Improved Reservoir Characterization And Simulation Of A

The objective of this Class III project was demonstrate that reservoir characterization and enhanced oil recovery (EOR) by CO2 flood can increase production from slope and basin clastic reservoirs in sandstones of the Delaware Mountain Group in the Delaware Basin of West Texas and New Mexico. Phase 1 of the project, reservoir characterization, focused on Geraldine Ford and East Ford fields, which are Delaware Mountain Group fields that produce from the upper Bell Canyon Formation (Ramsey sandstone). The demonstration phase of the project was a CO2 flood conducted in East Ford field, which is operated by Orla Petco, Inc., as the East Ford unit.

Implementation of the work program of Budget Period 2 of the East Binger Unit (''EBU'') DOE Project continues. Major development work planned for the project includes the drilling of three horizontal production and one vertical injection wells, the conversion of five wells from production to injection service, and the expansion of injection capacity at the nitrogen management facility. Other work items include initiation of project monitoring and continued reservoir simulation. EBU 74G-2, the injection well planned to support the production of EBU 64-3H, has been drilled. Completion was underway at the time of this report. EBU 64-3H was fracture-stimulated during the period, further increasing production from this new horizontal well. Drilling of the final two wells of the pilot project is planned for 2003. Both are planned as horizontal producing wells. Work also began on projects aimed at increasing injection in the pilot area. The project to add compression and increase injection capacity at the nitrogen management facility was initiated, with completion targeted for March 2003. Additional producer-to-injector conversions are expected to be implemented around the same time. The revised history match of the simulation model has been completed, and work has begun to evaluate options with forecast simulations. The quality of the history match is significantly improved over the prior match. The predicted distribution of remaining reserves in the field is significantly changed. Decisions on projects planned for implementation later in Budget Period 2 will be guided by new forecasts.

F. Jerry Lucia, working in America's main oil-rich state, has produced a work that goes after one of the holy grails of oil prospecting. One main target in petroleum recovery is the description of the three-dimensional distribution of petrophysical properties on the interwell scale in carbonate reservoirs. Doing so would improve performance predictions by means of fluid-flow computer simulations. Lucia's book focuses on the improvement of geological, petrophysical, and geostatistical methods, describes the basic petrophysical properties, important geology parameters, and rock fabrics from cores, and discusses their spatial distribution. A closing chapter deals with reservoir models as an input into flow simulators.

The Class 2 Project at West Welch was designed to demonstrate the use of advanced technologies to enhance the economics of improved oil recovery (IOR) projects in lower quality Shallow Shelf Carbonate (SSC) reservoirs, resulting in recovery of additional oil that would otherwise be left in the reservoir at project abandonment. Accurate reservoir description is critical to the effective evaluation and efficient design of IOR projects in the heterogeneous SSC reservoirs. Therefore, the majority of Budget Period 1 was devoted to reservoir characterization. Technologies being demonstrated include: (1) Advanced petrophysics; (2) Three-dimensional (3-D) seismic; (3) Crosswell bore tomography; (4) Advanced reservoir simulation; (5) Carbon dioxide (CO2) stimulation treatments; (6) Hydraulic fracturing design and monitoring; (7) Mobility control agents.

IMPROVED OIL RECOVERY IN MISSISSIPPIAN CARBONATE RESERVOIRS OF KANSAS - NEAR TERM - CLASS 2

Advanced Petroleum Reservoir Simulation

Application of Advanced Reservoir Characterization, Simulation, and Production Optimization Strategies to Maximize Recovery in Slope and Basin Clastic Reservoirs, West Texas (Delaware Basin), Class III.

Soft Computing for Reservoir Characterization and Modeling

Application of Reservoir Characterization and Advanced Technology to Improve Recovery and Economics in a Lower Quality Shallow Shelf Carbonate Reservoir

The focus of the project is to show that the use of advanced technology can improve the economics of CO2 projects in low permeability reservoirs. The approach involves the use of tomography, 3-D seismic and detailed petrophysical descriptions to enhance reservoir characterization. Cyclic CO2 stimulations and model designed frac treatments will be used to increase and facilitate oil recovery to improve project economics. The detailed reservoir characterization will be used to create a geological model for use in simulation to arrive at an optimum operating plan to be instituted during the second budget period. Objectives to be accomplished during the third quarter include: (1) Complete petrophysical description on cores from observation wells. (2) Apply petrophysical data to geologic model. (3) Conduct additional laboratory analysis on cores and fluids. (4) Refine 3-D seismic interpretations. (5) Complete tomography surveys. (6) Process tomography data. (7) Establish relationship between seismic and tomography interpretations. (8) Conduct preliminary simulator runs with improved geologic model. (9) Evaluate results of cyclic CO2 stimulation treatments. (10) Design frac treatment for linear flood fronts. All of the above objectives were worked on during the current quarter and the overall project is fairly well on schedule. The area of greatest concern time-wise is reservoir simulation. The simulator depends on the geologic model, which in turn depends on the petrophysical, 3-D seismic and tomography interpretations. Hence, the final geologic model won't be available until all of the reservoir characterization work is completed.

