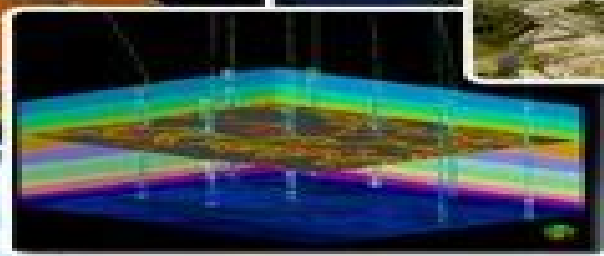
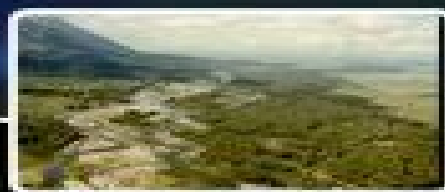
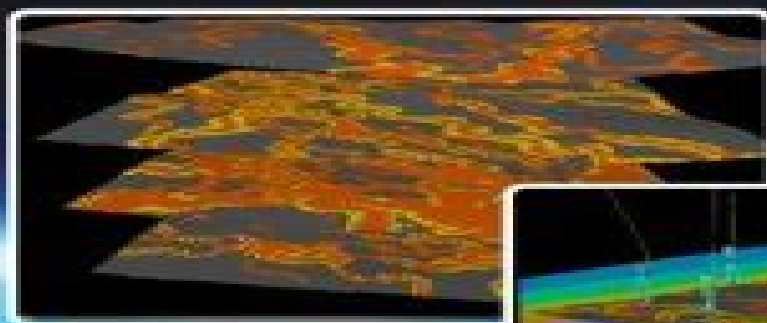


Uncertainty Analysis and Reservoir Modeling

Developing and Managing Assets in an Uncertain World



Edited by Y. Zee Ma and Paul La Pointe

Uncertainty Analysis In Reservoir Characterization M96 Aapg Memoir

Y. Zee Ma, Paul R. La Pointe



Uncertainty Analysis In Reservoir Characterization M96 Aapg Memoir:

Uncertainty Analysis and Reservoir Modeling Y. Zee Ma, Paul R. La Pointe, 2011-12-20 **Uncertainty Evaluation and Integration of Dynamic Data in Reservoir Characterization** Arjun Bathija, 1998 **Introduction to Geological Uncertainty Management in Reservoir Characterization and Optimization** Reza Yousefzadeh, Alireza Kazemi, Mohammad Ahmadi, Jebraeel Gholinezhad, 2023-04-08 This book explores methods for managing uncertainty in reservoir characterization and optimization. It covers the fundamentals, challenges, and solutions to tackle the challenges made by geological uncertainty. The first chapter discusses types and sources of uncertainty and the challenges in different phases of reservoir management along with general methods to manage it. The second chapter focuses on geological uncertainty, explaining its impact on field development and methods to handle it using prior information, seismic and petrophysical data, and geological parametrization. The third chapter deals with reducing geological uncertainty through history matching and the various methods used, including closed loop management, ensemble assimilation, and stochastic optimization. The fourth chapter presents dimensionality reduction methods to tackle high dimensional geological realizations. The fifth chapter covers field development optimization using robust optimization, including solutions for its challenges such as high computational cost and risk attitudes. The final chapter introduces different types of proxy models in history matching and robust optimization, discussing their pros and cons and applications. The book will be of interest to researchers and professors, geologists, and professionals in oil and gas production and exploration. **Markov Chain Monte Carlo Algorithm, Integrated 4D Seismic Reservoir Characterization and Uncertainty Analysis in a Bayesian Framework** Tiancong Hong, 2008 *Uncertainty Analysis in Hydrocarbon Reservoir Studies* Mohammad Jahidnezhad, 2014-01-17 Out of print. Unavailable for order, production, and distribution. **Applied Techniques to Integrated Oil and Gas Reservoir Characterization** Enwenode Onajite, 2021-04-09 Over the past several years, there has been a growing integration of data, geophysical, geological, petrophysical, engineering-related, and production-related in predicting and determining reservoir properties. As such, geoscientists now must learn the technology processes and challenges involved within their specific functions in order to optimize planning for oil field development. *Applied Techniques to Integrated Oil and Gas Reservoir Characterization* presents challenging questions encountered by geoscientists in their day-to-day work in the exploration and development of oil and gas fields and provides potential solutions from experts. From basin analysis of conventional and unconventional reservoirs to seismic attributes analysis, NMR for reservoir characterization, amplitude versus offset (AVO) well to seismic tie, seismic inversion, studies, rock physics, pore pressure prediction, and 4D for reservoir monitoring, the text examines challenges in the industry as well as the techniques used to overcome those challenges. This book includes valuable contributions from global industry experts: Brian Schulte, Schiefer Reservoir Consulting; Dr. Neil W. Craigie, Saudi Aramco; Matthijs van der Molen, Shell International E.P.; Dr. Fred W. Schroeder, ExxonMobil retired; Dr. Tharwat Hassane, Schlumberger.

