Reservoir Geomechanics
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Thermo-Poroelasticity and Geomechanics

The Future of Geological Modelling in Hydrocarbon Development

Structurally Complex Reservoirs

Core Analysis

Unconventional reservoirs cannot provide suitable modes of behavior and performance for today's unconventional reservoirs such as the evolution of porosity-permeability relationships with multiphysics coupled effects, which ultimately help determine production rates. Unconventional Reservoir Geomechanics delivers a reference that discusses a variety of approaches tailored in developing geomechanical models and provides a smarter tool to predict hydrocarbon extraction specifically for unconventional reservoirs. Starting with a full explanation on a more unified theoretical framework discussing permeability characterization, the authors advance to offer a full range of new modelling solutions followed by a series of lab-scale and field-scale applications to match the history-verified models, bridging a gap for engineers to fully understand the interactions of multiple processes in field scales from theory to practice. Going a step further, other applications such as CO2 sequestration in coal seam or shale gas reservoirs are explained to illustrate how unconventional reservoir geomechanics can be extended to solve related and even more complex challenges. Combining both theoretical and practical models backed by data, Unconventional Reservoir Geomechanics gives reservoir engineers a smarter and more sophisticated tool to approach today's more complex challenges. Combining both theoretical and practical models backed by data, Unconventional Reservoir Geomechanics gives reservoir engineers a smarter and more sophisticated tool to approach today's more complex challenges.

Challenges and Innovations in Geomechanics

Multiphase Fluid Flow in Porous and Fractured Reservoirs discusses the process of modeling fluid flow in petroleum and natural gas reservoirs, a practice that has become increasingly complex thanks to multiple factors such as horizontal drilling in the discovery of more unconventional reservoirs and resources. The book updates the reservoir engineer of today with the latest developments in reservoir simulation by combining a powerhouse of theory, analytical, and numerical methods to create stronger verification and validation modeling methods, ultimately improving recovery in stagnant and complex reservoirs. Going beyond the standard topics in past literature, coverage includes well treatment, Non-Newtonian fluids and rheological models,
Reservoir Geomechanics

Geomechanics investigates the origin, magnitude and deformational consequences of stresses in the crust. In recent years awareness of geomechanical processes has been heightened by societal debates on fracking, human-induced seismicity, natural geohazards and safety issues with respect to petroleum exploration drilling, carbon sequestration and radioactive waste disposal. This volume explores the common ground linking geomechanics with inter alia economic and petroleum geology, structural geology, petrophysics, seismology, geotechnics, reservoir engineering and production technology. Geomechanics is a rapidly developing field that brings together a broad range of subsurface professionals seeking to use their expertise to solve current challenges in applied and fundamental geoscience. A rich diversity of case studies herein showcase applications of geomechanics to hydrocarbon exploration and field development, natural and artificial geohazards, reservoir stimulation, contemporary tectonics and subsurface fluid flow. These papers provide a representative snapshot of the exciting state of geomechanics and establish it firmly as a flourishing subdiscipline of geology that merits broadest exposure across the academic and corporate geosciences.

Geomechanics and Hydraulic Fracturing for Shale Reservoirs

Core Analysis: A Best Practice Guide is a practical guide to the design of core analysis programs. Written to address the need for an updated set of recommended practices covering special core analysis and geomechanics tests, the book also provides unique insights into data quality control diagnosis and data utilization in reservoir models. The book's best practices and procedures benefit petrophysicists, geoscientists, reservoir engineers, and production engineers, who will find useful information on core data in reservoir static and dynamic models. It provides a solid understanding of the core analysis procedures and methods used by commercial laboratories, the details of lab data reporting required to create quality control tests, and the diagnostic plots and protocols that can be used to identify suspect or erroneous data. Provides a practical overview of core analysis, from coring at the well site to laboratory data acquisition and interpretation. Defines current best practice in core analysis preparation and test procedures, and the diagnostic tools used to quality control core data. Provides essential information on design of core analysis programs and to judge the quality and reliability of core analysis data ultimately used in reservoir evaluation. Of specific interest to those working in core analysis, porosity, relative permeability, and geomechanics.