The Cascade Sand zone of the Mission-Visco Lease in the Cascade Oil field of Los Angeles County, California, has been under water flood since 1970. Increasing water injection to increase oil production rates was being considered as an opportunity to improve oil recovery. However, a secondary gas cap had formed in the up-dip portion of the reservoir with very low gas cap pressures, creating concern that oil could be displaced into the gas cap resulting in the loss of recoverable oil. Therefore, injecting gas into the gas cap to keep the gas cap pressurized and restrict the influx of oil during water injection was also being considered. Further, it was recognized that the reservoir geology in the gas cap area is very complex with numerous folding and faulting and thus there are potential pressure barriers in several locations throughout the reservoir. With these conditions in mind, there were concerns regarding well to well continuity in the gas cap, which could interfere with the intended repressurization impact. Concerns about the pattern of gas flow from well to well, the possibilities of cycling gas without the desired increased pressure, and the possible loss of oil displaced into the gas cap resulted in the decision to conduct a gas tracer survey in an attempt to better define inter-well communication. Following the gas tracer survey, a reservoir model would be developed to integrate the findings of the gas tracer survey, known geologic and reservoir data, and historic production data. The reservoir model would be used to better define the reservoir characteristics and provide information that could help optimize the waterflood-gas injection project under consideration for efficient water and gas injection management to increase oil production. However, due to inadequate gas sampling procedures in the field and insufficiently developed laboratory analytical techniques, the laboratory was unable to detect the tracer in the gas samples taken. At that point, focus on, and an expansion of the scope of the reservoir simulation and modeling effort was initiated, using DOE's BOAST98 (a visual, dynamic, interactive update of BOAST3), 3D, black oil reservoir simulation package as the basis for developing the reservoir model. Reservoir characterization, modeling, and reservoir simulation resulted in a significant change in the depletion strategy. Information from the reservoir characterization and modeling effort indicate that in-fill drilling and relying on natural water influx from the aquifer could increase remaining reserves by 125,000 barrels of oil per well, and that up to 10 infill wells could be drilled in the field. Through this scenario, field production could be increased two to three times over the current 65 bopd. Based on the results of the study, permits have been applied for to drill a directional infill well to encounter the productive zone at a high angle in order to maximize the amount of pay and reservoirs encountered.

This report is a permanent record of a poster paper presented by the authors at the Third International Reservoir Characterization Technical Conference in Tulsa, Oklahoma on November 3--5, 1991. The subject is electromagnetic (EM) techniques that are being developed to monitor oil recovery processes to improve overall process performance. The potential impact of EM surveys is very significant, primarily in the areas of locating oil, identifying oil inside and outside the pattern, characterizing flow units, and pseudo-real time process control to optimize process performance and efficiency. Since a map of resistivity alone has little direct application to these areas, an essential part of the EM technique is understanding the relationship between the process and the formation resistivity at all scales, and integrating this understanding into reservoir characterization and simulation. First is a discussion of work completed on the core scale petrophysics of resistivity changes in an oil recovery process; a steamflood is used as an example. A system has been developed for coupling the petrophysics of resistivity with reservoir simulation to simulate the formation resistivity structure arising from a recovery process. Preliminary results are given for an investigation into the effect of heterogeneity and anisotropy on the EM technique, as well as the use of the resistivity simulator to interpret EM data in terms of reservoir and process parameters. Examples illustrate the application of the EM technique to improve process monitoring and reservoir characterization.

West Welch Unit is one of four large waterflood units in the Welch Field located in the Northwestern portion of Dawson County, Texas. The Welch Field was discovered in the early 1940's and produces oil under a solution gas drive mechanism from the San Andres formation at approximately 4800 ft. The field has been under waterflood for 30 years and a significant portion has been infill drilled on 20-ac density. A 1982-86 Pilot CO2 injection project in the offsetting South Welch Unit yielded positive results. The recent installation of a CO2 pipeline near the field allowed the phased development of a miscible CO2 injection project at the South Welch Unit. The reservoir quality is poorer at the West Welch Unit due to its relative position to sea level during deposition. Because of the proximity of a CO2 source and the CO2 operating experience that would be available from the South Welch Unit, West Welch Unit is an ideal location for demonstrating methods for enhancing economics of IOR projects in lower quality SSC reservoirs. This Class 2 project concentrates on the efficient design of a miscible CO2 project based on detailed reservoir characterization from advanced petrophysics, 3-D seismic interpretations and cross wellbore tomography interpretations. During the quarter, progress was made in both the petrophysical analysis and the tomography processing. The final geologic model is dependent upon the petrophysical analysis and the seismic and tomography interpretations. The actual reservoir simulation has started using the base geologic model, with which, all the preliminary simulation work is being done. Progress was also made in understanding the abnormal fracture wing orientation obtained in well 4807 and the cyclic CO2 demonstration results.

QUANTITATIVE METHODS FOR RESERVOIR CHARACTERIZATION AND IMPROVED RECOVERY

APPLICATION OF RESERVOIR CHARACTERIZATION AND ADVANCED TECHNOLOGY TO IMPROVE RECOVERY AND ECONOMICS IN A LOWER QUALITY SHALLOW SHELF SANANDRES RESERVOIR.

Application of Advanced Reservoir Characterization, Simulation, and Production Optimization Strategies to Maximize Recovery in Slope and Basin Clastic Reservoirs, West Texas (Delaware Basin). Technical Progress Report

Application of Advanced Reservoir Characterization, Simulation, and Production Optimization Strategies to Maximize Recovery in Slope and Basin Clastic Reservoirs, West Texas (Delaware Basin).

Application of Advanced Reservoir Characterization, Simulation, and Production Optimization Strategies to Maximize Recovery in Slope and Basin Clastic Reservoirs, West Texas (Delaware Basin). Quarterly Report, April 1,1996 - June 30, 1996

Reservoir Simulation: Machine Learning and Modeling helps the engineer step into the current and most popular advances in reservoir simulation, learning from current experiments and speeding up potential collaboration opportunities in research and technology. This reference explains common terminology, concepts, and equations through multiple figures and rigorous derivations, better preparing the engineer for the next step forward in a modeling project and avoid repeating existing progress. Well-designed exercises, case studies and numerical examples give the engineer a faster start on advancing their own cases. Both computational methods and engineering cases are explained, bridging the opportunities between computational science and petroleum engineering. This book delivers a critical reference for today's petroleum and reservoir engineer to optimize more complex developments. Understand commonly used and recent progress on definitions, models, and solution methods used in reservoir simulation World leading modeling and algorithms to study flow and transport behaviors in reservoirs, as well as the application of machine learning Gain practical knowledge with hand-on trainings on modeling and simulation through well designed case studies and numerical examples.