BP retired and others Presents a thorough understanding of the requirements of various disciplines in characterizing a wide spectrum of reservoirs Includes real life problems and challenging questions encountered by geoscientists in their day to day work along with answers from experts working in the field Provides an integrated approach among different disciplines geology geophysics petrophysics and petroleum engineering Offers advice from industry experts to geoscience students including career guides and interview tips Uncertainty Analysis of Reservoir Operation □□□,2014 *Reservoir Characterization and History Matching with Uncertainty Quantification Using Ensemble-based Data Assimilation with Data Re-parameterization* Mingliang Liu,2021 Reservoir characterization and history matching are essential steps in various subsurface applications such as petroleum exploration and production and geological carbon sequestration aiming to estimate the rock and fluid properties of the subsurface from geophysical measurements and borehole data Mathematically both tasks can be formulated as inverse problems which attempt to find optimal earth models that are consistent with the true measurements The objective of this dissertation is to develop a stochastic inversion method to improve the accuracy of predicted reservoir properties as well as quantification of the associated uncertainty by assimilating both the surface geophysical observations and the production data from borehole using Ensemble Smoother with Multiple Data Assimilation To avoid the common phenomenon of ensemble collapse in which the model uncertainty would be underestimated we propose to re parameterize the high dimensional geophysics data with data order reduction methods for example singular value decomposition and deep convolutional autoencoder and then perform the models updating efficiently in the low dimensional data space We first apply the method to seismic and rock physics inversion for the joint estimation of elastic and petrophysical properties from the pre stack seismic data In the production or monitoring stage we extend the proposed method to seismic history matching for the prediction of porosity and permeability models by integrating both the time lapse seismic and production data The proposed method is tested on synthetic examples and successfully applied in petroleum exploration and production and carbon dioxide sequestration *Reservoir Characterization* Larry W. Lake,Herbert B. Carroll,1986 **Practical Reservoir Engineering and Characterization** Richard O. Baker,Harvey W. Yarranton,Jerry Jensen,2015-04-30 Practical Reservoir Characterization expertly explains key technologies concepts methods and terminology in a way that allows readers in varying roles to appreciate the resulting interpretations and contribute to building reservoir characterization models that improve resource definition and recovery even in the most complex depositional environments It is the perfect reference for senior reservoir engineers who want to increase their awareness of the latest in best practices but is also ideal for team members who need to better understand their role in the characterization process The text focuses on only the most critical areas including modeling the reservoir unit predicting well behavior understanding past reservoir performance and forecasting future reservoir performance The text begins with an overview of the methods required for analyzing characterizing and developing real reservoirs then explains the different

methodologies and the types and sources of data required to characterize forecast and simulate a reservoir Thoroughly explains the data gathering methods required to characterize forecast and simulate a reservoir Provides the fundamental background required to analyze characterize and develop real reservoirs in the most complex depositional environments Presents a step by step approach for building a one two or three dimensional representation of all reservoir types

Uncertainty Analysis of the Effects of Reservoir Fluids on Seismic Properties William Ampomah,2012 **Reservoir Characterization, Modeling and Quantitative Interpretation** Shib Sankar Ganguli,V.P. Dimri,2023-10-27 Reservoir Characterization Modeling and Quantitative Interpretation Recent Workflows to Emerging Technologies offers a wide spectrum of reservoir characterization techniques and technologies focusing on the latest breakthroughs and most efficient methodologies in hydrocarbon exploration and development Topics covered include 4D seismic technologies AVAz inversion fracture characterization multiscale imaging technologies static and dynamic reservoir characterization among others The content is delivered through an inductive approach which will help readers gain comprehensive insights on advanced practices and be able to relate them to other subareas of reservoir characterization including CO₂ storage and data driven modeling This will be especially useful for field scientists in collecting and analyzing field data prospect evaluation developing reservoir models and adopting new technologies to mitigate exploration risk They will be able to solve the practical and challenging problems faced in the field of reservoir characterization as it will offer systematic industrial workflows covering every aspect of this branch of Earth Science including subsurface geoscientific perspectives of carbon geosequestration This resource is a 21st Century guide for exploration geologists geoscience students at postgraduate level and above and petrophysicists working in the oil and gas industry Covers the latest and most effective technologies in reservoir characterization including Avo analysis AVAz inversion wave field separation and Machine Learning techniques Provides a balanced blend of both theoretical and practical approaches for solving challenges in reservoir characterization Includes detailed industry standard practical workflows along with code structures for algorithms and practice exercises