Rock Mechanics for Resources, Energy and Environment

An Introduction to Reservoir Simulation Using MATLAB/GNU Octave

This book is meant for geoscientists and engineers who are beginners, and introduces them to the field of seismic data interpretation and evaluation. The exquisite seismic illustrations and real case examples interspersed in the text help the readers appreciate the interpretation of seismic data in a simple way, and at the same time, emphasize the multidisciplinary, integrated practical approach to data evaluation. A concerted effort has been made for the readers to realize that mindless interpretation of seismic data using sophisticated software packages, without having a grasp on the elementary principles of geology and geophysics, and coupled with their over-reliance on workstations to provide solutions can have appalling results all too very often.

Coupled Chemo-mechanical Processes in Reservoir Geomechanics

Engineers and geologists in the petroleum industry will find Petroleum Related Rock Mechanics, 2e, a powerful resource in providing a basis of rock mechanical knowledge – a knowledge which can greatly assist in the understanding of field behavior, design of test programs and the design of field operations. Not only does this text give an introduction to applications of rock mechanics within the petroleum industry, it has a strong focus on basics, drilling, production and reservoir engineering. Assessment of rock mechanical parameters is covered in depth, as is acoustic wave propagation in rocks, with possible link to 4D seismics as well as log interpretation. Learn the basic principles behind rock mechanics from leading academic and industry experts. Quick reference and guide for engineers and geologists working in the field. Keep informed and up to date on all the latest methods and fundamental concepts.

Multiphase Fluid Flow in Porous and Fractured Reservoirs

This book gathers the latest advances, innovations, and applications in the field of computational geomechanics, as presented by international researchers and engineers at the 16th International Conference of the International Association for Computer Methods and Advances in Geomechanics (IACMAG 2020/21). Contributions include a wide range of topics in geomechanics such as: monitoring and remote sensing, multiphase modelling, reliability and risk analysis, surface structures, deep structures, dams and earth structures, coastal engineering, mining engineering, earthquake and dynamics, soil-atmosphere interaction, ice mechanics, landfills and waste disposal, gas and petroleum engineering, geothermal energy, offshore technology, energy geostuctures, geomechanical numerical models and computational rail geotechnics.

Theory of Linear Poroelasticity with Applications to Geomechanics and
Hydrogeology

The increasing demand for hydrocarbons and decreasing reserves have created the necessity to produce oil and gas more efficiently and economically. Increasingly, oil and gas companies are focusing on unconventional hydrocarbons; oil sands, shales and CBM. For this class of reservoir materials, the geomechanical response of the reservoir can play an important role in the recovery process. For naturally fractured, stress sensitive reservoirs or thermal recovery processes, geomechanical processes play an even greater role in efficient, economic recovery. For simulations of these processes, most research efforts have been focused on reservoir geomechanical simulations using conventional reservoir simulators coupled to geomechanical codes. While coupled reservoir-geomechanics modeling has been recently widely studied in the literature, there is no applicable methodology implemented or proposed to mitigate the challenging computational cost involved with the inclusion of geomechanics in large multillion-cell reservoirs. Past studies so far have focused on different coupling schemes, but not on the efficient and robust simulation workflows. This research was conducted with the aim of development and application of various different strategies to include geomechanics into reservoir simulation workflows in large scale reservoirs and in a timely fashion process. The research was performed to allow the future simulators to perform high resolution reservoir-geomechanical simulations in a large scale (near field and far field) with long simulation time windows and lowest computational cost. Initially, analytical proxies were developed and recommending for implementation in lieu of complex reservoir simulations. The analytical model was for prediction of heavy oil geomechanical responses everywhere in the reservoir. The model adopted the use of the mathematical domain decomposition technique and a novel temperature front tracking developed in the very early stage of the research. As opposed to classical analytical models, the proxy predicted reservoir flow and mechanical behavior (on a synthetic case geometry with real hydraulic data) everywhere in the reservoir and in dynamic and transient flow regimes. Subsequent research was aimed at reservoir-geomechanics coupled model order reduction by use of a numerical proxy. The proxy took advantage of streamline linear space behavior and power in decomposition of the reservoir domain into sub-systems (delineation/drainage areas). The combination of localization and linearization allowed predicting both mechanical and fluid flow responses of the reservoir with only solving the pressure equation in Cartesian underlying 3D grids and the solution of saturation transport equation along only one streamline. Following this, a streamline-based reservoir-geomechanics coupling was proposed and was implemented within a Fortran-C++ based platform. The new developed technique was compared in terms of computational cost and results accuracy with the conventional hydromechanical coupling strategy that was developed on a C++ based platform by use of collocated FV-FEM discretization scheme. One of the final stages of the research explored different streamline-based reservoir-geomechanics coupling strategies for full-field reservoir simulations. Various coupling strategies including sequential coupling schemes and a semi-fully coupling scheme to embed geomechanics into streamline simulation workflow was developed and performed. Numerical software with advanced GUI was coded on QT programming language (C++ based) developed to couple mechanical simulator to streamline simulation engine. While streamline simulations were the center of the research, the last stage of research was conducted on numerical and physical stability, convergence and material balance errors of SL-based reservoir-geomechanics class of couplings. The results provided a solid foundation for proper selection of time-steps in SL-based coupling to ensure a numerically stable and physically robust hydromechanical simulation. As a result we showed that use of streamline simulation in both proxy forms and simulator forms have significant added value in full-field reservoir-geomechanics simulations.