Reservoir Characterization is a collection of papers presented at the Reservoir Characterization Technical Conference, held at the Westin Hotel-Galleria in Dallas on April 29-May 1, 1985. Conference held April 29-May 1, 1985, at the Westin Hotel—Galleria in Dallas. The conference was sponsored by the National Institute for Petroleum and Energy Research, Bartlesville, Oklahoma. Reservoir characterization is a process for quantitatively assigning reservoir properties, recognizing geologic information and uncertainties in spatial variability. This book contains 19 chapters, and begins with the geological characterization of sandstone reservoir, followed by the geological prediction of shale distribution within the Prudhoe Bay field. The subsequent chapters are devoted to determination of reservoir properties, such as porosity, mineral occurrence, and permeability variation estimation. The discussion then shifts to the utility of a Bayesian-type formalism to delineate qualitative ""soft"" information and expert interpretation of reservoir description data. This topic is followed by papers concerning reservoir simulation, parameter assignment, and method of calculation of wetting phase relative permeability. This text also deals with the role of discontinuous vertical flow barriers in reservoir engineering. The last chapters focus on the effect of reservoir heterogeneity on oil reservoir. Petroleum engineers, scientists, and researchers will find this book of great value.

The Class 2 Project at West Welch was designed to demonstrate the use of advanced technologies to enhance the economics of improved oil recovery (IOR) projects in lower quality Shallow Shelf Carbonate (SSC) reservoirs, resulting in recovery of additional oil that would otherwise be left in the reservoir at project abandonment. Accurate reservoir description is critical to the effective evaluation and efficient design of IOR projects in the heterogeneous SSC reservoirs. Therefore, the majority of Budget Period 1 was devoted to reservoir characterization. Technologies being demonstrated include: advanced petrophysics; three-dimensional seismic; cross-well bore tomography; advanced reservoir simulation; CO2 stimulation treatments; hydraulic fracturing design and monitoring; and mobility control agents. During the quarter, the project area was expanded to include an area where the seismic attribute mapping indicated potential for step-out locations. Progress was made on interpreting the crosswell seismic data and the CO2 performance simulation was further improved. Construction of facilities required for CO2 injection were completed.

This book explains the basic technologies, concepts, approaches, and terms used in relation to reservoir rocks. Accessible to engineers in varying roles, it provides the tools necessary for building reservoir characterization and simulation models that improve resource definition and recovery, even in complex depositional environments. The book is enriched with numerous examples from a wide variety of applications, to help readers understand the topics. It also describes in detail the key relationships between the different rock properties and their variables. As such, it is of interest to researchers, engineers, lab technicians, and postgraduate students in the field of petroleum engineering.

Incorporating Subcritical Crack Growth Mechanics Into Natural Fracture Characterization for Improved Reservoir Simulation

Electromagnetic Oil Field Mapping for Improved Process Monitoring and Reservoir Characterization

Practical Reservoir Engineering and Characterization

Geometric Modelling, Numerical Simulation, and Optimization:

Reservoir characterization for petroleum systems stands as a key source of competitive advantage amongst operators. Exploration and field development activities require large investments of engineering time and capital to be made in pursuit of improved short- and long-term economic decision-making posture. For this reason, identifying workflows from adjacent earth science fields of study to tackle reservoir characterization challenges is of utmost importance. Examined in this thesis is the idea of whether improved reservoir characterization can be a corollary of the modern advancements in geodesy. This thesis proposes a holistic workflow to improve subsurface reservoir characterization using commercially available tools and insights by incorporating modern Interferometric Synthetic Aperture Radar (InSAR) geodetic data to better inform model assumptions. Surface deformation measurement by InSAR is used to provide subsurface insights using as an example the "Polygon" field in Kazakhstan. This workflow leads to several key conclusions which could only be realized traditionally by drilling additional exploratory wells to collect the necessary data. Firstly, early seismic field work identified the presence of several faults which divide the area of study into three distinct blocks, which were assumed to be impermeable at the boundaries. However, due to the flow directions and rock deformation observed in the simulated reservoir and geomechanical models, only one of the three blocks exhibits "compartmentalization," or impermeable bounding at the faults. With a displacement of 20 meters at the fault faces, expected permeability values for these fault boundaries were anticipated to be less than 1 millidarcy of permeability; however, permeability above 1 Darcy exists across two of the three block fault boundaries. The geomechanical model of the reservoir predicts subsidence at surface while InSAR shows localized uplifts of several centimeters on the western and eastern edges of the studied blocks. The only way to match the subsurface geomechanics model with the directly measured InSAR is to implement a no-flow boundary at the eastern fault that delineates the westernmost block. As a result, a strategy for improved recovery efficiency from the western compartmentalized block is proposed to enhance pressure maintenance and improve waterflood effectiveness. Also, further geomechanical and InSAR comparison suggests the presence of a weak edge aquifer influx behavior in the area of study flowing north to south. In summary, the combination of reservoir simulation, geomechanical modelling, and direct InSAR measurement represents a significant opportunity for improving reservoir characterization using readily available techniques at an incrementally low cost.

QUANTITATIVE METHODS FOR RESERVOIR CHARACTERIZATION AND IMPROVED RECOVERYAPPLICATION TO HEAVY OIL SANDS.