Reservoir Characterization of Non Gaussian Field Using Combined Ensemble Based Method Samson B. Folarin,2020 The proper reservoir characterization was a decade long challenge for both geoscientists and reservoir engineers because of the complex subsurface structures Ensemble Kalman filter was studied rigorously as a promising method for quantify the reservoir uncertainty quantification Because of its computational efficiency and easy implementation on any simulator petroleum engineers recommended ensemble Kalman filter EnKF as a useful history matching technique It failed because of the Gaussian assumption and the inconsistency that exist between the updated static and dynamics parameters which violate the field s material balance Wang et al 2012 introduced an improved method called half iterative ensemble Kalman filter HIEnKF to overcome the shortcomings of the EnKF The new method HIEnKF appears to be promising in the field of history matching but has its drawback Mary Wheeler et al 2013 introduced the ensemble smoother method to overcome the

computational cost induced by HIEnKF Various challenges arise from the existing methods that motivated us to propose new techniques that can give a promising result in petroleum engineering We designed our first method by considering the advantage of half iterative EnKF and ensemble smoother The combined half iterative EnKF and ensemble smoother CoHIEnKFS characterize a Gaussian field better than the existing methods Previous work has shown poor characterization on reservoirs with non Gaussian permeability distribution which fails to satisfy HIEnKF Gaussian assumption We apply a normal score transformation on CoHIEnKFS to meet this assumption The new method normal score combined half iterative EnKF and ES produces a good result in the petroleum history matching field

Statistical Reservoir Characterization, Simulation, and Optimization of Field Scale-gas Assisted Gravity Drainage (GAGD) Process with Uncertainty Assessments Watheq Jasim Mohammed Al-Mudhafar, 2016

AAPG Hedberg Research Conference ,2000

Applications of Level Set and Fast Marching Methods in Reservoir Characterization Jiang Xie, 2012

Reservoir characterization is one of the most important problems in petroleum engineering It involves forward reservoir modeling that predicts the fluid behavior in the reservoir and inverse problem that calibrates created reservoir models with given data In this dissertation we focus on two problems in the field of reservoir characterization depth of investigation in heterogeneous reservoirs and history matching and uncertainty quantification of channelized reservoirs The concept of depth of investigation is fundamental to well test analysis Much of the current well test analysis relies on analytical solutions based on homogeneous or layered reservoirs However such analytic solutions are severely limited for heterogeneous and fractured reservoirs particularly for unconventional reservoirs with multistage hydraulic fractures We first generalize the concept to heterogeneous reservoirs and provide an efficient tool to calculate drainage volume using fast marching methods and estimate pressure depletion based on geometric pressure approximation The applicability of proposed method is illustrated using two applications in unconventional reservoirs including flow regime visualization and stimulated reservoir volume estimation Due to high permeability contrast and non Gaussianity of channelized permeability field it is difficult to history match and quantify uncertainty of channelized reservoirs using traditional approaches We treat facies boundaries as level set functions and solve the moving boundary problem history matching with the level set equation In addition to level set methods we also exploit the problem using pixel based approach The reversible jump Markov Chain Monte Carlo approach is utilized to search the parameter space with flexible dimensions Both proposed approaches are demonstrated with two and three dimensional examples

DEVELOPMENT OF AN ADVANCED APPROACH FOR NEXT-GENERATION INTEGRATED RESERVOIR CHARACTERIZATION. , 2005

Accurate high resolution three dimensional 3D reservoir characterization can provide substantial benefits for effective oilfield management By doing so the predictive reliability of reservoir flow models which are routinely used as the basis for investment decisions involving hundreds of millions of dollars and designed to recover millions of barrels of oil can be significantly improved Even a small improvement in incremental recovery for high value assets can

result in important contributions to bottom line profitability Today's standard practice for developing a 3D reservoir description is to use seismic inversion techniques These techniques make use of geostatistics and other stochastic methods to solve the inverse problem i.e. to iteratively construct a likely geologic model and then upscale and compare its acoustic response to that actually observed in the field This method has several inherent flaws such as 1 The resulting models are highly non unique multiple equiprobable realizations are produced meaning 2 The results define a distribution of possible outcomes the best they can do is quantify the uncertainty inherent in the modeling process and 3 Each realization must be run through a flow simulator and history matched to assess its appropriateness and therefore 4 The method is labor intensive and requires significant time to complete a field study thus it is applied to only a small percentage of oil and gas producing assets A new approach to achieve this objective was first examined in a Department of Energy DOE study performed by Advanced Resources International ARI in 2000 2001 The goal of that study was to evaluate whether robust relationships between data at vastly different scales of measurement could be established using virtual intelligence VI methods The proposed workflow required that three specific relationships be established through use of artificial neural networks ANN's core to log log to crosswell seismic and crosswell to surface seismic One of the key attributes of the approach which should result in the creation of high resolution reservoir characterization with greater accuracy and with less uncertainty than today's methods is the inclusion of borehole seismic such as crosswell and or vertical seismic profiling VSP in the data collection scheme Borehole seismic fills a critical gap in the resolution spectrum of reservoir measurements between the well log and surface seismic scales thus establishing important constraints on characterization outcomes The results of that initial study showed that it is in fact feasible to establish the three critical relationships required and that use of data at different scales of measurement to create high resolution reservoir characterization is possible Based on the results of this feasibility study in September 2001 the DOE again through ARI launched a subsequent two year government industry R D project to further develop and demonstrate the technology The goals of this project were to 1 Make improvements to the initial methodology by incorporating additional VI technologies such as clustering using core measurements in place of magnetic resonance image MRI logs and streamlining the workflow among others 2 Demonstrate the approach in an integrated manner at a single field site and validate it via reservoir modeling or other statistical methods

