Industry Leader in Reservoir Engineering, Formation Evaluation, and Geological Services for the Oil & Gas Industry.
Cobb & Associates Services Provided to Assist With:

- **Reservoir Management**
  - Reservoir analysis
  - Waterflood field studies
  - Reservoir simulation
  - Gas field studies
  - Unitization studies
  - Pressure transient test analysis
  - Enhanced oil recovery
  - Unconventional resource analysis and valuation
  - Reservoir surveillance programs
  - Worse case discharge (WCD) modeling
  - Waterflood feasibility workshops
  - Gas storage field planning and evaluation
  - CO₂ Sequestration candidate evaluation

- **Financial Decisions**
  - Property evaluations
  - Property acquisitions
  - Property sales
  - Reserve estimates
  - Investment analysis and economic evaluation
  - Due diligence

- **Geological Evaluation and Reservoir Characterization**
  - Field development studies
  - Petrophysical analysis
  - Core interpretation; SCAL program design and oversight
  - Formation evaluation programs
  - Exploration and evaluation programs
  - Basin studies

- **Training**
  - Waterflood: Performance Predictions and Surveillance
  - Simulation Based Waterflood Analysis

- **Technical Representation**
  - Engineering and management committees
  - Expert witness testimony
  - Mediation
Waterflooding: Performance Predictions and Surveillance

This five-day course covers the reservoir engineering aspects of waterflooding. The seminar combines geology, rock and fluid properties, and immiscible displacement theory to develop waterflooding prediction techniques and to aid in the evaluation of actual waterflood performance behavior. Detailed predictions of oil and water producing rates, water injection rates, and recovery efficiency (areal, vertical, and displacement), and an analysis of other variables which control recovery efficiency are included. Also discussed are waterflood surveillance techniques such as production plots, WOR analysis, floodable pore volume versus primary depletion pore volume, injection profile testing, pressure transient testing, step-rate testing, Hall plots, pattern balancing, bubble maps, volumetric sweep evaluation, and injection efficiency determination. These surveillance techniques provide the engineer with data required for the efficient management of both new and mature waterfloods. Several waterflood case studies are reviewed.

The course is ideally suited for engineers and geologists with several years of waterflood experience; however, the course is presented in a manner so that both beginning and experienced personnel will find the material very useful. The course content and example problems have been selected to teach and illustrate important concepts.

This course is available to the public several times a year; check our schedule at www.wmcobb.com for the next upcoming course. Upon special request this course can be taught in house, please contacts us for more information.

Instructor

Michael L. Wiggins, Ph.D., P.E.

Course Outline

- Factors Controlling Waterflood Recovery
- Review of Rock Properties and Fluid Flow
- Determination of Oil in Place
- Mechanism of Immiscible Fluid Displacement (displacement sweep)
- Flood Patterns and Areal Sweep Efficiency
- Reservoir Heterogeneity
- Injection Rates and Pressures
- Waterflood Performance Prediction
- Waterflood Surveillance
- Planning a Waterflood
Simulation Based Waterflood Analysis

Traditional waterflood evaluation methods can be quite good, but they can also be cumbersome to use. These calculations are typically done by hand, or in spreadsheets, and they are tedious and time consuming. Tools exist today to expedite the waterflood evaluation process while incorporating and enhancing theoretical waterflood principles. One such tool is reservoir simulation using a single pattern model to predict waterflood performance of a typical field pattern. Such models are significant improvements over traditional methods in that they can incorporate variable reservoir rock and fluid properties, fluid saturations, and primary depletion. Pattern models allow the user to test sensitivity to unknown parameters. As an added bonus, these models are fast and easy to use.

This five-day course covers waterflood theory and the traditional waterflood evaluation techniques. Attendees will also learn basic reservoir simulation skills, after which they will use a single pattern simulation model to solve numerous waterflood evaluation problems. The example problems are specifically designed to address real-world situations and they also reinforce theoretical waterflood principles. The specific software used in the course is Merlin, a black oil reservoir simulation model created and marketed by Gemini Solutions, Inc. There are other simulation models available which have similar capabilities. Attendees will receive a complimentary 45 day evaluation license of the Merlin pattern model software.

Individual computers and software will be provided, as well as daily lunches.

Attendees who complete the course will receive a certificate for 4.0 Continuing Education Credits (CEU) which is equivalent to 40 Professional Development Hours (PDH).

Instructor

Frank J. “Deacon” Marek, P.E.