The Class 2 Project at West Welch was designed to demonstrate the use of advanced technologies to enhance the economics of improved oil recovery (IOR) projects in lower quality Shallow Shelf Carbonate (SSC) reservoirs, resulting in recovery of additional oil that would otherwise be left in the reservoir at project abandonment. Accurate reservoir description is critical to the effective evaluation and efficient design of IOR projects in the heterogeneous-SSC reservoirs. Therefore, the majority of Budget Period 1 was devoted to reservoir characterization. Technologies being demonstrated include: advanced petrophysics; three-dimensional seismic; cross-well bore tomography; advanced reservoir simulation; carbon dioxide (CO2) stimulation treatments; hydraulic fracturing design and monitoring; and mobility control agents. During the quarter, simulation history matching was made using the seismic integrated geologic model. Cross well seismic work continued, using the revised processing software.

The demand for oil and gas is increasing yearly, whereas proven oil and gas reserves are being depleted. The potential of stripper oil and gas fields to supplement the national energy supply is large. In 2006, stripper wells accounted for 15% and 8% of US oil and gas production, respectively. With increasing energy demand and current high oil and gas prices, integrated reservoir studies, secondary and tertiary recovery methods, and infill drilling are becoming more common as operators strive to increase recovery from stripper oil and gas fields. The primary objective of this research was to support optimized production of oil and gas from stripper well fields by evaluating one stripper gas field and one stripper oil field. For the stripper gas field, I integrated geologic and engineering data to build a detailed reservoir characterization model of the Second White Specks (SSPK) reservoir in Garden Plains field, Alberta, Canada. The objectives of this model were to provide insights to controls on gas production and to validate a simulation-based method of infill drilling assessment. SSPK was subdivided into Units A? D using well-log facies. Units A and B are the main producing units. Unit A has better reservoir quality and lateral continuity than Unit B. Gas production is related primarily to porosity-netthickness product and permeability and secondarily to structural position, minor structural features, and initial reservoir pressure. For the stripper oil field, I evaluated the Green River formation in the Wells Draw area of Monument Butte field, Utah, to determine interwell connectivity and to assess optimal recovery strategies. A 3D geostatistical model was built, and geological realizations were ranked using production history matching with streamline simulation. Interwell connectivity was demonstrated for only major sands and it increases as well spacing decreases. Overall connectivity is low for the 22 reservoir zones in the study area. A water-flood-only strategy provides more oil recovery than a primary-then-waterflood strategy over the life of the field. For new development areas, water flooding or converting producers to injectors should start within 6 months of initial production. Infill drilling may effectively produce unswept oil and double oil recovery. CO2 injection is much more efficient than N2 and CH4 injection. Water-alternating-CO2 injection is superior to continuous CO2 injection in oil recovery. The results of this study can be used to optimize production from Garden Plains and Monument Butte fields. Moreover, these results should be applicable to similar stripper gas and oil field fields. Together, the two studies demonstrate the utility of integrated reservoir studies (from geology to engineering) for improving oil and gas recovery.

Application of Reservoir Characterization and Advanced Technology to Improve Recovery and Economics in a Lower Quality Shallow Shelf San Andres Reservoir. Quarterly Progress Report, April 1--June 30, 1997

Application of Reservoir Characterization and Advanced Technology to Improve Recovery and Economics in a Lower Quality Shallow Shelf Carbonate Reservoir. Quarterly Progress Report, August 1995--December 1995

SMALL, GEOLOGICALLY COMPLEX RESERVOIRS CAN BENEFIT FROM RESERVOIR SIMULATION.

Application of Reservoir Characterization and Advanced Technology to Improve Recovery and Economic in a Lower Quality Shallow Shelf Carbonate Reservoir. First Quarter 1995

Reservoir Simulations

The objective of this project is to demonstrate that detailed reservoir characterization of slope and basin clastic reservoirs in sandstones of the Delaware Mountain Group in the Delaware Basin of West Texas and New Mexico is a cost effective way to recover a higher percentage of the original oil in place through strategic placement of infill wells and geologically based field development. Project objectives are divided into two major phases. The objectives of the reservoir characterization phase of the project are to provide a detailed understanding of the architecture and heterogeneity of two fields, the Ford Geraldine unit and Ford West field, which produce from the Bell Canyon and Cherry Canyon Formations, respectively, of the Delaware Mountain Group and to compare Bell Canyon and Cherry

Canyon reservoirs. Reservoir characterization will utilize 3-D seismic data, high-resolution sequence stratigraphy, subsurface field studies, outcrop characterization, and other techniques. Once the reservoir-characterization study of both fields is completed, a pilot area of approximately 1 mi2 in one of the fields will be chosen for reservoir simulation. The objectives of the implementation phase of the project are to (1) apply the knowledge gained from reservoir characterization and simulation studies to increase recovery from the pilot area, (2) demonstrate that economically significant unrecovered oil remains in geologically resolvable untapped compartments, and (3) test the accuracy of reservoir characterization and flow simulation as predictive tools in resource preservation of mature fields. A geologically designed, enhanced-recovery program (CO2 flood, waterflood, or polymer flood) and well-completion program will be developed, and one to three infill wells will be drilled and cored. Technical progress is summarized for: geophysical characterization; reservoir characterization; outcrop characterization; and recovery technology identification and analysis.

