An Introduction to Mudrock Reservoirs: Basin Setting, Stratigraphy, Sedimentology and Rock Properties (G042)

Tutor(s)

Jeff May: Geological Consultant; Affiliate Faculty, Colorado School of Mines.

Overview

The evaluation of shale reservoirs presents a unique challenge: whereas some of the approaches applied are the same as for conventional reservoirs, many new methodologies and tools have been developed for the assessment of this unconventional resource. In this seminar, participants are exposed to the latest concepts of mudrock sedimentation and how it relates to reservoir properties. The development of mudrock successions, including depositional processes and stratigraphic cycles, is highlighted. Goals of the course include:

- Providing practical techniques for assessing reservoir heterogeneity during play reconnaissance ('data mining') and regional evaluation ('sweet spot' mapping).
- Interpreting and correlating well logs within a sequence-stratigraphic framework.
- Learning what components are fundamental to core description and interpretation, including observations on composition, texture, sedimentary structures and fractures.
- Developing an understanding of the factors that control reservoir quality: mineralogy, lithologic components, cements, fabric, fractures and pore systems. Methods used to investigate these rock properties also will be discussed.

Duration and Logistics

Classroom version: A 2-day classroom course comprising a mix of lectures (80%) and hands-on exercises (20%). The manual will be provided in digital format and participants will be required to bring a laptop or tablet computer to follow the lectures and exercises.

Virtual version: Four 4-hour interactive online sessions presented over 4 days. A digital manual and exercise materials will be distributed to participants before the course. Some reading and several exercises are to be completed by participants off-line.

Level and Audience

Fundamental. Intended for all subsurface professionals involved in the evaluation of unconventional resources. Geologists, geophysicists, petrophysicists and engineers who want to understand mudrock deposition relative to reservoir properties will benefit from the concepts and techniques presented. Participants should have a basic familiarity with resource plays. Some understanding of depositional processes and sequence stratigraphy is recommended.

Objectives

You will learn to:

1. Determine the key geologic parameters that affect the attributes of shale reservoirs.

2. Identify the components of basin analysis required when scoping a new shale play.
3. Integrate a variety of data types necessary to identify and map optimum drilling locations and targets.
4. 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.
5. Assess the basic stratigraphic framework of shale reservoirs and understand how systematic vertical changes relate to fabric, composition, texture and, ultimately, reservoir quality.
6. Interpret and correlate well logs utilizing a sequence stratigraphic framework.
7. Understand the observations and methodology necessary when describing and interpreting mudrock cores.
8. Define the key rock parameters that control reservoir quality and mechanical properties.
9. Describe the latest methodologies of pore-scale imaging for shale evaluation.

Course Content

Introduction

- Mudrock definition
- Lithologic heterogeneity
- Critical play element

Data mining (play reconnaissance)

- Published literature
- Existing production
- Mud log shows and tests
- Core, cuttings and outcrop samples

Regional evaluation (sweet spot identification)

- Basin analysis
- Isopach and isolith mapping
- Rock quality mapping
- Hydrocarbon saturation mapping
- Structure mapping
- Pressure compartments and thermal anomalies
- Organic geochemistry
- Geophysical attribute mapping

Stratigraphic framework

- Basinal setting
- Depositional processes
- Organisms and organic matter
- Stratigraphic cyclicity
- Sequence stratigraphy and well log patterns
- Regional correlations and variations

Core description

- Mudrock classification
- Composition and texture
- Sedimentary structures and depositional processes
- Fracture types and styles
- Mechanical stratigraphy

Rock description (reservoir quality)

- Mineralogy and lithologic components
- Fabric
- Pore systems
- Cements
- Fractures
- Fluids

Exercises conducted during the course include:

- Mowry Shale Sequence Stratigraphy – core interpretation and regional well log correlation
- Niobrara Formation – well log sequence stratigraphy
- Graneros and Greenhorn Formations – well log sequence stratigraphy