Principles of Applied Reservoir Simulation

This thesis presents an impressive summary of the potential to use passive seismic methods to monitor the sequestration of anthropogenic CO2 in geologic reservoirs. It brings together innovative research in two distinct areas – seismology and geomechanics – and involves both data analysis and numerical modelling. The data come from the Weyburn-Midale project, which is currently the largest Carbon Capture and Storage (CCS) project in the world. James Verdon's results show how passive seismic monitoring can be used as an early warning system for fault reactivation and top seal failure, which may lead to the escape of CO2 at the surface.

Production-induced Changes in Reservoir Geomechanics

Geomechanical and Petrophysical Properties of Mudrocks

A full account of thermo-poroelasticity and thermo-poromechanics with derivations to problems, for both experienced and novice researchers.

Geomechanics, Fluid Dynamics and Well Testing, Applied to Naturally Fractured Carbonate Reservoirs

Course held May 19-20, 2011 during the 2011 joint CSPG-CSEG-CWLS convention, "Recovery: energy, environment, economy".

Geomechanics Applied to the Petroleum Industry

Use of Streamline Simulation in Large Scale Reservoir-geomechanical Modeling of Reservoirs

This volume reviews our current understanding and ability to model the complex distribution and behaviour of fault and fracture networks, highlighting their fluid compartmentalizing effects and storage-transmissivity characteristics, and outlining approaches for predicting the dynamic fluid flow and geomechanical behaviour of these reservoirs. This collection of 25 papers provides an overview of recent progress and outstanding issues in the areas of structural complexity of reservoir geometry, detection and prediction of faults and
fractures, compartmentalizing effects of fault systems and complex siliciclastic reservoirs and critical controls affecting fractured reservoirs.

Advanced Modelling with the MATLAB Reservoir Simulation Toolbox

This monograph is based on subsurface hydrodynamics and applied geomechanics and places them in a unifying framework. It focuses on the understanding of physical and mechanical properties of geomaterials by presenting mathematical models of deformation and fracture with related experiments.

Unconventional Reservoir Geomechanics

In geomechanics, existing design methods are very much dependent upon sophisticated on-site techniques to assess ground conditions. This book describes numerical analysis, computer simulation and modelling that can be used to answer some highly complex questions associated with geomechanics. The contributors, who are all international experts in the field, also give insights into the future directions of these methods. Numerical Analysis and Modelling in Geomechanics will appeal to professional engineers involved in designing and building both onshore and offshore structures, where geomechanical considerations may well be outside the usual codes of practice, and therefore specialist advice is required. Postgraduate researchers, degree students carrying out project work in this area will also find the book an invaluable resource.

Unconventional Reservoir Geomechanics

Naturally fractured reservoirs constitute a substantial percentage of remaining hydrocarbon resources; they create exploration targets in otherwise impermeable rocks, including under-explored crystalline basement; and they can be used as geological stores for anthropogenic carbon dioxide. Their complex behaviour during production has traditionally proven difficult to predict, causing a large degree of uncertainty in reservoir development. The applied study of naturally fractured reservoirs seeks to constrain this uncertainty by developing new understanding, and is necessarily a broad, integrated, interdisciplinary topic. This book addresses some of the challenges and advances in knowledge, approaches, concepts, and methods used to characterize the interplay of rock matrix and fracture networks, relevant to fluid flow and hydrocarbon recovery. Topics include: describing, characterizing and identifying controls on fracture networks from outcrops, cores, geophysical data, digital and numerical models; geomechanical influences on reservoir behaviour; numerical modelling and simulation of fluid flow; and case studies of the exploration and development of carbonate, siliciclastic and metamorphic naturally fractured reservoirs.