The OXY-operated Class 2 Project at West Welch is designed to demonstrate how the use of advanced technology can improve the economics of miscible CO2 injection projects in lower quality Shallow Shelf Carbonate reservoirs. The research and design phase (Budget Period 1) primarily involved advanced reservoir characterization. The current demonstration phase (Budget Period 2) is the implementation of the reservoir management plan for an optimum miscible CO2 flood design based on the reservoir characterization. Although Budget Period 1 for the Project officially ended 12/31/96, reservoir characterization and simulation work continued during the Budget Period 2. During the fifth and sixth annual reporting periods (8/3/98-8/2/00) covered by this report, work continued on interpretation of the cross well seismic data to create porosity and permeability profiles which were distributed into the reservoir geostatistically. The initial interwell seismic CO2 monitor survey was conducted, the acquired data processed and interpretation started. Only limited well work and facility construction was conducted in the project area. The CO2 injection initiated in October 1997 was continued, although the operator had to modify the operating plan in response to low injection rates, well performance and changes in CO2 supply. CO2 injection was focused in a smaller area to increase the reservoir processing rate. By the end of the reporting period three producers had shown sustained oil rate increases and ten wells had experienced gas (CO2) breakthrough.

This annual report describes progress during the final year of the project entitled ''Improved Oil Recovery in Mississippian Carbonate Reservoirs in Kansas''. This project funded under the Department of Energy's Class 2 program targets improving the reservoir performance of mature oil fields located in shallow shelf carbonate reservoirs. The focus of the project was development and demonstration of cost-effective reservoir description and management technologies to extend the economic life of mature reservoirs in Kansas and the mid-continent. As part of the project, tools and techniques for reservoir description and management were developed, modified and demonstrated, including PfEFFER spreadsheet log analysis software. The world-wide-web was used to provide rapid and flexible dissemination of the project results through the Internet. A summary of demonstration phase at the Schaben and Ness City North sites demonstrates the effectiveness of the proposed reservoir management strategies and technologies. At the Schaben Field, a total of 22 additional locations were evaluated based on the reservoir characterization and simulation studies and resulted in a significant incremental production increase. At Ness City North Field, a horizontal infill well (Mull Ummel No. 4H) was planned and drilled based on the results of reservoir characterization and simulation studies to optimize the location and length. The well produced excellent and predicted oil rates for the first two months. Unexpected presence of vertical shale intervals in the lateral resulted in loss of the hole. While the horizontal well was not economically successful, the technology was demonstrated to have potential to recover significant additional reserves in Kansas and the Midcontinent. Several low-cost approaches were developed to evaluate candidate reservoirs for potential horizontal well applications at the field scale, lease level, and well level, and enable the small independent producer to identify efficiently candidate reservoirs and also to predict the performance of horizontal well applications.

Shared Earth Modeling introduces the reader to the processes and concepts needed to develop shared earth models. Shared earth modeling is a cutting-edge methodology that offers a synthesis of modeling paradigms to the geoscientist and petroleum engineer to increase reservoir output and profitability and decrease guesswork. Topics range from geology, petrophysics, and geophysics to reservoir engineering, reservoir simulation, and reservoir management. Shared Earth Modeling is a technique for combining the efforts of reservoir engineers, geophysicists, and petroleum geologists to create a simulation of a reservoir. Reservoir engineers, geophysicists, and petroleum geologists can create separate simulations of a reservoir that vary depending on the technology each scientist is using. Shared earth modeling allows these scientists to consolidate their findings and create an integrated simulation. This gives a more realistic picture of what the reservoir actually looks like, and thus can drastically cut the costs of drilling and time spent mapping the reservoir. First comprehensive publication about Shared Earth Modeling Details cutting edge methodology that provides integrated reservoir simulations

Reservoir Characterization

Samuel Berger 1843-1900

Integrated Reservoir Characterization and Simulation Studies in Stripper Oil and Gas Fields

IMPROVED MISCIBLE NITROGEN FLOOD PERFORMANCE UTILIZING ADVANCED RESERVOIR CHARACTERIZATION AND HORIZONTAL LATERALS IN A CLASS I RESERVOIR - EAST BINGER (MARCHAND) UNIT.

Geological and Petrophysical Characterization of the Ferron Sandstone for 3-D Simulation of a Fluvial-deltaic Reservoir

The objective of the Ferron Sandstone project was to develop a comprehensive, interdisciplinary, quantitative characterization of a fluvial-deltaic reservoir to allow realistic inter-well and reservoir-scale models to be developed for improved oil-field development in similar reservoirs world-wide. Quantitative geological and petrophysical information on the Cretaceous Ferron Sandstone in east-central Utah was collected. Both new and existing data were integrated into a three-dimensional model of spatial variations in porosity, storativity, and tensorial rock permeability at a scale appropriate for inter-well to regional-scale reservoir simulation. Simulation results could improve reservoir management through proper infill and extension drilling strategies, reduction of economic risks, increased recovery from existing oil fields, and more reliable reserve calculations. This 471-page report describes the geological and petrophysical characteristics of the fluvial-deltaic Upper Cretaceous Ferron Sandstone. The report includes Ferron facies analysis, regional sequence stratigraphy, evaluation of three case-study areas, geostatistics, and a 3-D oil and gas reservoir simulation of the Ferron.

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

This edited volume addresses the importance of mathematics for industry and society by presenting highlights from contract research at the Department of Applied Mathematics at SINTEF, the largest independent research organization in Scandinavia. Examples range from computer-aided geometric design, via general purpose computing on graphics cards, to reservoir simulation for enhanced oil recovery. Contributions are written in a tutorial style.

The OXY-operated Class 2 Project at West Welch is designed to demonstrate how the use of advanced technology can improve the economics of miscible CO{sub 2} injection projects in lower quality Shallow Shelf Carbonate reservoirs. The research and design phase (Budget Period 1) primarily involved advanced reservoir characterization. The current demonstration phase (Budget Period 2) is the implementation of the reservoir management plan for an optimum miscible CO{sub 2} flood design based on the reservoir characterization. Although Budget Period 1 for the Project officially ended 12/31/96, reservoir characterization and simulation work continued during the Budget Period 2. During the seventh annual reporting period (8/3/00-8/2/01) covered by this report, work continued on interpretation of the interwell seismic data to create porosity and permeability profiles which were distributed into the reservoir geostatistically. The initial interwell seismic CO{sub 2} monitor survey was conducted and the acquired data processed and interpretation started. Only limited well work and facility construction were conducted in the project area. The CO{sub 2} injection initiated in October 1997 was continued, although the operator had to modify the operating plan in response to low injection rates, well performance and changes in CO{sub 2} supply. CO{sub 2} injection was focused in a smaller area to increase the reservoir processing rate. By the end of the reporting period three producers had shown sustained oil rate increases and six wells had experienced gas (CO{sub 2}) breakthrough.

