abnormalities. This book not only offers a valuable resource for geophysical researchers; it also demonstrates how geophysics theories and methods can be practically implemented to protect our environment and promote the development of human society.*

*Parameter Estimation and Inverse Problems, Second Edition provides geoscience students and professionals with answers to common questions like how one can derive a physical model from a finite set of observations containing errors, and how one may determine the quality of such a model. This book takes on these fundamental and challenging problems, introducing students and professionals to the broad range of approaches that lie in the realm of inverse theory. The authors present both the underlying theory and practical algorithms for solving inverse problems. The authors' treatment is appropriate for geoscience graduate students and advanced undergraduates with a basic working knowledge of calculus, linear algebra, and statistics.*

*Parameter Estimation and Inverse Problems, Second Edition introduces readers to both Classical and Bayesian approaches to linear and nonlinear problems with particular attention paid to computational, mathematical, and statistical issues related to their application to geophysical problems. The textbook includes Appendices covering essential linear algebra, statistics, and notation in the context of the subject. Includes appendices for review of needed concepts in linear, statistics, and vector calculus. Accessible to students and professionals without a highly specialized mathematical background.*

*This book presents state-of-the-art geophysical inverse theory developed in modern mathematical terminology. The book brings together fundamental results developed by the Russian mathematical school in regularization theory and combines them with the related research in geophysical inversion carried out in the West. It presents*

*a detailed exposition of the methods of regularized solution of inverse problems based on the ideas of Tikhonov regularization, and shows the different forms of their applications in both linear and nonlinear methods of geophysical inversion. This text is the first to treat many kinds of inversion and imaging techniques in a unified mathematical manner. The book is divided in five parts covering the foundations of the inversion theory and its applications to the solution of different geophysical inverse problems, including potential field, electromagnetic, and seismic methods. The first part is an introduction to inversion theory. The second part contains a description of the basic methods of solution of the linear and nonlinear inverse problems using regularization. The following parts treat the application of regularization methods in gravity and magnetic, electromagnetic, and seismic inverse problems. The key connecting idea of these applied parts of the book is the analogy between the solutions of the forward and inverse problems in different geophysical methods. The book also includes chapters related to the modern technology of geophysical imaging, based on seismic and electromagnetic migration. This volume is unique in its focus on providing a link between the methods used in gravity, electromagnetic, and seismic imaging and inversion, and represents an exhaustive treatise on inversion theory.*
*Applications in Hydrogeology*
*Computational Methods for Inverse Problems*
*Geophysical Inverse Theory and Regularization Problems*
*Bayesian Approach to Inverse Problems*
*Parameter Estimation and Inverse Problems*

Seismic inversion aims to reconstruct a quantitative model of the Earth subsurface, by solving an inverse problem based on seismic measurements. There are at least three fundamental issues to be solved simultaneously: non-linearity, non-uniqueness, and instability. This book covers the basic theory and techniques used in seismic inversion, corresponding to these three issues, emphasising the physical interpretation of theoretical concepts and practical solutions. This book is written for master and doctoral students who need to understand the mathematical tools and the engineering aspects of the inverse problem needed to obtain geophysically meaningful solutions. Building on the basic theory of linear inverse problems, the methodologies of seismic inversion are explained in detail, including ray-impedance inversion and waveform tomography etc. The application methodologies are categorised into convolutional and wave-equation based groups. This systematic presentation simplifies the subject and enables an in-depth understanding of seismic inversion. This book also provides a practical guide to reservoir geophysicists who are attempting quantitative reservoir characterisation based on seismic data. Philosophically, the seismic inverse problem allows for a range of possible solutions, but the

techniques described herein enable geophysicists to exclude models that cannot satisfy the available data. This book summarises the author's extensive experience in both industry and academia and includes innovative techniques not previously published.

This book presents a carefully selected group of methods for unconstrained and bound constrained optimization problems and analyzes them in depth both theoretically and algorithmically. It focuses on clarity in algorithmic description and analysis rather than generality, and while it provides pointers to the literature for the most general theoretical results and robust software, the author thinks it is more important that readers have a complete understanding of special cases that convey essential ideas. A companion to Kelley's book, Iterative Methods for Linear and Nonlinear Equations (SIAM, 1995), this book contains many exercises and examples and can be used as a text, a tutorial for self-study, or a reference. Iterative Methods for Optimization does more than cover traditional gradient-based optimization: it is the first book to treat sampling methods, including the Hooke-Jeeves, implicit filtering, MDS, and Nelder-Mead schemes in a unified way, and also the first book to make connections between sampling methods and the traditional gradient-methods. Each of the main algorithms in the text is described in pseudocode, and a collection of MATLAB codes is available. Thus, readers can experiment with the algorithms in an easy way as well as implement them in other languages.