Microseismic Monitoring and Geomechanical Modelling of CO2 Storage in Subsurface Reservoirs

What makes this book so different and valuable to the engineer is the accompanying software, used by reservoir engineers all over the world every day. The new software, IFLO (replacing WINB4D, in previous editions), is a simulator that the engineer can easily install in a Windows operating environment. IFLO generates simulations of how the well can be tapped and feeds this to the engineer in dynamic 3D perspective. This completely new software is much more functional, with better graphics and more scenarios from which the engineer can generate simulations. BENEFIT TO THE READER: This book and software helps the reservoir engineer do his or her job on a daily basis, better, more economically, and more efficiently. Without simulations, the engineer can generate simulations. BENEFIT TO THE READER: This book and software helps the reservoir engineer do his or her job on a daily basis, better, more economically, and more efficiently. Without simulations, the reservoir engineer would not be able to do his or her job at all, and the technology available in this product is far superior to most companies internal simulation software.

Numerical Analysis and Modelling in Geomechanics

The 3D geological model is still regarded as one of the newest and most innovative tools for reservoir management purposes. The computer modelling of structures, rock properties and fluid flow in hydrocarbon reservoirs has evolved from a specialist activity to part of the standard desktop toolkit. The application of these techniques has allowed all disciplines of the subsurface team to collaborate in a common workspace. In today's asset teams, the role of the geological model in hydrocarbon development planning is key and will be for some time ahead. The challenges that face the geologists and engineers will be to provide more seamless interaction between static and dynamic models. This interaction requires the development of conventional and unconventional modelling algorithms and methodologies in order to provide more risk-assessed scenarios, thus enabling geologists and engineers to better understand and capture inherent uncertainties at each aspect of the geological model's life.

Geomechanics in Reservoir Simulation

Presents advanced reservoir simulation methods used in the widely-used MRST open-source software for researchers, professionals, students.

Petroleum Related Rock Mechanics

Praise for Reservoir Geomechanics: --

Environmental Geomechanics

A surge of interest in the geomechanical and petrophysical properties of mudrocks (shales) has taken place in recent years following the development of a shale gas industry in the United States and elsewhere, and with the prospect of similar developments in the UK. Also, these rocks are of particular importance in excavation and construction geotechnics and other rock engineering applications, such as underground natural gas storage, carbon dioxide disposal and radioactive waste storage. They may greatly influence the stability of natural and engineered slopes. Mudrocks, which make up almost three-quarters of all the sedimentary rocks on
Earth, therefore impact on many areas of applied geoscience. This volume focuses on the mechanical behaviour and various physical properties of mudrocks. The 15 chapters are grouped into three themes: (i) physical properties such as porosity, permeability, fluid flow through cracks, strength and geotechnical behaviour; (ii) mineralogy and microstructure, which control geomechanical behaviour; and (iii) fracture, both in laboratory studies and in the field.

**CIGOS 2019, Innovation for Sustainable Infrastructure**

The study of reservoir and repository performance requires the integration of many different fields in Earth sciences, among them rock physics and geomechanics. The aims of this book is to emphasize how rock physics and geomechanics help to get a better insight into important issues linked to reservoir management for exploitation of natural resources, and to reservoir safety assessment for hazardous waste storage in geological environment. The studies presented here deal with the hydromechanical coupling in fractured rocks, the key experiments in safety assessment, the development of damaged zones during excavation in a shaley formation, the influence of temperature on the properties of shales, the poroelastic response of sandstones, the development and propagation of compaction bands in reservoir rocks, imaging techniques of geomechanics, the characterization and modelling of reservoirs using 4D seismic data, the mechanical behaviour of fractured rock masses, the petrophysical properties of fault zones, models for rock deformation by pressure solution and the elastic anisotropy in cracked rocks.

**Reservoir Geomechanics and Casing Stability, X1-3Area, Daqing Oilfield**

CO2 capture and geological storage is seen as the most effective technology to rapidly reduce the emission of greenhouse gases into the atmosphere. Up until now and before proceeding to an industrial development of this technology, laboratory research has been conducted for several years and pilot projects have been launched. So far, these studies have mainly focused on transport and geochemical issues and few studies have been dedicated to the geomechanical issues in CO2 storage facilities. The purpose of this book is to give an overview of the multiphysics processes occurring in CO2 storage facilities, with particular attention given to coupled geomechanical problems. The book is divided into three parts. The first part is dedicated to transport processes and focuses on the efficiency of the storage complex and the evaluation of possible leakage paths. The second part deals with issues related to reservoir injectivity and the presence of fractures and occurrence of damage. The final part of the book concerns the serviceability and ageing of the geomaterials whose poromechanical properties may be altered by contact with the injected reactive fluid.