Reservoir Characterization and Simulation of Enhanced Oil Recovery for Bakken

An Integrated Approach

Application of Reservoir Characterization and Advanced Technology to Improve Recovery and Economics in a Lower Quality Shallow Shelf San Andres Reservoir. Quarterly Progress Report, January 1--March 31, 1997

Hymns in Santali

Machine Learning and Modeling

The objective of this project is to demonstrate that detailed reservoir characterization of slope and basin clastic reservoirs in sandstones of the Delaware Mountain Group in the Delaware Basin of West Texas and New Mexico is a cost effective way to recover a higher percentage of the original oil in place through strategic placement of infill wells and geologically based field development. Project objectives are divided into two major phases. The objectives of the reservoir characterization phase of the project are to provide a detailed understanding of the architecture and heterogeneity of two fields, the Ford Geraldine unit and Ford West field, which produce from the Bell Canyon and Cherry Canyon Formations, respectively, of the Delaware Mountain Group and to compare Bell Canyon and Cherry Canyon reservoirs. Reservoir characterization will utilize 3-D seismic data, high-resolution sequence stratigraphy, subsurface field studies, outcrop characterization, and other techniques. One the reservoir-characterization study of both field is completed, a pilot area of approximately 1 mi2 in one of the fields will be chosen for reservoir simulation. The objectives of the implementation phase of the project are to: (1) apply the knowledge gained from reservoir characterization and simulation studies to increase recovery from the pilot area; (2) demonstrate that economically significant unrecovered oil remains in geologically resolvable untapped compartments; and (3) test the accuracy of reservoir characterization and flow simulation as predictive tools in resource preservation of mature fields. A geologically designed, enhanced recovery program (CO2 flood, waterflood, or polymer flood) and well-completion program will be developed, and one to three infill well will be drilled and cored. Technical progress is summarized for: geophysical characterization; reservoir characterization; outcrop characterization; and producibility problem characterization.

The Class 2 Project at West Welch was designed to demonstrate the use of advanced technologies to enhance the economics of improved oil recovery (IOR) projects in lower quality Shallow Shelf Carbonate (SSC) reservoirs, resulting in recovery of additional oil that would otherwise be left in the reservoir at project abandonment. Accurate reservoir description is critical to the effective evaluation and efficient design of IOR projects in the heterogeneous SSC reservoirs. Therefore, the majority of Budget Period 1 was devoted to reservoir characterization. Technologies being demonstrated include: advanced petrophysics; three-dimensional seismic; cross-well bore tomography; advanced reservoir simulation; CO2 stimulation treatments; hydraulic fracturing design and monitoring; and mobility control agents. During the quarter, cross well seismic work continued, using the revised processing software. The validity of the seismic-guided mapping was confirmed by the drilling of a well. Revised CO2 performance projects were run using the enhanced geologic model in which the seismic data had been incorporated. Facilities for supplying and distributing CO2 to the area were designed and bids solicited for the materials and construction.

Advanced Petroleum Reservoir Simulation Add precision and ease to the process of reservoir simulation. Until simulation software and other methods of reservoir characterization were developed, engineers had to drill numerous wells to find the best way to extract crude oil and natural gas. Today, even with highly sophisticated reservoir simulations software available, reservoir simulation still involves a great deal of guesswork. Advanced Petroleum Reservoir Simulation provides an advanced approach to petroleum reservoir simulation, taking the guesswork out of the process and relying more thoroughly on science and what is known about the individual reservoir. This state of the art publication in petroleum simulation: Describes solution techniques that allow multiple solutions to the complete equations, without linearization. Solves the most difficult reservoir engineering problems such as viscous fingering. Highlights the importance of non-linear solvers on decision tree with scientific argument. Discusses solution schemes in relation to other disciplines and revolutionizes risk analysis and decision making. Includes companion software with 3-D, 3-phase multipurpose simulator code available for download from www.scrivenerpublishing.com. By providing a valuable tool to support reservoir simulation predictions with real science, this book is an essential reference for engineers, scientists and geologists.

The objective of this project is to demonstrate that detailed reservoir characterization of slope and basin clastic reservoirs in sandstones of the Delaware Mountain Group in the Delaware Basin of West Texas and New Mexico is a cost effective way to recover a higher percentage of the original oil in place through strategic placement of infill wells and geologically based field development. Project objectives are divided into two major phases. The objectives of the reservoir characterization phase of the project were to provide a detailed understanding of the architecture and heterogeneity of two fields, the Ford Geraldine unit and Ford West field, which produce from the Bell Canyon and Cherry Canyon Formations, respectively, of the Delaware Mountain Group and to compare Bell Canyon and Cherry Canyon reservoirs. Reservoir characterization utilized 3-D seismic data, high-resolution sequence stratigraphy, subsurface field studies, outcrop characterization, and other techniques. Once the reservoir-characterization study of both fields was completed, a pilot area of approximately 1 mi 2 in one of the fields was chosen for reservoir simulation. The objectives of the implementation phase of the project are to (1) apply the knowledge gained from reservoir characterization and simulation studies to increase recovery from the demonstration area, (2) demonstrate that economically significant unrecovered oil can be recovered by a CO 2 flood of the demonstration area, and (3) test the accuracy of reservoir characterization and flow simulation as predictive tools in resource preservation of mature fields. A geologically designed, enhanced-recovery CO 2 flood and well-completion program will be developed. Through technology transfer workshops and other presentations, the knowledge gained in this study can then be applied to increase production from the more than 100 other Delaware Mountain Group reservoirs.

