



HANDBOOK OF GEOPHYSICAL EXPLORATION
SEISMIC EXPLORATION

Klaus Helbig and Sven Treitel, Editors

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Quantitative Borehole
Acoustic Methods

by X.-M. TANG and A. CHENG

Quantitative Borehole Acoustic Methods

**Hua Wang, M. Nafi Töksöz, Michael C
Fehler**



Quantitative Borehole Acoustic Methods:

Quantitative Borehole Acoustic Methods X.M. Tang, Chuen Hon Arthur Cheng, 2004-01-27 Acoustic logging is a multidisciplinary technology involving basic theory instrumentation and data processing interpretation methodologies The advancement of the technology now allows for a broad range of measurements to obtain formation properties such as elastic wave velocity and attenuation formation permeability and seismic anisotropy that are important for petroleum reservoir exploration With these advances it is easier to detect and characterize formation fractures estimate formation stress field and locate estimate petroleum reserves The technology has evolved from the monopole acoustic logging into the multipole including dipole cross dipole and even quadrupole acoustic logging measurements The measurement process has developed from the conventional wireline logging into the logging while drilling stage For such a fast developing technology with applications that are interesting to readers of different backgrounds it is necessary to have systematic documentation of the discipline including the theory methods and applications as well as the technology's past present and near future development trends Quantitative Borehole Acoustic Methods provides such documentation with emphasis on the development over the past decade Although considerable effort has been made to provide a thorough basis for the theory and methodology development emphasis is placed on the applications of the developed methods The applications are illustrated with field data examples Many of the acoustic waveform analysis processing methods described in the book are now widely used in the well logging industry

Borehole Acoustic Logging - Theory and Methods Hua Wang, M. Nafi Toksöz, Michael C Fehler, 2020-07-30 This book covers the principles historical development and applications of many acoustic logging methods including acoustic logging while drilling and cased hole logging methods Benefiting from the rapid development of information technology the subsurface energy resource industry is moving toward data integration to increase the efficiency of decision making through the use of advanced big data and artificial intelligence technologies such as machine deep learning However wellbore failure may happen if evaluations of risk and infrastructure are made using data mining methods without a complete understanding of the physics of borehole measurements Processed results from borehole acoustic logging will constitute part of the input data used for data integration Therefore to successfully employ modern techniques for data assimilation and analysis one must fully understand the complexity of wave mode propagation how such propagation is influenced by the well and the materials placed within the well i.e. the cement casing and drill strings and ultimately how waves penetrate into and are influenced by geological formations State of the art simulation methods such as the discrete wavenumber integration method DWM and the finite difference method FDM are introduced to tackle the numerical challenges associated with models containing large material contrasts such as the contrasts between borehole fluids and steel casings Waveforms and pressure snapshots are shown to help the reader understand the wavefields under various conditions Advanced data processing methods including velocity analyses within the time and frequency domains are

utilized to extract the velocities of different modes Furthermore the authors discuss how various formation parameters influence the waveforms recorded in the borehole and describe the principles of both existing and potential tool designs and data acquisition schemes This book greatly benefits from the research and knowledge generated over four decades at the Earth Resources Laboratory ERL of the Massachusetts Institute of Technology MIT under its acoustic logging program Given its scope the book is of interest to geophysicists including borehole geophysicists and seismologists petrophysicists and petroleum engineers who are interested in formation evaluation and cementation conditions In addition this book is of interest to researchers in the acoustic sciences and to 4th year undergraduate and postgraduate students in the areas of geophysics and acoustical physics