Course Outline

• Waterflood theory and traditional evaluation techniques
• Reservoir simulation principles and introduction to the Merlin single pattern simulation model
• Working example problems in Merlin
  • Problem 1 – Build model and deplete under primary production.
  • Problem 2 – Construct model with Dykstra-Parsons V factor (permeability variation) of 0.7 and predict waterflood performance.
  • Problem 3 – Construct pattern model and make several runs varying oil viscosity between runs.
  • Problem 4 – Study sensitivity to vertical permeability.
• Students work waterflood problems brought to class.
## Areas Worked

### United States

<table>
<thead>
<tr>
<th>State/Region</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alabama</td>
<td></td>
</tr>
<tr>
<td>Alaska (Cook Inlet; North Slope)</td>
<td></td>
</tr>
<tr>
<td>Arkansas*</td>
<td></td>
</tr>
<tr>
<td>Arizona</td>
<td></td>
</tr>
<tr>
<td>California (Steam Flood; Offshore; Onshore)</td>
<td></td>
</tr>
<tr>
<td>Colorado</td>
<td></td>
</tr>
<tr>
<td>Florida</td>
<td></td>
</tr>
<tr>
<td>Illinois</td>
<td></td>
</tr>
<tr>
<td>Indiana</td>
<td></td>
</tr>
<tr>
<td>Kansas</td>
<td></td>
</tr>
<tr>
<td>Kentucky</td>
<td>Louisiana (including Gulf of Mexico)*</td>
</tr>
<tr>
<td>Michigan (including CO2 EOR)*</td>
<td></td>
</tr>
<tr>
<td>Mississippi (including Deep Sour Gas)*</td>
<td></td>
</tr>
<tr>
<td>Montana*</td>
<td></td>
</tr>
<tr>
<td>Nebraska</td>
<td></td>
</tr>
<tr>
<td>New Mexico*</td>
<td></td>
</tr>
<tr>
<td>New York</td>
<td></td>
</tr>
<tr>
<td>North Dakota*</td>
<td></td>
</tr>
<tr>
<td>Ohio*</td>
<td></td>
</tr>
<tr>
<td>Oklahoma*</td>
<td>Oregon</td>
</tr>
<tr>
<td>Pennsylvania*</td>
<td>South Dakota</td>
</tr>
<tr>
<td>Texas (including Gulf of Mexico)*</td>
<td></td>
</tr>
<tr>
<td>Utah*</td>
<td></td>
</tr>
<tr>
<td>Virginia*</td>
<td>West Virginia*</td>
</tr>
<tr>
<td>Wyoming*</td>
<td></td>
</tr>
</tbody>
</table>

### International

<table>
<thead>
<tr>
<th>Country</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Angola</td>
<td>Equatorial Guinea</td>
</tr>
<tr>
<td>Argentina</td>
<td>Egypt</td>
</tr>
<tr>
<td>Australia</td>
<td>France</td>
</tr>
<tr>
<td>Azerbaijan</td>
<td>Guatemala</td>
</tr>
<tr>
<td>Bangladesh</td>
<td>Honduras</td>
</tr>
<tr>
<td>Barbados</td>
<td>Indonesia</td>
</tr>
<tr>
<td>Belize</td>
<td>Malaysia</td>
</tr>
<tr>
<td>Bolivia</td>
<td>Mexico</td>
</tr>
<tr>
<td>Brazil</td>
<td>New Zealand</td>
</tr>
<tr>
<td>Canada (including oil shale)</td>
<td>Nigeria</td>
</tr>
<tr>
<td>Colombia</td>
<td>Oman</td>
</tr>
<tr>
<td>Congo</td>
<td>Peru</td>
</tr>
<tr>
<td>Dubai</td>
<td>Qatar</td>
</tr>
<tr>
<td>Russia</td>
<td>Saudi Arabia</td>
</tr>
<tr>
<td>Saudi Arabia</td>
<td>South Africa (Offshore)</td>
</tr>
<tr>
<td>South Africa (Offshore)</td>
<td>Syria</td>
</tr>
<tr>
<td>Syria</td>
<td>Thailand</td>
</tr>
<tr>
<td>Trinidad</td>
<td>Tunisia</td>
</tr>
<tr>
<td>Tunisia</td>
<td>United Kingdom</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>United Arab Emirates</td>
</tr>
<tr>
<td>United Arab Emirates</td>
<td>Venezuela</td>
</tr>
<tr>
<td>Venezuela</td>
<td>Western Siberia</td>
</tr>
<tr>
<td>Vietnam</td>
<td>Yemen</td>
</tr>
</tbody>
</table>

*Unconventional Oil and Gas.
Technical Team
Frank J. “Deacon” Marek is President at William M. Cobb & Associates, Inc. (Cobb & Associates). He has over 39 years of industry experience with a focus on reservoir engineering and field studies. He has been a consulting reservoir engineer since joining William M. Cobb & Associates, Inc. in 1985.