Fundamentals of Reservoir Rock Properties

Application of Advanced Reservoir Characterization, Simulation, and Production Optimization Strategies to Maximize Recovery in Slope and Basin Clastic Reservoirs, West Texas. Technical Progress Report, April 1--June 30, 1995

APPLICATION OF RESERVOIR CHARACTERIZATION AND ADVANCED TECHNOLOGY TO IMPROVE RECOVERY AND ECONOMICS IN A LOWER QUALITY SHALLOW SHELF SAN ANDRES RESERVOIR.

Methodologies for Integrated Reservoir Simulations

Integrated Flow Simulation and Time-lapse Seismic Reservoir Characterization in Conjunction with an Enhanced Oil Recovery Project, Postle Field, Texas County, Oklahoma

The objective of this project is to demonstrate that detailed reservoir characterization of slope and basin clastic reservoirs in sandstones of the Delaware Mountain Group in the Delaware Basin of West Texas and New Mexico is a cost effective way to recover a higher percentage of the original oil in place through strategic placement of infill wells and geologically based field development. Project objectives are divided into two major phases. The objectives of the reservoir characterization phase of the project are to provide a detailed understanding of the architecture and heterogeneity of two fields, the Ford Geraldine unit and Ford West field, which produce from the Bell Canyon and Cherry Canyon Formations, respectively, of the Delaware Mountain Group and to compare Bell Canyon and Cherry Canyon reservoirs. Reservoir characterization will utilize 3-D seismic data, high-resolution sequence stratigraphy, subsurface field studies, outcrop characterization, and other techniques. Once the reservoir- characterization study of both fields is completed, a pilot area of approximately 1 mi2 in one of the fields will be chosen for reservoir simulation. The objectives of the implementation phase of the project are to (1) apply the knowledge gained from reservoir characterization and simulation studies to increase recovery from the pilot area, (2) demonstrate that economically significant unrecovered oil remains in geologically resolvable untapped compartments, and (3) test the accuracy of reservoir characterization and flow simulation as predictive tools in resource preservation of mature fields. A geologically designed, enhanced-recovery program (CO2 flood, waterflood, or polymer flood) and well-completion program will be developed, and one to three infill wells will be drilled and cored. Progress to date is summarized for reservoir characterization.

The project objective was to detail better ways to assess and exploit intelligent oil and gas field information through improved modeling, sensor technology, and process control to increase ultimate recovery of domestic hydrocarbons. To meet this objective we investigated the use of permanent downhole sensors systems (Smart Wells) whose data is fed real-time into computational reservoir models that are integrated with optimized production control systems. The project utilized a three-pronged approach (1) a value of information analysis to address the economic advantages, (2) reservoir simulation modeling and control optimization to prove the capability, and (3) evaluation of new generation sensor packaging to survive the borehole environment for long periods of time. The Value of Information (VOI) decision tree method was developed and used to assess the economic advantage of using the proposed technology; the VOI demonstrated the increased subsurface resolution through additional sensor data. Our findings show that the VOI studies are a practical means of ascertaining the value associated with a technology, in this case application of sensors to production. The procedure acknowledges the uncertainty in predictions but nevertheless assigns monetary value to the predictions. The best aspect of the procedure is that it builds consensus within interdisciplinary teams The reservoir simulation and modeling aspect of the project was developed to show the capability of exploiting sensor information both for reservoir characterization and to optimize control of the production system. Our findings indicate history matching is improved as more information is added to the objective function, clearly indicating that sensor information can help in reducing the uncertainty associated with reservoir characterization. Additional findings and approaches used are described in detail within the report. The next generation sensors aspect of the project evaluated sensors and packaging survivability issues. Our findings indicate that packaging represents the most significant technical challenge associated with application of sensors in the downhole environment for long periods (5+ years) of time. These issues are described in detail within the report. The impact of successful reservoir monitoring programs and coincident improved reservoir management is measured by the production of additional oil and gas volumes from existing reservoirs, revitalization of nearly depleted reservoirs, possible re-establishment of already abandoned reservoirs, and improved economics for all cases. Smart Well monitoring provides the means to understand how a reservoir process is developing and to provide active reservoir management. At the same time it also provides data for developing high-fidelity simulation models. This work has been a joint effort with Sandia National Laboratories and UT-Austin's Bureau of Economic Geology, Department of Petroleum and Geosystems Engineering, and the Institute of Computational and Engineering Mathematics.

