





N162: The Geology of a Devonian Gas Shale play: A field workshop in the Appalachian Basin (*New York and Pennsylvania, USA*)

Instructor(s): Terry Engelder

6 Days	Competence Level: Skilled
	Field Course
	Classroom Elements

Summary

The Devonian Catskill Delta complex of the northern Appalachian Basin contains numerous organic-rich 'black' shales which serve as source and seal for oil and gas fields in the basin and are prospective reservoirs for unconventional gas plays. This course explores the structural geology of these shales, with a focus on the influence of stratigraphy on their brittle behavior and suitability as unconventional reservoirs.

Learning Outcomes

Participants will learn to:

1. Analyze the structural setting of the Devonian organic-rich shales within the Catskill Delta complex of the Appalachian Basin.
2. Assess the mechanics of basin development, including the roles of compaction, consolidation and stress.
3. Evaluate mechanisms for generation of abnormal fluid pressure in basins, including the role of disequilibrium compaction in top seal development and the role of hydrocarbon generation in pressure development.
4. Estimate the timing of hydrocarbon maturation and migration in source beds and the impact on joint initiation.
5. Evaluate mechanisms of seal leakage by joint propagation, including driving mechanisms for joint growth, velocities of joint propagation and multiple joint driving mechanisms for loss of seal integrity.
6. Judge the control of lithology on jointing in a fractured reservoir, including joint interconnectivity and concomitant permeability, joint interaction on propagation, cross cutting relationships in reservoir permeability, source and reservoir rock permeability with time and joint density and spacing as a function of bed thickness.
7. Evaluate the development of composite joints.
8. Assess relationships between jointing and regional tectonics.

Duration and Training Method

A six-day field course, starting in Buffalo, NY and ending in Pittsburgh, PA, comprising workshops, outcrop and core instruction augmented with topical lectures. Outcrop observations will be coupled with seismic sections, well logs, organic petrology, geochemistry and case studies. A visit will be made to Penn State University to view Devonian core.



Physical Demand

The physical demands for this class are LOW according to the Nautilus Training Alliance field course grading system. The field stops will be in the flat to hilly, wooded terrain of western New York and Pennsylvania. The weather can be cool and dry to warm and humid. Participants will be taking short to moderate hikes (less than 3.2 km (2 miles) each) with a maximum elevation change on any hike of less than 200 m (660 ft). Some walks will be along a lakeshore or small rivers. Transport is by bus, mostly on black-top roads.



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Who Should Attend

The course is aimed primarily at geoscientists and other technical staff working to understand the role of fractures in unconventional shale gas plays, but should be of interest to all staff working with fractured rocks.

Prerequisites and Linking Courses

Familiarity with shale gas plays, as presented in M082 (Appraising and Developing Unconventional Reservoirs), would be an advantage but is not essential. Nautilus Training Alliance courses that address structural topics of resource plays at a Skilled Application level include N134 (Carbonate and Shale Faulting and Fracturing Field Seminar, Texas, USA), N231 (Understanding, Evaluating and Managing Fractured Reservoirs with Core Workshop) and N266 (Stress and Geomechanical Analyses, Texas, USA). Additional classes on shale plays are N206 (Seismic Tools for Unconventional Reservoirs), N271 (The Bakken/Sappington/Three Forks Resource Play, Montana, USA), and N287 (Exploiting Clastic Resource Plays in Fluvial through Shallow Marine Environments, Alberta, Canada). Related courses on the engineering program include N944 (Shale Gas and Shale Oil Completions Using Multi-Stage Fracturing and Horizontal Wells) and N957 (Forecasting Production and Estimating Reserves in Unconventional Reservoirs).

Course Content

Outcrops of the Catskill Delta complex are found in the deep post-glacial valleys that are exposed on the Appalachian Plateau. The outcrops illustrate the multiphase nature of fluid pressure generation in a hydrocarbon system within delta complexes at continental margins. This field trip addresses the following issues concerning the development of hydrocarbon systems within overpressured source and reservoir rocks:

1. Mechanics of basin development

- Compaction
- Consolidation
- Stress in basin development

2. Mechanisms for generation of abnormal fluid pressure in basins

- The role of disequilibrium compaction in top seal development
- The role of hydrocarbon generation in pressure development

3. The timing of hydrocarbon maturation and migration

- The mechanism for joint initiation during primary migration in source beds
- The mechanism for joint initiation during secondary migration in reservoir beds



4. Mechanisms of seal leakage by joint propagation

- Driving mechanisms for joint growth



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- Issues associated with velocity of joint propagation
- Vertical joint growth and horizontal propagation based on surface morphology
- Multiple joint driving mechanisms for loss of seal integrity

5. Control of lithology on jointing in developing a fractured reservoir

- Development of a joint interconnectivity and concomitant permeability
- Joint interaction on propagation
- Cross cutting relationships in reservoir permeability
- The development of source and reservoir rock permeability with time
- Development of joint density and spacing as a function of bed thickness

6. Aspects of pressure compartment geometry

7. The development of composite joints

8. Issues concerning the relationship between jointing and regional tectonics

Itinerary (subject to change)

Day 0:

- Start in Buffalo NY
- Introductory lecture

Day 1:

- Lecture
- Field Stops: Dunkirk, NY
- Silver Creek, NY
- Eighteen Mile Creek, NY
- Sturgeon Point, Hamburg, NY
- Overnight in Buffalo NY

Day 2:

- Lecture
- Field Stops: Eighteen Mile Creek, NY
- LeRoy, NY
- Portageville, NY
- Dansville, NY
- Overnight in Ithaca NY



Day 3:

- Lecture
- Field Stops: Watkins Glen, NY
- Trumansburg, NY



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Overnight in Ithaca NY

Day 4:

- Lecture
 - Field Stops: Moonshine Falls, NY
 - Union Springs, NY
 - Moravia, NY
 - Cortland, NY
- Overnight in Ithaca NY

Day 5:

- Lecture
 - Field Stops: Tioga, PA
 - Washingtonville, PA
 - Sunbury, PA
 - Selinsgrove, PA
 - Elmsport, PA
 - Antis Fort, PA
- Overnight in State College PA

Day 6:

- Lecture
 - Core Workshop
 - Field stops: Lewistown, PA
 - Newton-Hamilton, PA
 - Huntingdon, PA
 - Frankstown, PA
- Overnight in Pittsburgh PA

Day 7:

Travel home