Inverse and Ill-Posed Problems is a collection of papers presented at a seminar of the same title held in Austria in June 1986. The papers discuss inverse problems in various disciplines; mathematical solutions of integral equations of the first kind; general considerations for ill-posed problems; and the various regularization methods for integral and operator equations of the first kind. Other papers deal with applications in tomography, inverse scattering, detection of radiation sources, optics, partial differential equations, and parameter estimation problems. One paper discusses three topics on ill-posed problems, namely, the imposition of specified types of discontinuities on solutions of ill-posed problems, the use of generalized cross validation as a data based termination rule for iterative methods, and also a parameter estimation problem in reservoir modeling. Another paper investigates a statistical method to determine the truncation level in Eigen function expansions and for Fredholm equations of the first kind where the data contains some errors. Another paper examines the use of singular function expansions in the inversion of severely ill-posed problems arising in confocal scanning microscopy, particle sizing, and velocimetry. The collection can benefit many mathematicians, students, and professor of calculus, statistics, and advanced mathematics.

Providing an up-to-date overview of the most popular global optimization methods used in interpreting geophysical observations, this new edition includes a detailed description of the theoretical development underlying each method and a thorough explanation of the design, implementation and limitations of algorithms. New and expanded chapters provide details of recently developed methods, such

as the neighborhood algorithm, particle swarm optimization, hybrid Monte Carlo and multi-chain MCMC methods. Other chapters include new examples of applications, from uncertainty in climate modeling to whole earth studies. Several different examples of geophysical inversion, including joint inversion of disparate geophysical datasets, are provided to help readers design algorithms for their own applications. This is an authoritative and valuable text for researchers and graduate students in geophysics, inverse theory and exploration geoscience, and an important resource for professionals working in engineering and petroleum exploration.

Technology and Application of Environmental and Engineering Geophysics
Acoustic and Elastic Wave Fields in Geophysics, Part II
Geophysical Inversion
Simultaneous Source Seismic Acquisition
Foundations of Geophysical Electromagnetic Theory and Methods

*The Workshop on Parameter Identification and Inverse Problems in Hydrology, Geology and Ecology, Karlsruhe, April 10-12, 1995, was organized to bring to gether an interdisciplinary group drawn from the areas of science, engineering and mathematics for the following purposes: - to promote, encourage and influence more understanding and cooperation in the community of parameter identifiers from various disciplines, - to forge unity in diversity by bringing together a variety of disciplines that attempt to understand the reconstruction of inner model parameters, un known nonlinear constitutive relations, heterogeneous structures inside of geological objects, sources or sinks from observational data, - to discuss modern regularization tools for handling improperly posed pro blems and strategies of incorporating a priori knowledge from the applied problem into the model and its treatment. These proceedings contain some of the results of the workshop, representing a bal anced selection of contributions from the various groups of participants. The reviewed invited and contributed articles are grouped according to the broad headings of hydrology, non-linear diffusion and soil physics, geophysical methods, mathematical analysis of inverse and ill-posed problems and parallel algorithms for inverse problems. Some of the issues adressed by the articles in these proceedings include the rela tion between least squares and direct formulations of inverse problems for partial differential equations, nonlinear regularization, identification of nonlinear consti tutive relations, fast parallel algorithms for large scale inverse problems, reduction of model structures, geostatistical inversion techniques.*

*This unique textbook provides the foundation for understanding and applying techniques commonly used in geophysics to process and interpret modern digital data. The geophysicist's toolkit contains a range of techniques which may be divided into two main groups: processing, which concerns time series analysis and is used to separate the signal of interest from background noise; and inversion, which involves generating some map or physical model from the data. These two groups of techniques are normally taught separately,*

*but are here presented together as parts I and II of the book. Part III describes some real applications and includes case studies in seismology, geomagnetism, and gravity. This textbook gives students and practitioners the theoretical background and practical experience, through case studies, computer examples and exercises, to understand and apply new processing methods to modern geophysical datasets. Solutions to the exercises are available on a website at http://publishing.cambridge.org/resources/0521819652*
*This book gives an introduction to the practical treatment of inverse problems by means of numerical methods, with a focus on basic mathematical and computational aspects. To solve inverse problems, we demonstrate that insight about them goes hand in hand with algorithms.*
*This publication is designed to provide a practical understanding of methods of parameter estimation and uncertainty analysis. The practical problems covered range from simple processing of time- and space-series data to inversion of potential field, seismic, electrical, and electromagnetic data. The various formulations are reconciled with field data in the numerous examples provided in the book; well-documented computer programmes are also given to show how easy it is to implement inversion algorithms.*
*Introduction to Geostatistics*
*Robust Statistics and Regularization in Geophysical Inverse Theory*
*Inverse Theory and Applications in Geophysics*
*Theory and Practice*
*A Survey of the Field as the Journal Celebrates Its 75th Anniversary*