Handbook of Borehole Acoustics and Rock Physics for Reservoir Characterization Vimal Saxena, Michel Krief, Ludmila Adam, 2018-04-28 The Handbook of Borehole Acoustics and Rock Physics for Reservoir Characterization combines in a single useful handbook the multidisciplinary domains of the petroleum industry including the fundamental concepts of rock physics acoustic logging waveform processing and geophysical application modeling through graphical examples derived from field data It includes results from core studies together with graphics that validate and support the modeling process and explores all possible facets of acoustic applications in reservoir evaluation for hydrocarbon exploration development and drilling support The Handbook of Borehole Acoustics and Rock Physics for Reservoir Characterization serves as a technical guide and research reference for oil and gas professionals scientists and students in the multidisciplinary field of reservoir characterization through the use of petrosonics It overviews the fundamentals of borehole acoustics and rock physics with a focus on reservoir evaluation applications explores current advancements through updated research and identifies areas of future growth Presents theory application and limitations of borehole acoustics and rock physics through field examples and case studies Features Petrosonic Workflows for various acoustic applications and evaluations which can be easily adapted for practical reservoir modeling and interpretation Covers the potential advantages of acoustic based techniques and summarizes key results for easy geophysical application

Multi-Component Acoustic Characterization of Porous Media Karel N. van Dalen, 2013-01-11 The feasibility to extract porous medium parameters from acoustic recordings is investigated The thesis gives an excellent discussion of our basic understanding of different wave modes using a full waveform and multi component approach Focus lies on the dependency on porosity and permeability where especially the latter is difficult to estimate In this thesis this sensitivity is shown for interface wave and reflected wave modes For each of the pseudo Rayleigh and pseudo Stoneley interface waves unique estimates for permeability and porosity can be obtained when impedance and attenuation are combined The pseudo Stoneley wave is most sensitive to permeability both the impedance and the attenuation are controlled by the fluid flow Also from reflected wave modes unique estimates for permeability and porosity can be obtained when the reflection coefficients of different reflected modes are combined In this case the sensitivity to permeability is caused by subsurface heterogeneities generating mesoscopic fluid flow at seismic

frequencies The results of this thesis suggest that estimation of in situ permeability is feasible provided detection is carried out with multi component measurements The results of this thesis argely affect geotechnical and reservoir engineering practices

Experimental and Numerical Simulations of Rock Physics Huaimin Dong,Yihuai Zhang,Weichao Yan,2025-09-01 Rock physics experiments and numerical simulations are indispensable tools in geology and mineral resources exploration Experiments can provide real data on the physical properties of rocks while numerical simulations can reproduce these properties and predict behavior under unknown conditions on a computer Understanding the physical properties of rocks is crucial in energy source exploration and development Rock physics experiments can perform various tests on samples under controlled environments These experiments can provide real data on the physical properties In contrast numerical simulations have the advantages of low cost and high flexibility Through numerical simulations the physical properties of rocks can be reproduced on a computer and their behavior under unknown conditions can be predicted Combining rock physics experiments with numerical simulations can provide a more comprehensive understanding of the physical properties of rocks and offer more accurate data support for energy source exploration and development

The Rock Physics Handbook Gary Mavko,Tapan Mukerji,Jack Dvorkin,2009-04-30 The Rock Physics Handbook addresses the relationships between geophysical observations and the underlying physical properties of rocks It distills a vast quantity of background theory and laboratory results into a series of concise chapters that provide practical solutions to problems in geophysical data interpretation This expanded second edition presents major new chapters on statistical rock physics and velocity porosity clay models for clastic sediments Other new and expanded topics include anisotropic seismic signatures borehole waves models for fractured media poroelastic models and attenuation models This new edition also provides an enhanced set of appendices with key empirical results data tables and an atlas of reservoir rock properties extended to include carbonates clays gas hydrates and heavy oils Supported by a website hosting MATLAB routines for implementing the various rock physics formulas this book is a vital resource for advanced students and university faculty as well as petroleum industry geophysicists and engineers

Numerical Modeling of Coupled Phenomena in Science and Engineering Mario César Suárez Arriaga,Jochen Bundschuh,Francisco Javier Dominguez-Mota,2008-12-01 Mathematics is a universal language Differential equations mathematical modeling numerical methods and computation form the underlying infrastructure of engineering and the sciences In this context mathematical modeling is a very powerful tool for studying engineering problems natural systems and human society This interdisciplinary book cont