**Geomechanics and Fluidodynamics**

Presents numerical methods for reservoir simulation, with efficient implementation and examples using widely-used online open-source code, for researchers, professionals and advanced students. This title is also available as Open Access on Cambridge Core.

**Rock Physics and Geomechanics in the Study of Reservoirs and Repositories**

Describing an efficient drilling program is a key step for the development of an oil and/or gas field. Variations in reservoir pressure, saturation and temperature, induced by reservoir production or CO2 injection, involve various coupled physical and chemical processes. Geomechanics, which consider all thermo-hydromechanical phenomena involved in rock behavior, play an important role in every operation involved in the exploitation of hydrocarbons from drilling to production, and in CO2 geological storage operations as well. Pressure changes in the reservoir modify the in situ stresses and induce strains, not only within the reservoir itself, but also in the entire sedimentary column. In turn, these induced strains modify the fluids flow in the reservoir and change the wellbore stability parameters. This book offers a large overview on applications of Geomechanics to petroleum industry. It presents the fundamentals of rock mechanics, describes the methods used to characterise rocks in the laboratory and the modelling of their mechanical behaviour; it gives elements of numerical geomechanical modelling at the site scale. It also presents the role of geomechanics in the optimisation of drilling and production: it encompasses drillability, wellbore stability, sand production and hydraulic fracturing; it provides the basic attainments to deal with the environmental aspects of heave or subsidence of the surface layers, CO2 sequestration and well abandonment; and it shows how seismic monitoring and geomechanical modelling of reservoirs can help to optimise production or check cap rock integrity. This book will be of interest to all engineers involved in oil field development and petroleum engineering students, whether drillers or producers. It aims also at providing a large range of potential users with a simple approach of a broad field of knowledge.

**Geomechanical Studies of the Barnett Shale, Texas, USA**

The theory of linear poroelasticity describes the interaction between mechanical effects and adding or removing fluid from rock. It is critical to the study of such geological phenomena as earthquakes and landslides and is important for numerous engineering projects, including dams, groundwater withdrawal, and petroleum extraction. Now an advanced text synthesizes in one place, with one notation, numerous classical solutions and applications of this highly useful theory. The introductory chapter recounts parallel developments in geomechanics, hydrogeology, and reservoir engineering that are unified by the tenets of poroelasticity. Next, the theory’s constitutive and governing equations and their associated material parameters are described. These equations are then specialized for different simplifying geometries: unbounded problem domains including plane strain, radial symmetry, and axisymmetry. Example problems from geomechanics, hydrogeology, and petroleum engineering are incorporated throughout to illustrate poroelastic behavior and solution methods for a wide variety of real-world scenarios. The final chapter provides outlines for finite-element and boundary-element formulations of the field’s governing equations.

Whether read as a course of study or consulted as a reference by researchers and professionals, this volume’s user-friendly presentation makes accessible one of geophysics’ most important subjects and will do much to reduce poroelasticity’s reputation as difficult to master.
Geomechanics in CO2 Storage Facilities

This book presents selected articles from the 5th International Conference on Geotechnics, Civil Engineering Works and Structures, held in Ha Noi, focusing on the theme "Innovation for Sustainable Infrastructure", aiming not only to raise awareness of the vital importance of sustainable infrastructure development but to also highlight the essential roles of innovation and technology in planning and building sustainable infrastructure. It provides an international platform for researchers, practitioners, policymakers and entrepreneurs to present their recent advances and to exchange knowledge and experience on various topics related to the theme of "Innovation for Sustainable Infrastructure".