At Cobb & Associates, Deacon has performed oil and gas reserve studies and field studies for independent, major and national oil companies. Various types of studies include year-end reserve studies, acquisition/divestiture analysis, litigation and regulatory support, and enhanced recovery studies. Waterflood feasibility and optimization studies have become a specialty of Deacon’s. He has conducted more than 130 waterflood workshops in recent years, assisting clients in quickly identifying and quantifying the waterflood potential of their oil properties. Deacon has also conducted numerous field-wide waterflood studies for domestic and international projects.

Deacon also has considerable experience with producing oil and gas properties in the Gulf of Mexico, on the shelf and in deep water. He has assisted several clients with well permitting issues, specifically with worse case discharge (WCD) calculations required by the Bureau of Ocean Energy Management.

Deacon is a member of the Society of Petroleum Engineers (SPE) and the Society of Petroleum Evaluation Engineers (SPEE). He has served as Chairman of the Dallas section of both organizations, and he was General Chairman of SPE’s Hydrocarbon Economics and Evaluation Symposium in 1999. Deacon has received SPE’s Section and Regional Service Awards, and he was SPE Dallas Section Outstanding Engineer in 2005.

Deacon is a registered professional engineer in the state of Texas.

EDUCATION

B.S., Petroleum Engineering
Texas A&M University, May 1977
Randal M. “Randy” Brush is Chief Operating Officer of William M. Cobb & Associates, Inc. (Cobb & Associates), has over 34 years of petroleum industry experience, both as a reservoir engineering consultant with Cobb & Associates since 1995 and as an engineer and manager at Atlantic Richfield Company from 1980 to 1995. He uses engineering analysis, mathematical modeling, and appropriate data collection and analysis techniques to evaluate the injection of gas and water into underground geologic formations and the production of oil, gas, and water from those formations.

Randy specializes in reservoir evaluation, management, and simulation studies to estimate oil and gas reserves, and provides ultimate recovery estimates by predicting reservoir performance under alternate development plans and various reservoir drive mechanisms. These evaluations typically relate to water injection projects, enhanced oil recovery projects (such as those using CO₂, hydrocarbon gas, polymer, and steam injection), gas storage projects, field redevelopment, and CO₂ sequestration. Recent projects include several simulation-based redevelopment evaluations of both sandstone and carbonate reservoirs; gas storage evaluations in Kansas, Texas, Colorado, and Wyoming; domestic and international reserves certifications using both deterministic and probabilistic techniques; CO₂ miscible and immiscible flood evaluations of both domestic and international properties; reviewing oil and gas reservoirs for CO₂ sequestration; analytical screening studies of waterflood candidates; and the successful unitization proceedings for several Texas waterflood projects.

Randy has served as an expert witness on a number of domestic and international projects, and has testified before several state and Federal courts, regulatory agencies, and legislative bodies. He is a member of the Society of Petroleum Engineers (SPE), where he has been a technical review committee member and Session Chairman of the Annual Technical Conference and Exhibition since 1999, and the Society of Petroleum Evaluation Engineers. Randy has several SPE technical papers and publications, and is a registered professional engineer in Texas.

EDUCATION

M.S., Petroleum Engineering
Stanford University, January 1981

B.S., Chemical Engineering, with honors
Rice University, May 1978
Donald L. Bailey

Donald L. Bailey is Senior Vice President of Geosciences for William M. Cobb & Associates, Inc. (Cobb & Associates). Don has over 35 years of continuous professional experience in the upstream petroleum industry, including exploration and production in various basins worldwide. He has been a geosciences consultant for over 20 years.

Before joining Cobb & Associates in 1996, Don was employed by Chevron in California, Houston, and Saudi Arabia. During his tenure with Chevron, he was responsible for exploration evaluation and lease management for offshore California, reservoir development for onshore California and Texas, and reservoir description and waterflood maintenance for the eastern onshore reservoirs of Saudi Arabia. Don has experience in a wide range of carbonate, siliciclastic, and unconventional reservoirs.