Quantitative Borehole Acoustic Methods X.M. Tang,A. Cheng,2004-02-10 Acoustic logging is a multidisciplinary technology involving basic theory instrumentation and data processing interpretation methodologies The advancement of the technology now allows for a broad range of measurements to obtain formation properties such as elastic wave velocity and attenuation formation permeability and seismic anisotropy that are important for petroleum reservoir exploration With these advances it is easier to

detect and characterize formation fractures estimate formation stress field and locate estimate petroleum reserves The technology has evolved from the monopole acoustic logging into the multipole including dipole cross dipole and even quadrupole acoustic logging measurements The measurement process has developed from the conventional wireline logging into the logging while drilling stage For such a fast developing technology with applications that are interesting to readers of different backgrounds it is necessary to have systematic documentation of the discipline including the theory methods and applications as well as the technology s past present and near future development trends Quantitative Borehole Acoustic Methods provides such documentation with emphasis on the development over the past decade Although considerable effort has been made to provide a thorough basis for the theory and methodology development emphasis is placed on the applications of the developed methods The applications are illustrated with field data examples Many of the acoustic waveform analysis processing methods described in the book are now widely used in the well logging industry

Seismic While Drilling F.B Poletto,F. Miranda,2004-06-30 The purpose of this book is to give a theoretical and practical introduction to seismic while drilling by using the drill bit noise This recent technology offers important products for geophysical control of drilling It involves aspects typical of borehole seismics and of the drilling control surveying hitherto the sole domain of mudlogging For aspects related to the drill bit source performance and borehole acoustics the book attempts to provide a connection between experts working in geophysics and in drilling There are different ways of thinking related to basic knowledge operational procedures and precision in the observation of the physical quantities The goal of the book is to help build a bridge between geophysicists involved in seismic while drilling who may need to familiarize themselves with methods and procedures of drilling and drilling rock mechanics and drillers involved in geosteering and drilling of smart wells who may have to familiarize themselves with seismic signals wave resolution and radiation For instance an argument of common interest for drilling and seismic while drilling studies is the monitoring of the drill string and bit vibrations This volume contains a large number of real examples of SWD data analysis and applications

Borehole Imaging Gail Williamson,M. A. Lovell,Peter K. Harvey,1999 *High-pressure physical behavior of minerals and rocks: Mineralogy, petrology and geochemistry* Lidong Dai,Xi Liu,Geeth Manthilake,Vassilios Saltas,Haiying Hu,2023-02-08 *Basic Theory in Reflection Seismology* J.K. Costain,C. Coruh,2004-10-27 The material in this volume provides the basic theory necessary to understand the principles behind imaging the subsurface of the Earth using reflection and refraction seismology For reflection seismology the end product is a record section from a collection of wiggly traces that are recorded in the field from which information about the properties of subsurface structure and rock can be derived For the most part the principles of imaging are the same regardless of the depth to the target the same mathematical background is necessary for targeting a shallow water table as for investigating the base of the earth s continental crust at a depth of 30 50 km

Petroleum Engineering Handbook: pt. A and pt. B. Reservoir engineering and petrophysics Larry W. Lake,2007 Volume V Reservoir

engineering and petrophysics helps reservoir engineers learn how to acquire and interpret data that describe reservoir rock and fluid properties understand and predict fluid flow in the reservoir estimate reserves and calculate project economics simulate reservoir performance and measure the effectiveness of a reservoir management system

