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## N250: Evaluation Methods for Shale Reservoirs

Format and Duration

Classroom - 5 Days

Instructor(s): Jeff May, Dick Merkel, Dan Jarvie, George King and John Randolph

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### Summary

**Business Impact:** This course presents current views on the evaluation methods required to **assess new plays, identify sweet spots, and select optimal landing zones.**

The evaluation of shale reservoirs presents a challenge: whereas some of the approaches applied are the same as those used for conventional reservoirs, some new tools and many new methodologies have been developed for this rapidly evolving subject. More than ever, the evaluation requires an integrated, multi-disciplinary effort by geoscientists, petrophysicists, and engineers.

### Learning Outcomes

Participants will learn to:

1. Determine the key geologic parameters that control the attributes of shale reservoirs, including hydrocarbon storage and deliverability.
2. Establish the components of basin analysis required when scoping a new shale play.
3. Evaluate the variety of depositional processes and changes in environmental conditions recorded in a shale succession and tie that information back to well-log character.
4. Assess the basic stratigraphic framework of shale reservoirs and understand how systematic vertical changes relate to fabric, composition, texture, geomechanics, and, ultimately, reservoir quality.
5. Select methods for determining reservoir properties of shales.
6. Assess geomechanical properties of shales.
7. Understand basic geochemistry results and apply geochemical techniques to evaluate and target tight oil
8. Determine petroleum quality and production potential
9. Assess general gas and oil production potential of candidate shale reservoirs.
10. Select limiting factors in shale hydrocarbon production such as faults, regional fractures, fluid saturations, natural fractures, and frac barriers.
11. Assess technologies and factors that can influence hydraulic fracture growth.
12. Evaluate the role that pre-stack seismic inversion tools can play in characterizing unconventional reservoirs.
13. Investigate methods to predict geomechanical reservoir properties using seismic data.
14. Discuss how distributed acoustic sensing (DAS) can assist with reservoir characterization.

### Training Method

This is a classroom or virtual classroom course featuring lectures from specialists in various fields. Lectures are enhanced with classroom exercises.

### Who Should Attend

All subsurface professionals who are involved in the evaluation of shale resources. Geologists, geophysicists and petrophysicists will learn about recent developments in their own areas of expertise,

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while drilling, completion, and reservoir engineers, will benefit by increasing their awareness of the geologic attributes that affect targeting and volumetrics.

### Prerequisites and Linking Courses

Participants should have a familiarity with resource plays prior to taking this class, such as is offered in N313 (Evaluating Resource Plays).

Several Nautilus Training Alliance courses expand on concepts discussed in N250. These include N241 (Depositional Processes, Fabrics and Stratigraphic Framework of Mudrocks: Application to Shale Reservoirs, CO and WY, USA), N409 (Improved Hydraulic Fracture Design Using Microseismic Imaging), N944 (Shale Gas and Shale Oil Completions using Multi-Stage Fracturing and Horizontal Wells), and N470 (AVO Reflectivity, Pre-stack Inversion, and Quantitative Seismic Interpretation).

### Course Content

This seminar-style course will present an overview of the mudrock petroleum system and then offer views from technical experts on recent evaluation trends on each of several topics: petrophysics and geomechanics, geochemistry, reservoir and completion engineering, and microseismic monitoring.

The course will cover the following items:

#### Day 1 and 2: The Mudrock Petroleum System- Deposition, Stratigraphy and Basin Setting (Jeff May)

- Introduction
  - Mudrock Definition
  - Lithologic Heterogeneity
  - Critical Play Elements
- Data Mining ( Play Reconnaissance) and Regional Basin Analysis (Sweet Spot Evaluation)
  - Published Literature
  - Existing Production
  - Mudlog Shows and Tests
  - Core, Cuttings, Outcrop Samples
- Stratigraphic Framework
  - Depositional Processes
  - Stratigraphic Cyclicality
  - Well-Log Patterns
  - Sequence Stratigraphy
  - Regional Correlations and Variations
- Core Description
  - Mudrock Classification
  - Composition and Texture
  - Sedimentary Structures and Depositional Processes
  - Mechanical Stratigraphy

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- Rock Description (Reservoir Quality)
  - Mineralogy
  - Pore Sizes and Pore Throats
  - Matrix and System Permeability

### Day 3: Petrophysics and Geomechanics for Shale Reservoirs (Dick Merkel)

- Introduction
  - What is a Shale Reservoir?
- Log Evaluation - Petrophysics
  - Log Responses for Organic Shales
  - Mineralogy Determination
  - Quantifying Kerogen / TOC
  - Porosity
  - Saturation
  - Permeability
- Log Evaluation – Geomechanics
- Lateral Evaluation

### Day 4, morning: Shale Completions (Neal Nagel)

This section presents explanations of and practical understanding of completion methods for shale reservoirs.

- Basic shale candidate selection using petrophysical, geochemical and petroleum engineering information
- Well planning, construction, and stimulation
- Production forecasting
- Environmental conservation
- It is illustrated with examples from five commercial North American shale plays: Barnett, Eagle Ford, Gothic, Horn River and Marcellus.

### Day 4, afternoon: Seismic Interpretation Workflows for Unconventional Reservoirs (John Randolph)

This section will present an overview of current seismic interpretation workflows designed to characterize unconventional reservoirs and also to extract geomechanical properties useful in wellbore/completion designs. Topics will include:

- Overview of reservoir responses to seismic waves.
- Seismic inversion tools.
- Seismic-well calibration using petrophysical cross plots.
- Case studies.

### Day 5: Geochemistry for Shale Reservoirs (Andrew Pepper)

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- Conventional vs Unconventional Petroleum Systems
- Basic Definitions in Source Rock Evaluation
- Analytical Screening Methods
- Organic Matter Type and Maturity
- Origin and Correlation of Natural Gas
- Shale Resource Data Collection and Integration