Many scientific, medical or engineering problems raise the issue ofrecovering some physical quantities from indirect measurements; forinstance, detecting or quantifying flaws or cracks within amaterial from acoustic or electromagnetic measurements at itssurface is an essential problem of non-destructive evaluation. Theconcept of inverse problems precisely originates from the idea ofinverting the laws of physics to recover a quantity of interestfrom measurable data. Unfortunately, most inverse problems are ill-posed, which meansthat precise and stable solutions are not easy to devise.Regularization is the key concept to solve inverse problems. The goal of this book is to deal with inverse problems andregularized solutions using the Bayesian statistical tools, with aparticular view to signal and image estimation. The first three chapters bring the theoretical notions that make itpossible to cast inverse problems within a mathematical framework.The next three chapters address the fundamental inverse problem ofdeconvolution in a comprehensive manner. Chapters 7 and 8 deal withadvanced statistical questions linked to image estimation. In thelast five chapters, the main tools introduced in the previouschapters are put into a practical context in important applicativeareas, such as astronomy or medical imaging.
"Optimization and Regularization for Computational Inverse Problems and Applications" focuses on advances in inversion theory and recent developments with practical applications, particularly emphasizing the combination of optimization and regularization for solving inverse problems. This book covers both the methods, including standard regularization theory, Fejer processes for

linear and nonlinear problems, the balancing principle, extrapolated regularization, nonstandard regularization, nonlinear gradient method, the nonmonotone gradient method, subspace method and Lie group method; and the practical applications, such as the reconstruction problem for inverse scattering, molecular spectra data processing, quantitative remote sensing inversion, seismic inversion using the Lie group method, and the gravitational lensing problem. Scientists, researchers and engineers, as well as graduate students engaged in applied mathematics, engineering, geophysics, medical science, image processing, remote sensing and atmospheric science will benefit from this book. Dr. Yanfei Wang is a Professor at the Institute of Geology and Geophysics, Chinese Academy of Sciences, China. Dr. Sc. Anatoly G. Yagola is a Professor and Assistant Dean of the Physical Faculty, Lomonosov Moscow State University, Russia. Dr. Changchun Yang is a Professor and Vice Director of the Institute of Geology and Geophysics, Chinese Academy of Sciences, China.

Parameter Estimation and Inverse Problems, Third Edition, is structured around a course at New Mexico Tech and is designed to be accessible to typical graduate students in the physical sciences who do not have an extensive mathematical background. The book is complemented by a companion website that includes MATLAB codes that correspond to examples that are illustrated with simple, easy to follow problems that illuminate the details of particular numerical methods. Updates to the new edition include more discussions of Laplacian smoothing, an expansion of basis function exercises, the addition of stochastic descent, an improved presentation of Fourier methods and exercises, and more. Features examples that are illustrated with simple, easy to follow problems that illuminate the details of a particular numerical method Includes an online instructor's guide that helps professors teach and customize exercises and select homework problems Covers updated information on adjoint methods that are presented in an accessible manner

Geophysical Data Analysis: Discrete Inverse Theory is an introductory text focusing on discrete inverse theory that is concerned with parameters that either are truly discrete or can be adequately approximated as discrete. Organized into 12 chapters, the book's opening chapters provide a general background of inverse problems and their corresponding solution, as well as some of the basic concepts from probability theory that are applied throughout the text. Chapters 3-7 discuss the solution of the canonical inverse problem, that is, the linear problem with Gaussian statistics, and discussions on problems that are non-Gaussian and nonlinear are covered in Chapters 8 and 9. Chapters 10-12 present examples of the use of inverse theory and a discussion on the numerical algorithms that must be employed to solve inverse problems on a computer. This book is of value to graduate students and many college seniors in the applied sciences.

Seismic Inversion

Iterative Methods for Optimization

Mathematical Modelling

Selected Papers of the 7th International Conference on Environmental and Engineering Geophysics, ICEEG-Beijing 2016

Geophysical Inverse Theory

**Provides a basic understanding of both the underlying mathematics and the computational methods used to solve inverse problems.**
**Geophysical Data Analysis: Understanding Inverse Problem Theory and Practice**
**Geophysical Electromagnetic Theory and Methods**
**Inverse Problem Theory and Methods for Model Parameter Estimation**
**Theory and Practice of AVO Analysis**