Don specializes in reservoir characterization through integrated interpretation of log and core analysis data, subsurface and seismic mapping, and cross section studies. His geoscience expertise includes: reservoir characterization, geostatistics, and 3D earth modeling using Petrel software; siliciclastic, carbonate, and shaly sand formation evaluation/log analysis; 2D and 3D seismic interpretation; structural mapping in a variety of regimes; regional stratigraphic studies and sequence stratigraphy applications; fractured reservoir analysis; siliceous shale oil recovery; waterflood and enhanced recovery evaluation and management; gas storage evaluation and management; and exploration economic evaluation and decision analysis.

Don also has extensive legal support experience in equity disputes, arbitration, and litigation, including expert witness testimony. He is a registered professional geologist in the state of Texas. Don is a member of the American Association of Petroleum Geologists (AAPG) and the Society of Petroleum Engineers (SPE).

EDUCATION

M.B.A.
California State University, Bakersfield, June 1996

Completed M.S. Coursework, Geology
University of Southwestern Louisiana May 1980

B.S., Geology
Millsaps College, May 1978
Dr. Michael L. Wiggins is Director of Technology and Training and Senior Vice President of William M. Cobb & Associates, Inc. (Cobb & Associates). Prior to his current role, Mike was president of an independent oil and gas producer and served as a Senior Vice President (2006-2010) and President (2011-2013) of William M. Cobb & Associates, Inc. He has over 35 years of professional experience in academia and the upstream oil and gas industry including drilling, production, and reservoir engineering. His industry experience includes employment with major and independent E&P companies and he has been offering petroleum engineering consulting services to the industry for over 20 years. His technical interests include reservoir management and engineering, production operations, well performance, and production optimization.

Before joining Cobb & Associates in 2006, Mike was a professor of petroleum and geological engineering at the University of Oklahoma, serving on the faculty for 15 years. In this role, he taught courses and conducted research related to reservoir engineering, production operations, and petroleum project evaluation. He has co-authored numerous papers in his areas of expertise and received research funding from various governmental agencies, international oil companies, and national oil companies. In addition, he has conducted numerous short courses in the areas of reservoir management, reservoir engineering, waterflood design and evaluation, well completions, production operations, and petroleum project evaluation.

Mike is a Distinguished Member of the Society of Petroleum Engineers (SPE) and has served on the SPE Board of Directors. He has been the Executive Editor for SPE Production and Facilities and has served as a technical editor for SPE since 1991. He has served on numerous program committees for SPE technical meetings and served as the General Chairman for the 2016 SPE Improved Oil Recovery Conference and General Chairman for the 2003 SPE Production and Operations Symposium.

Mike is a registered professional engineer in the states of Texas and Oklahoma. His activities at Cobb & Associates include reservoir studies, oil and gas reserve evaluations and audits, improved recovery design, educational courses, and litigation support including expert witness services.

EDUCATION

Ph.D. Petroleum Engineering
Texas A&M University, May 1991

M.Eng. Petroleum Engineering
Texas A&M University, August 1988

B.S. Petroleum Engineering
Texas A&M University, May 1979
Brent W. Hale is Vice President of William M. Cobb & Associates Inc. (Cobb & Associates). He has over 35 years of professional experience in reservoir engineering and has specialized in vertically fractured gas well analysis, horizontal well analysis and coal bed methane well analysis. He has experience with coal bed methane reservoirs in Colorado, New Mexico, Wyoming, Oklahoma, and Kansas. He has studied low permeability and shale gas reservoirs in Colorado, Kansas, Louisiana, New Mexico, North Dakota, Michigan, Oklahoma, Pennsylvania, Texas, and Wyoming. He has managed production operations and environmental, health, and safety operations with significant work with governmental agencies.

Before joining Cobb & Associates, he was a director with the Williams Companies with various responsibilities including production operations, environmental, health, and safety operations, and reservoir engineering and geologic services with a focus on acquisition and development of oil and gas properties.

Brent is a member of the Society of Petroleum Engineers (SPE), the Society of Petroleum Evaluation Engineers (SPEE), and the American Association of Petroleum Geologists (AAPG). He has served as section chairman of the Salt Lake Section of the Society of Petroleum Engineers and has served on the SPE Gas Technology Committee. He has also served on the SPEE Resource Play Evaluation committee. He has authored or co-authored technical papers dealing with low permeability gas reservoirs, shale gas reservoirs, and coal seam gas reservoirs. Brent is also co-author of SPEE Monograph’s 3 & 4.

