

Core Facies Analysis of Conventional and Resource Plays: Lessons from the Mowry and Niobrara Petroleum Systems, Powder River Basin (G011)



Tutor(s)

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Overview

This core-based facies analysis course will use the petroleum system of the prolific Powder River Basin to develop realistic depositional models and sequence stratigraphic frameworks that can be used to better predict the extent and continuity of unconventional resources. Demonstrations will introduce participants to core handling, description and data integration techniques. Lectures and exercises will re-familiarize participants with lithofacies and facies associations and will describe applications of core-facies analysis to reservoir characterization of siliceous and calcareous mudstones, muddy sandstones and sandstones. Cores will be from the Powder River Basin, but learnings may be applied to resource plays in other basins.

Duration and Logistics

A 5-day classroom course comprising a mix of classroom lectures (25%) and core description exercises (75%) at the USGS Core Research Center, Lakewood, CO. The manual will be provided in digital format and you will be required to bring a laptop or tablet computer to the course.

Level and Audience

Fundamental. This course is intended for entry-level through mid-career geoscientists, reservoir engineers and petrophysicists who want to extract maximum value from cores, in order to improve exploration play analysis and reservoir characterization of both conventional and unconventional resources. Participants should have a basic knowledge of clastic and carbonate sedimentology and stratigraphy.

Objectives

You will learn to:

1. Identify the important physical and biological parameters of core, including sedimentary structures, biogenic structures, significant surfaces and diagenetic textures. We will examine siliceous and calcareous mudstones, muddy sandstones and sandstones.
2. Calibrate core descriptions with wireline log data.
3. Evaluate source rock potential of mudstones using elemental chemistry data (XRF), TOC, RockEval (Vre) and vitrinite reflectance (Vro) data.
4. Integrate routine core analysis and/or unconventional shale and tight rock analysis with core descriptions to better understand the controls on porosity and permeability.

5. Identify basic structural features in cores, such as faults and fractures, and relate them to mechanical stratigraphy, in situ stresses and borehole stability issues.
6. Develop a sequence stratigraphic framework from core descriptions and wireline log data.
7. Compare reservoir characteristics with production performance to identify target zones for horizontal well placement.
8. Discretize core descriptions for core-to-log facies analysis and reservoir modelling input.

Course Content

Course Details

The Powder River Basin contains two world-class source rocks: the Lower Cretaceous Mowry Shale and the Upper Cretaceous Niobrara Formation. Together they have generated as much as 20 BBO. Basin-margin structures have produced only 1,300 MMBO and 1 TCFG, and conventional and unconventional reservoirs have produced only 1,000 MMBO and 2 TCFG. Much of that 20 BBO remains trapped within unconventional resource plays, such as the tight oil sandstones of the Frontier, Turner, Shannon, Sussex and Parkman formations and the source rocks themselves.

This core-based, facies analysis course provides the foundation for developing realistic depositional models and sequence stratigraphic frameworks that can be used to better predict the extent and continuity of these unconventional resources. Core-based facies analyses of conventional oil and gas reservoirs have led to the successful development of unconventional resource plays in adjacent areas. Core-based sequence stratigraphic evaluations have consistently provided new interpretations that have led to new field discoveries and/or identification of stratigraphic compartments within existing fields. Participants on this course will learn core description techniques and sequence stratigraphic workflows to characterize reservoirs from siliciclastic and mixed carbonate-siliciclastic environments. Core examples are from conventional and unconventional resource plays and include delta plain, shoreline, shelf and offshore marine environments.

Day 1

- Introduction to coring, core handling and core description basics
- Introduction to the Mowry petroleum system
- Examples: Lower Cretaceous Thermopolis (Skull Creek) and Mowry Shale

Day 2

- Introduction to deltaic, shoreline and valley fill depositional systems
- Examples: Fall River Formation and Muddy Sandstone

Day 3

- Introduction to the Niobrara petroleum system
- Example: Niobrara Formation

Day 4

- Introduction to shoreline, nearshore and shelf depositional systems
- Examples: Shelf sandstone deposits of the Wall Creek Member of the Frontier Formation and Turner Sandy Member of the Carlile Formation

Day 5

- Examples: Sussex Sandstone and Parkman Sandstone
- Course wrap-up