Novel Stochastic Inversion Methods and Workflow for Reservoir Characterization and Monitoring Yang Xue, 2013

Reservoir models are generally constructed from seismic well logs and other related datasets using inversion methods and geostatistics It has already been recognized by the geoscientists that such a process is prone to non uniqueness Practical methods for estimation of uncertainty still remain elusive In my dissertation I propose two new methods to estimate uncertainty in reservoir models from seismic well logs and well production data The first part of my research is aimed at estimating reservoir impedance models and their uncertainties from seismic data and well logs This constitutes an inverse

problem and we recognize that multiple models can fit the measurements A deterministic inversion based on minimization of the error between the observation and forward modeling only provides one of the best fit models which is usually band limited A complete solution should include both models and their uncertainties which requires drawing samples from the posterior distribution A global optimization method called very fast simulated annealing VFSA is commonly used to approximate posterior distribution with fast convergence Here I address some of the limitations of VFSA by developing a new stochastic inference method named Greedy Annealed Importance Sampling GAIS GAIS combines VFSA with greedy importance sampling GIS which uses a greedy search in the important regions located by VFSA to attain fast convergence and provide unbiased estimation I demonstrate the performance of GAIS on post and pre stack data from real fields to estimate impedance models The results indicate that GAIS can estimate both the expectation value and the uncertainties more accurately than using VFSA alone Furthermore principal component analysis PCA as an efficient parameterization method is employed together with GAIS to improve lateral continuity by simultaneous inversion of all traces The second part of my research involves estimation of reservoir permeability models and their uncertainties using quantitative joint inversion of dynamic measurements including synthetic production data and time lapse seismic related data Impacts from different objective functions or different data sets on the model uncertainty and model predictability are investigated as well The results demonstrate that joint inversion of production data and time lapse seismic related data water saturation maps here reduces model uncertainty improves model predictability and shows superior performance than inversion using one type of data alone

Parameter Estimation and Uncertainty Quantification in Water Resources Modeling Philippe Renard, Frederick Delay, Daniel M. Tartakovsky, Velimir V. Vesselinov, 2020-04-22 Numerical models of flow and transport processes are heavily employed in the fields of surface soil and groundwater hydrology They are used to interpret field observations analyze complex and coupled processes or to support decision making related to large societal issues such as the water energy nexus or sustainable water management and food production Parameter estimation and uncertainty quantification are two key features of modern science based predictions When applied to water resources these tasks must cope with many degrees of freedom and large datasets Both are challenging and require novel theoretical and computational approaches to handle complex models with large number of unknown parameters

Characterization and Assessment of Uncertainty in San Juan Reservoir Santa Rosa Field Ernesto Jose Becerra, 2005 This study proposes a new easily applied method to quantify uncertainty in production forecasts for a volumetric gas reservoir based on a material balance model p_z vs G subscript p The new method uses only observed data and mismatches between regression values and observed values to identify the most probable value of gas reserves The method also provides the range of probability of values of reserves from the minimum to the maximum likely value The method is applicable even when only limited information is available from a field Previous methods suggested in the literature require more information than our new method Quantifying uncertainty in reserves

estimation is becoming increasingly important in the petroleum industry. Many current investment opportunities in reservoir development require large investments, many in harsh exploration environments with intensive technology requirements and possibly marginal investment indicators. Our method of quantifying uncertainty uses a priori information which could come from different sources, typically from geological data used to build a static or prior reservoir model. Additionally, we propose a method to determine the uncertainty in our reserves estimate at any stage in the life of the reservoir for which pressure production data are available. We applied our method to San Juan reservoir at Santa Rosa Field, Venezuela. This field was ideal for this study because it is a volumetric reservoir for which the material balance method, the p_z vs G_p plot, appears to be appropriate.

Whispering the Strategies of Language: An Mental Journey through **Uncertainty Analysis In Reservoir Characterization M96 Aapg Memoir**

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