N471: The Petroleum System in Unconventional Exploration & Production: Geology, Geochemistry and Basin Modeling

Tutor(s): Andy Pepper

4 Days	Competence Level: Basic Application
Classroom Course	

Summary

The course teaches how to use regional geology, geochemistry and petroleum systems modeling in evaluating unconventional/resource play reservoirs. The processes discussed range from deposition of the organic-rich rock; generation, expulsion, migration and accumulation processes leading to saturation of the reservoir; to the prediction of reservoir and produced fluid properties and values. This class will arm geologists and engineers with advanced capabilities to: identify, map and evaluate new plays; identify storage and production sweet spots in plays; identify vertical/by-passed storage and production sweet spots to optimize landing zones in new and existing plays.

Learning Outcomes

Participants will learn to:

1. Understand modern approaches to categorizing source rocks: their potential and distribution
2. Establish the link between organic matter and petroleum: the organofacies scheme and the geochemistry and composition of oil & gas
3. Identify how the thermics of sedimentary basins and kinetics/organic matter quality control expelled petroleum volumes and compositions
4. Understand the effects of pressure and capillarity: petroleum migration and accumulation are flip-sides of the same process, controlling reservoir saturation patterns
5. Differentiate between potentially producible fluid vs. immobile sorbed petroleum in organic-rich reservoirs
6. Employ sweet-spot mapping of well performance from a pressure and fluid perspective, and fluid prediction using advanced pyrolysis methods in well samples

Duration and Training Method

This is a four-day classroom course. The materials are provided electronically to be followed on a laptop; a poster session and numerous 'Quick Quiz's punctuate the lectures. Examples are provided from the Permian and Williston basins, as well as the Barnett, Eagle Ford and Marcellus unconventional plays.

The class exercise is a through-going evaluation of a 'disguised' producing unconventional basin, starting at the early exploration phase and ending with a reservoir evaluation. The exercise is done on paper and requires no knowledge of basin modeling software.

Class time can be adapted somewhat to address problems brought by Students.

Who Should Attend

Exploration and development/production geoscientists and reservoir engineers who need to understand the fundamentals of how the petroleum system works to determine fluid saturation and composition in unconventional/resource plays.

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Prerequisites and Linking Courses

There are no prerequisites for this class. Participants need no prior knowledge of the basic concepts of the formation, migration and accumulation of petroleum in sedimentary basins, since the class is taught from modern first principles.

Complementary courses include N010 (Geochemistry and Petroleum System Modeling) and N084 (Petroleum Generation and Migration), N250 Evaluation Methods for Shale Reservoirs, N184 (Unconventional Resources: The Main Oil Systems), N084 (Petroleum Generation and Migration), N313 (Evaluating Resource Plays: The Geology and Engineering of Low Permeability Oil and Gas Reservoirs).

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

Course Content

This class uses modern petroleum systems (geochemistry and thermal/fluid flow modeling) approaches, including some all-new modeling of petroleum saturation and composition in unconventional reservoirs. No prior knowledge of geochemistry and basin modeling is required: the class contains all the information needed for a geoscientist to understand the 'unconventional' petroleum system, building upon an understanding of geology and reservoir engineering principles. The class is also suitable for reservoir engineers working unconventional plays, who wish to understand the fundamentals of unconventional reservoir geology.

Topics:

Charge | Source Rock Potential - 'The Feedstock'

- Measurements of organic richness and potential
- How organic matter (OM) in source rocks is deposited: variations in distribution, thickness, organic carbon content and organic matter type (organofacies)
- How source rock volumetric potential and system gas/oil potential can be quantified (ultimate expellable potential)

Charge | 'Making the Petroleum'

- Modeling generation of petroleum from, and sorption of petroleum in, OM
- Understanding thermal stress levels for oil and gas generation from, and cracking of sorbed oil to gas in, OM
- Prediction of petroleum composition expelled from OM: gas-oil ratio (GOR)

Charge | 'Moving the Petroleum'

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- Sorbed vs. fluid petroleum phases in OM-rich rocks
- Petroleum fluid phase behavior
- Migration/saturation of the fluid phase within, and adjacent to, the source bed
- Migration into the conventional fluid system - the 'flip side' of unconventional reservoir storage

Trap | Seal and Column 'Building the Petroleum Saturation'

- Controls on pressure evolution in sedimentary basins
- Controls on saturation in reservoir rocks: hydrodynamics, buoyancy, capillary entry pressure and interfacial tension
- Recognizing the unconventional reservoir as a petroleum system: source, reservoir and seal
- Capillary pressure and architecture of saturation patterns in unconventional reservoirs

Reservoir | Storage 'Storing the Petroleum'

- 'Unconventional' core measurements of porosity and saturation - effects of Dean-Stark cleaning
- Measuring and modeling sorbed vs. mobile fluid phase saturations
- Profiles of fluid phase saturation in 'classic' unconventional petroleum plays
- Fluid phase properties: predicting GOR and Formation Volume Factor
- Petroleum-In-Place sweet-spot logging and mapping - Permian Basin Wolfcamp example

Reservoir | Deliverability 'Producing the Petroleum'

- Pressure - a key limitation on delta-P
- Modeling fluid viscosity in unconventional reservoir fluids
- Petroleum deliverability/rate sweet-spot logging and mapping - Permian Basin Wolfcamp example

Product | 'Valuing the Petroleum'

- Properties of the produced liquid stream that affect sales value
- Properties of the produced gas stream that affect sales value