Improved prediction of interwell reservoir heterogeneity has the potential to increase productivity and to reduce recovery cost for California's heavy oil sands, which contain approximately 2.3 billion barrels of remaining reserves in the Temblor Formation and in other formations of the San Joaquin Valley. This investigation involves application of advanced analytical property-distribution methods conditioned to continuous outcrop control for improved reservoir characterization and simulation, particularly in heavy oil sands. The investigation was performed in collaboration with Chevron Production Company U.S.A. as an industrial partner, and incorporates data from the Temblor Formation in Chevron's West Coalinga Field. Observations of lateral variability and vertical sequences observed in Temblor Formation outcrops has led to a better understanding of reservoir geology in West Coalinga Field. Based on the characteristics of stratigraphic bounding surfaces in the outcrops, these surfaces were identified in the subsurface using cores and logs. The bounding surfaces were mapped and then used as reference horizons in the reservoir modeling. Facies groups and facies tracts were recognized from outcrops and cores of the Temblor Formation and were applied to defining the stratigraphic framework and facies architecture for building 3D geological models. The following facies tracts were recognized: incised valley, estuarine, tide- to wave-dominated shoreline, diatomite, and subtidal. A new minipermeameter probe, which has important advantages over previous methods of measuring outcrop permeability, was developed during this project. The device, which measures permeability at the distal end of a small drillhole, avoids surface weathering effects and provides a superior seal compared with previous methods for measuring outcrop permeability. The new probe was used successfully for obtaining a high-quality permeability data set from an outcrop in southern Utah. Results obtained from analyzing the fractal structure of permeability data collected from the southern Utah outcrop and from core permeability data provided by Chevron from West Coalinga Field were used in distributing permeability values in 3D reservoir models. Spectral analyses and the Double Trace Moment method (Lavallee et al., 1991) were used to analyze the scaling and multifractality of permeability data from cores from West Coalinga Field. T2VOC, which is a numerical flow simulator capable of modeling multiphase, multi-component, nonisothermal flow, was used to model steam injection and oil production for a portion of section 36D in West Coalinga Field. The layer structure and permeability distributions of different models, including facies group, facies tract, and fractal permeability models, were incorporated into the numerical flow simulator. The injection and production histories of wells in the study area were modeled, including shutdowns and the occasional conversion of production wells to steam injection wells. The framework provided by facies groups provides a more realistic representation of the reservoir conditions than facies tracts, which is revealed by a comparison of the history-matching for the oil production. Permeability distributions obtained using the fractal results predict the high degree of heterogeneity within the reservoir sands of West Coalinga Field. The modeling results indicate that predictions of oil production are strongly influenced by the geologic framework and by the boundary conditions. The permeability data collected from the southern Utah outcrop, support a new concept for representing natural heterogeneity, which is called the fractal/facies concept. This hypothesis is one of the few potentially simplifying concepts to emerge from recent studies of geological heterogeneity. Further investigation of this concept should be done to more fully apply fractal analysis to reservoir modeling and simulation. Additional outcrop permeability data sets and further analysis of the data from distinct facies will be needed in order to fully develop this new concept.

The objective of this project is to demonstrate that detailed reservoir characterization of slope and basin clastic reservoirs in sandstones of the Delaware Mountain Group in the Delaware Basin of West Texas and New mexico is a cost-effective way to recover a higher percentage of the original oil in place through strategic placement of infill wells and geologically based field development. Project objectives are divided into two major phases. The objectives of the reservoir characterization phase of the project are to provide a detailed understanding of the architecture and heterogeneity of two fields, the Ford Geraldine Unit and Ford West field, which produce from the Bell Canyon and Cherry Canyon Formations, respectively, of the Delaware Mountain Group and to compare Bell Canyon and Cherry Canyon reservoirs. Reservoir characterization will utilize 3-D seismic data, high-resolution sequence stratigraphy, subsurface field studies, outcrop characterization, and other techniques. Once the reservoir characterization study of both fields is completed, a pilot area of approximately 1 mi2 in one of the fields will be chosen for reservoir simulation. The objectives of the

implementation phase of the project are to (1) apply the knowledge gained from reservoir characterization and simulation studies to increase recovery from the pilot area, (2) demonstrate that economically significant unrecovered oil remains in geologically resolvable untapped compartments, and (3) test the accuracy of reservoir characterization and flow simulation as predictive tools in resource preservation of mature fields. A geologically designed, enhanced recovery program (CO2 flood, waterflood, or polymer flood) and well-completion program will be developed, and one to three infill wells will be drilled and cored.

Shared Earth Modeling

Reservoirs, Strategies, & Modeling

Application of Reservoir Characterization and Advanced Technology to Improve Recovery and Economics in a Lower Quality Shallow Shelf San Andres Reservoir. Quarterly Progress Report, July 1--September 30, 1997

Applied Mathematics at SINTEF

Carbonate Reservoir Characterization

In the middle of the 20th century, Genrich Altshuller, a Russian engineer, analysed hundreds of thousands of patents and scientific publications. From this analysis, he developed TRIZ (G. Altshuller, "40 Principles: TRIZ Keys to Technical Innovation. TRIZ Tools," Volume 1, First Edition, Technical Innovation Center, Inc. , Worcester, MA, January 1998; Y. Salamatov, "TRIZ: The Right Solution at the Right Time. A Guide to Innovative Problem Solving. " Insytec B. V. , 1999), the theory of inventive problem solving, together with a series of practical tools for helping engineers solving technical problems. Among these tools and theories, the substance-field theory gives a structured way of representing problems, the patterns of evolution show the lifecycle of technical systems, the contradiction matrix tells you how to resolve technical contradictions, using the forty principles that describe common ways of improving technical systems. For example, if you want to increase the strength of a device, without adding too much extra weight to it, the contradiction matrix tells you that you can use "Principle 1: Segmentation," or "Principle 8: Counterweight," or "Principle 15: Dynamicity," or "Principle 40: Composite Materials. " I really like two particular ones: "Principle 1: Segmentation," and Principle 15: Dynamicity. " "Segmentation" shows how systems evolve from an initial monolithic form into a set of independent parts, then eventually increasing the number of parts until each part becomes small enough that it cannot be identified anymore.

Indbydelse til Oprettelse af "Danske Foreninger" Marts 1849

APPLICATION TO HEAVY OIL SANDS.

A Poster Presentation

Application of Advanced Reservoir Characterization, Simulation, and Production Optimization Strategies to Maximize Recovery in Slope and Basin Clastic Reservoirs, West Texas (Delaware Basin). Quarterly Report, October 1 - December 31, 1996

Improved Reservoir Characterization by Incorporating Geodetic Data in a Western Kazakhstan Oilfield