Advances in Near-surface Seismology and Ground-penetrating Radar, Volume 15 Richard D. Miller, John H. Bradford, Klaus Holliger, Rebecca B. Latimer, 2010-01-11 Advances in Near surface Seismology and Ground penetrating Radar SEG Geophysical Developments Series No 15 is a collection of original papers by renowned and respected authors from around the world Technologies used in the application of near surface seismology and ground penetrating radar have seen significant advances in the last several years Both methods have benefited from new processing tools increased computer speeds and an expanded variety of applications This book divided into four sections Reviews Methodology Integrative Approaches and Case Studies Captures the most significant cutting edge issues in active areas of research unveiling truly pertinent studies that address fundamental applied problems This collection of manuscripts grew from a core group of papers presented at a post convention workshop Advances in Near surface Seismology and Ground penetrating Radar held during the 2009 SEG Annual Meeting in Houston Texas This is the first cooperative publication effort between the near surface communities of SEG AGU and EEGS It will appeal to a large and diverse audience that includes researchers and practitioners inside and outside the near surface geophysics community Publisher description

Methods in Karst Hydrogeology Nico Goldscheider, David Drew, 2014-04-21 Filling a gap in the karst literature this book describes methods most appropriate for use in karst terrains These include methods that are basic to all hydrogeological studies such as hydraulic investigations hydrochemistry geophysics isotope chemistry and modelling with the emphasis placed on their application to karst systems The various chapters of this book are written by experts in all the different methods Most of the chapters are multi authored and the authors include hydrogeologists who are experienced in evaluating a variety of karst environments and who together provide a balanced view of all the karst methods

A Practical Guide to Borehole Geophysics in Environmental Investigations W. Scott Keys, 2017-12-06 Borehole geophysics is frequently applied in hydrogeological environmental investigations where for example sites must be evaluated to determine the distribution of contaminants It is a cost effective method for obtaining information during several phases of such investigations Written by one of world s leading experts in the field A Practical Guide to Borehole Geophysics in Environmental Investigations explains the basic principles of the many tools and techniques used in borehole logging projects Applications are presented in terms of broad project objectives providing a hands on guide to geophysical logging programs including specific examples of how to obtain and interpret data that meet particular hydrogeologic objectives

Advances in Geophysics Haruo Sato, Michael Fehler, 2009-02-26 Seismic waves generated by earthquakes have been interpreted to provide us information about the Earth s structure across a variety of scales For short periods of less than 1 second the envelope of seismograms changes significantly with increased travel

distance and coda waves are excited by scattering due to randomly distributed heterogeneities in the Earth Deterministic structures such as horizontally uniform velocity layer models in traditional seismology cannot explain these phenomena This book focuses on the Earth heterogeneity and scattering effects on seismic waves Topics covered are recent developments in wave theory and observation including coda wave analysis for mapping medium heterogeneity and monitoring temporal variation of physical properties radiation of short period seismic waves from an earthquake fault weak localization of seismic waves attenuation of seismic waves in randomly porous media synthesis of seismic wave envelopes in short periods and laboratory investigations of ultrasonic wave propagation in rock samples Understanding new methods for the analysis of short period seismic waves to characterize the random heterogeneity of the Earth on many scales Observations of seismic wave scattering Discussion of techniques for mapping medium heterogeneity and for monitoring temporal change in medium characteristics Up to date techniques for the synthesis of wave envelopes in random media **Use of Airborne, Surface,**

and Borehole Geophysical Techniques at Contaminated Sites,1993 **Aquifer Characterization Techniques**

Robert G. Maliva,2016-05-26 This book presents an overview of techniques that are available to characterize sedimentary aquifers Groundwater flow and solute transport are strongly affected by aquifer heterogeneity Improved aquifer characterization can allow for a better conceptual understanding of aquifer systems which can lead to more accurate groundwater models and successful water management solutions such as contaminant remediation and managed aquifer recharge systems This book has an applied perspective in that it considers the practicality of techniques for actual groundwater management and development projects in terms of costs technical resources and expertise required and investigation time A discussion of the geological causes types and scales of aquifer heterogeneity is first provided Aquifer characterization methods are then discussed followed by chapters on data upscaling groundwater modelling and geostatistics This book is a must for every practitioner graduate student or researcher dealing with aquifer characterization The Conterminous United States Mineral Assessment Program Denise A. Wiltshire,John N. Fischer,Forest P. Lyford,Andrew J. Cohen,1984

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