Plasticity and Geomechanics

This thesis presents five studies of a gas shale reservoir using diverse methodologies to investigate geomechanical and transport properties that are important across the full reservoir lifecycle. Using the Barnett shale as a case study, we investigated adsorption, permeability, geomechanics, microseismicity, and stress evolution in two different study areas. The main goals of this thesis can be divided into two parts: first, to investigate how flow properties evolve with changes in stress and gas species, and second, to understand how the interactions between stress, fractures, and microseismicity control the creation of a permeable reservoir volume during hydraulic fracturing. In Chapter 2, we present results from adsorption and permeability experiments conducted on Barnett shale rock samples. We found Langmuir-type adsorption of CH4 and N2 at magnitudes consistent with previous studies of the Barnett shale. Three of our samples demonstrated BET-type adsorption of CO2, in contrast to all previous studies on CO2 adsorption in gas shales, which found Langmuir-adsorption. At low pressures (600 psi), we found preferential adsorption of CO2 over CH4 ranging from 1.6x to 5.5x. While our measurements were conducted at low pressures (up to 1500 psi), when our model fits are extrapolated to reservoir pressures they reach similar adsorption magnitudes as have been found in previous studies. At these high reservoir pressures, the very large preferential adsorption of CO2 over CH4 (up to 5-10x) suggests a significant potential for CO2 storage in gas shales like the Barnett if practical problems of injectivity and matrix transport can be overcome. We successfully measured permeability versus effective stress on two intact Barnett shale samples. We measured permeability on two identical effective stress coefficients less than 1 on both samples, invalidating our hypothesis that there might be through-going flow paths within the soft, porous organic kerogen that would lead the permeability effective stress coefficient to be greater than 1. The results suggest that microcracks are likely the dominant flow paths at these scales. In Chapter 3, we present integrated geodetic, geophysical, and geomechanical data in order to characterize the rock properties in our Barnett shale study area and to model the stress state in the reservoir before hydraulic fracturing occurred. Five parallel, horizontal wells were drilled in the study area and then fractured using three different techniques. We used the well logs from a vertical pilot well and a horizontal well to constrain the stress state in the reservoir. While there was some variation along the length of the well, we were able to determine a best fit stress state of Pp = 4.48 psi/ft, 6v = 1.1 psi/ft, SHmax = 0.73 psi/ft, and SHmin = 0.68 psi/ft. Applying this stress state to the mapped natural fractures indicates that there is significant potential for induced shear slip on natural fracture planes in this region of the Barnett, particularly close to the main hydraulic fracture where the pore pressure increase during hydraulic fracturing is likely to be very high. In Chapter 4, we present new techniques to quantify the robustness of hydraulic fracturing in gas shale reservoirs. The case study we analyzed involves five parallel horizontal wells in the Barnett shale with 51 frac stages. To investigate the numbers, sizes, and types of microearthquakes initiated during each frac stage, we created Gutenberg-Richter-type magnitude distribution plots to see if the size of events follows the characteristic scaling relationship found in natural earthquakes. We found that slickwater fracturing does generate a log-linear distribution of microearthquakes, but that it creates proportionally more small events than natural earthquake sources. Finding considerable variability in the generation of microearthquakes, we used the magnitude analysis as a proxy for the "robustness" of the stimulation of a given stage. We found that the

Recovery

This thesis presents an important step towards a deeper understanding of naturally fractured carbonate reservoirs (NFCRs). It demonstrates the various kinds of discontinuities using geological evidence, mathematical kinematics model and computed tomography and uses this as a basis for proposing a new classification for NFCRs. Additionally, this study takes advantage of rock mechanics theory to illustrate how natural fractures can collapse due to fluid flow and pressure changes in the fractured media. The explanations and mathematical modeling developed in this dissertation can be used as diagnostic tools to predict fluid velocity, fluid flow, tectonic fracture collapse, pressure velocity behavior during reservoir depletion, considering stress-sensitive and non-stress-sensitive, with nonlinear terms in the diffusivity equation applied to NFCRs. Furthermore, the book presents the description of real reservoirs with their field data as the principal goal in the mathematical description of the realistic phenomenology of NFCRs.