Brent is a registered professional engineer in the states of Texas and Utah. His activities at Cobb and Associates include reservoir studies, oil and gas reserve evaluations and audits, environmental sound mitigation studies, and litigation support including expert witness services.

EDUCATION

M. S., Petroleum Engineering
University of Wyoming, May 1979

B. S., Petroleum Engineering
University of Wyoming, May 1976
Robert E. Williams, Jr. is Senior Geologist / GeoSystems Manager for William M. Cobb & Associates, Inc. (Cobb & Associates). Robert has over 18 years of experience as a consultant geologist in exploration and production in a variety of basins throughout the world.

Robert specializes in comprehensive structural and stratigraphic geological interpretations using various software packages, including Geographix, Apprentice, Petra, and SMT. He is responsible for reservoir characterization through integration of core, well log, and seismic data. He has experience organizing and maintaining digital databases and data rooms for acquisitions and divestitures. His geoscience expertise includes: structural, isopach and reservoir parameter mapping; 2D and 3D seismic interpretation; well log interpretation; cross section interpretation and construction, and technical spreadsheet data evaluation; Robert also has experience performing geological support for worse case discharge (WCD) calculations for GOM drilling permits.

Robert has legal support experience in equity disputes, arbitration, and litigation. He is a registered professional geologist in the state of Texas. He is a member of the American Association of Petroleum Geologists (AAPG), the Society of Petroleum Engineers (SPE) and Dallas Geological Society (DGS).

Robert is also the system administrator at Cobb & Associates. His daily responsibilities include maintaining our email server, data server, network, printers, website, phone system, and voice mail system. He also provides hardware and software technical support for all users.

Before joining Cobb & Associates in 2001, Robert was employed by Gaffney-Cline & Associates (GCA) in Dallas. During his time at GCA, he was responsible for digitizing or creating structure and net pay maps for reservoir volumetric calculations. While with GCA, Robert acquired significant Russian well log evaluation experience. Robert worked closely with the engineers to determine reservoir characteristics. He also was an assistant system administrator helping with daily operations (email server, data server), as well as technical support for approximately 25 employees on various software.

EDUCATION

B.S. in Geology
Oklahoma State University – Stillwater, Oklahoma Dec. 1991
**Andrea Mielcarek**

**Andrea S. Mielcarek** joined Cobb & Associates in May of 2009 as a staff engineer. In this role she supports projects including SEC reserve reporting, property evaluations for sales and acquisitions, and due diligence reviews for lending institutions. Her experience includes oil and gas reserve estimation and economic evaluation through traditional reservoir engineering methods. Andrea is proficient in the AIRES and PHDWin economic software packages.

Prior to joining Cobb & Associates, Andrea worked as a manufacturing process engineer for 3M where she supported daily manufacturing operations, managed product quality issues and led process optimization projects.

**EDUCATION**

B.S. Chemical Engineering  
Texas A&M University, May 2005
Engineering:

- **William M. Cobb** – Ph.D. degree in Petroleum Engineering from Stanford University. Bill has over 40 years of experience as a petroleum engineering consultant specializing in waterflooding, pressure transient analysis, and property management. He has conducted numerous one-week short courses on the subjects of waterflooding, pressure transient analysis, and petroleum economics. His industry experience includes employment with major and independent oil companies.

- **M. Fred Duewall** – B.S. degree in Mechanical Engineering from Texas A&M University. Fred is a registered professional engineer with over 38 years of experience in the oil and gas industry. Fred specializes in auditing petroleum assets for lending institutions and determining the value of properties for potential acquisition or sale.

Geology, Geophysics, and Petrophysics:

- **J. Frederick “Rick” Sarg** – Ph.D. degree in Geology from the University of Wisconsin. Over thirty (30) years of extensive petroleum exploration and production experience in research, supervisory, and operations assignments. Rick was a member of the exploration research group that developed sequence stratigraphy, where his emphasis was on carbonate sequence concepts. He has authored or co-authored twenty-seven (27) papers on carbonate sedimentology and stratigraphy.

- **Joseph R. “Joe” Davis** – Ph.D. degree in Geology from the University of Texas. Over thirty (30) years of technical and supervisory experience with major oil and gas companies, independent oil and gas companies, and consulting. Joe is an expert geophysical interpreter and has wide-ranging geophysical and geological experience in a variety of basins worldwide. Joe has extensive experience as an expert witness in legal disputes and arbitration.