





N463: Geological Drivers for Tight-Oil and Unconventional Plays in the Powder River Basin and Applications to Other Basins (*Wyoming, USA*)

Instructor(s): Randi Martinsen and Lee Krystinik

5 Days	Competence Level: Foundation
 Field Course	
 Classroom Elements	
MODERATE	Moderate Physical Demand

Summary

Sometimes your engineer can't just "hit it harder and frack past the problem". Geoscientists and their engineering colleagues will examine controls on location, thickness, natural fracturing and ultimate reservoir quality of "tight-oil sandstones" and "source rock" resource plays in the Powder River Basin. Lateral and vertical heterogeneity, synsedimentary and post-burial tectonic deformation are focal points because these factors dramatically impact the choice of completion methodology, development plans and reservoir management at the single well and field scale. Concepts presented apply to unconventional plays along the Rockies, into Canada, the Gulf Coast of Texas and Louisiana, West Texas, Latin America, Europe and Asia.

Learning Outcomes

Participants will learn to:

1. Ascertain the sedimentary origin of the major tight oil & unconventional resource plays in the Powder River Basin
2. Understand the scale and reservoir characteristics through a range of enigmatic isolated reservoirs. This entails observation of rapid lateral reservoir changes, different reservoir performance and different completion strategies
3. Identify and predict reservoir facies & geometries: "fringe" vs. "core" and how this impacts development plans and long-term reservoir management
4. Establish the impact of synsedimentary tectonics & transgressive erosion on reservoir preservation
5. Integrate faulting & regional fracture systems into sedimentary reservoir characterization to better predict and avoid parent/child production issues
6. Build conceptual models for optimal reservoir quality/diagenesis ("Goldilocks" rocks)
7. Develop and synthesize the above outcomes for application to other basins

Duration and Training Method

This is a five-day field course in the Powder River Basin (PRB), Wyoming designed specifically to help geoscientists and engineers understand why their reservoirs perform as they do. The PRB is a highly oil-rich basin with outcrops of producing reservoirs exposed around its margins, making it an excellent laboratory to study hydrocarbon reservoirs. The daily itinerary includes short conceptual lectures and exercises with full days of outcrop work to determine vertical and lateral aspects of reservoirs, including natural fracture networks.




Physical Demand

The physical demands for this class are MODERATE, according to the Nautilus field course grading system. The outcrops are generally less than 50 m (150 ft) of relief, and all exposures are within 1 km (0.6 miles) of where the vehicles will park. Scrambling over rock outcrops will be required, with the longest hike approximating 1.6 km (1 mile) over broken terrain. The field area is at an elevation of approximately 2200 m (6600 ft). Summer temperatures in this part of Wyoming are moderate, although



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weather can be as cool as freezing and as high as 38°C (100.4°F). Weather in the summer is typically dry, sunny, and occasionally windy, but rain and rarely snow or sleet may occur. Driving will be in SUVs on black-top and unpaved roads.

Who Should Attend

The intent of this course is to bring engineers and geoscientists together on excellent rock outcrops that are highly productive in the nearby subsurface. Additionally, to develop a mutual appreciation and common conceptual perspective regarding the impact of depositional systems, synsedimentary tectonics, transgressive erosion and later tectonic deformation/fracturing on their reservoirs. This understanding leads to a pragmatic decision process regarding completion methodology and reservoir management strategies. This field course is appropriate for those with limited experience who wish to broaden their understanding, and more-experienced participants seeking to integrate more recent geological concepts for identification, analysis and prediction of “tight oil sandstones” and “source rock” resource plays

Prerequisites and Linking Courses

There are no prerequisites for this class.

Additional insight into resource plays at a Foundation Application level is presented in N184 (Unconventional Resources: The Main Oil Systems), N259 (From Outcrop to Subsurface: Understanding and Evaluating Shale Resource Plays), N313 (Evaluating Resource Plays: The Geology and Engineering of Low Permeability Oil and Gas Reservoirs), N305 (Core Facies Analysis for Resource Plays) and N274 (Unconventional Resource Engineering for Geoscientists).

More advanced coverage may be found in a number of courses, including D250 (Evaluation Methods for Shale Reservoirs), N284 (Seismic Attributes and Pre-Stack Inversion Tools for Characterizing Unconventional Reservoirs), N986 (Reservoir and Production Engineering of Resource Plays), N957 (Forecasting Production and Estimating Reserves in Unconventional Reservoirs), and N944 (Shale Gas and Shale Oil Completions Using Multi-Stage Fracturing and Horizontal Wells).

Please refer to the Unconventional Resources Competency Map on our website for a complete listing of related courses.




Course Content

Excellent outcrops of all major horizontal drilling target horizons in the Powder River Basin are used as our laboratory. “Tight oil sandstone” reservoirs to be investigated include the Shannon, Sussex, Parkman, Teapot, Turner and Frontier. This trip also addresses the Niobrara and Mowry petroleum systems and how these transgressive, fine-grained “source-rock” resource plays vary regionally in their sedimentology and composition, and their attendant propensity for porosity and fracturing. This allows geologists and engineers to work together in determining sweet spots and avoiding “money disposal” areas.



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The itinerary below is pending and subject to change

Day 0: Travel Day

- Travel Day to Casper, Wyoming, USA
- Reception and Introductory lecture

Day 1: Casper

- Overview of the Powder River Basin, the key productive unconventional resource plays, and Niobrara petroleum system: Niobrara, Teapot and Parkman reservoirs and the reservoir engineering issues they pose.
- Outcrop Stops: Niobrara Fm. marls, Teapot and Parkman shoreface and deltaic successions, unconformity and valley fill.

Day 2: Casper

- Lecture on the Shannon and Sussex isolated sandstone bodies, relationships within the Niobrara petroleum system and analogs, and underlying successions.
- Outcrop stops illustrating Shannon and Sussex sandstone body variability; Frontier, Mowry and Niobrara strata and why this matters in the subsurface for ultimate economics.

Day 3: Casper

- Lecture on the Mowry Fm. petroleum system, and Frontier and Mowry formation reservoirs.
- Outcrop stops on Frontier, Niobrara and Mowry strata. These units behave differently from each other as reservoirs and have different drilling and completion issues as demonstrated in the field.

Day 4: Casper to Newcastle

- Lecture on the eastern Powder River Basin exposures: facies changes and controls.
- Outcrop stops: Frontier, Niobrara and Mowry strata near Douglas & Redbird. These rocks change a lot around the basin and impact where we should drill and how we should complete the zones of interest.




Day 5: Newcastle

- Lecture on trend analysis and basinal transport orientations, and subsurface relationships exercise.
- Outcrop stops: Turner, Mowry, and Niobrara strata and discussion of reservoir complexity and the impact on engineering considerations.
- Final night dinner in Casper



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Day 6: Travel Day

- Return from Casper, Wyoming.