Seismic Data Interpretation and Evaluation for Hydrocarbon Exploration and Production
Reservoir geomechanics investigates the implications of rock deformation, strain localization, and failure for completion and production of subsurface energy reservoirs. For example, effective hydraulic fracture placement and reservoir pressure management are among the most important applications for maximizing hydrocarbon production. The correct use of these applications requires understanding the interaction of fluid flow and rock deformations. In the past a considerable amount of effort has been made to describe the role of poroelastic and thermal effects in geomechanics. However, a number of chemical processes that commonly occur in reservoir engineering have been disregarded in reservoir geomechanics despite their significant effect on the mechanical behavior of rocks and, therefore, fluid flow. This dissertation focuses on the mechanical effects of two particular chemical processes: gas-desorption from organic-rich rocks and mineral dissolution in carbonate-rich formations. The methods employ a combination of laboratory studies, field data analysis, and numerical simulations at various length scales. The following conclusions are the results of this work: (1) a novel introduced numerical model for fluid flow with effects of gas sorption and shear-failure-impairing permeability captures the complex permeability evolution during gas production in coal reservoirs; the simulation results also indicate the presence non-negligible sorption stresses in shale reservoirs, (2) mineral dissolution of mineralized fractures, similar to pore pressure depletion or thermal cooling/heating can increase stress anisotropy, which can reactivate critically-oriented natural fractures; in-situ stress chemical manipulation can be used advantageously to enlarge the stimulated reservoir volume, (3) semicircular bending experiments on acidized rock samples show that non-planar fractures follow high porosity regions and large pores, and that fracture toughness correlates well with local porosity. Numerical modeling based on the Phase-Field approach shows that a direct relationship between fracture toughness and porosity permits replicating fracture stress intensity at initiation and non-planar fracture propagation patterns observed in experiments, and (4) numerical simulations based on a novel reactive fluid flow model coupled with geomechanics show that mineral dissolution (i) lower fracture breakdown pressure, (ii) can bridge a transition from a toughness-dominated regime to uncontrolled fracture propagation at constant injection pressures, and (iii) can increase fracture complexity by facilitating propagation of stalled fracture branches. The understanding of the geo-mechanical coupled processes is critical for safe and effective injection of CO2 and reactive fluids in the subsurface, such as in hydraulic fracturing, deep geothermal energy, and carbon geological sequestration applications.

Advances in the Study of Fractured Reservoirs

Reservoir Geomechanics

This book is intended as a reference book for advanced graduate students and research engineers in shale gas development or rock mechanical engineering. Globally, there is widespread interest in exploiting shale gas resources to meet rising energy demands, maintain energy security and stability in supply and reduce dependence on higher carbon sources of energy, namely coal and oil. However, extracting shale gas is a resource intensive process and is dependent on the geological and geomechanical characteristics of the source rocks, making the development of certain formations uneconomic using current technologies. Therefore, evaluation of the physical and mechanical properties of shale, together with technological advancements, is critical in verifying the economic viability of such formation. Accurate geomechanical information about the rock and its variation through the shale is important since stresses along the wellbore can control fracture initiation and frac development. In addition, hydraulic fracturing has been widely employed to enhance the production of oil and gas from underground reservoirs. Hydraulic fracturing is a complex operation in which the fluid is pumped at a high pressure into a selected section of the wellbore. The interaction between the hydraulic fractures and natural fractures is the key to fracturing effectiveness prediction and high gas development. The development and growth of a hydraulic fracture through the natural fracture systems of shale is probably more complex than can be described here, but may be somewhat predictable if the fracture system and the development of stresses can be explained. As a result, comprehensive shale geomechanical experiments, physical modeling experiment and numerical investigations should be conducted to reveal the fracturing mechanical behaviors of shale.

Applied Petroleum Geomechanics

This interdisciplinary book encompasses the fields of rock mechanics, structural geology and petroleum engineering to address a wide range of geomechanical problems that arise during the exploitation of oil and gas reservoirs. It considers key practical issues such as prediction of pore pressure, estimation of hydrocarbon column heights and fault seal potential, determination of optimally stable well trajectories, casing set points and mud weights, changes in reservoir performance during depletion, and production-induced faulting and subsidence. The book establishes the basic principles involved before introducing practical measurement and experimental techniques to improve recovery and reduce exploitation costs. It illustrates their successful application through case studies taken from oil and gas fields around the world. This book is a practical reference for geoscientists and engineers in the petroleum and geothermal industries, and for research scientists interested in stress measurements and their application to problems of faulting and fluid flow in the crust.

Geomechanics and Geology

This book contains the Proceedings of EUROCK 2013 – The 2013 ISRM International Symposium, which was held on 23-26 September 2013 in Wroclaw, Poland. The Symposium was organized by the ISRM National Group POLAND and the Institute of Geotechnics and Hydrotechnics of the Wroclaw Institute of Technology. The focus of the Symposium was on recent developments in rock mechanics and geomechanics. The Symposium was on recent developments in rock mechanics and geomechanics. The Symposium was on recent developments in rock mechanics and geomechanics. The Symposium was on recent developments in rock mechanics and geomechanics.