Working with Unconventional Petroleum Systems (G032)

Tutor(s)

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Overview

This course teaches how to use Petroleum Systems Analysis (regional geology, geochemistry and petroleum systems modeling) to evaluate unconventional/resource play reservoirs. The subject matter ranges from deposition of organic matter in the source rock (generation, expulsion, migration and accumulation processes leading to saturation of the reservoir), to the prediction of reservoir and produced fluid properties and value. This class will equip geologists and engineers with advanced capabilities to: identify, map and evaluate new plays; identify storage and production sweet spots in plays; and identify vertical/by-passed storage and production sweet spots to optimize landing zones in new and existing plays.

Duration and Logistics

Classroom version: 5 days, a mix of lectures (75%) and quizzes/exercises (25%). 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: Five 4-hour interactive online sessions presented over 5 days, including a mix of lectures (75%) and quizzes/exercises (10%). A digital manual and hard-copy exercise materials will be distributed to participants before the course.

Level and Audience

Advanced. Intended for exploration, exploitation and production geoscientists, reservoir and completion engineers and managers who need to understand how the petroleum system works to determine fluid saturation and composition in resource plays. A basic familiarity with resource plays is assumed.

Objectives

You will learn to:

1. Understand modern approaches to describing source rocks: their expulsion potential and distribution.
2. Establish the link between organic matter and petroleum: the organofacies scheme and the geochemistry and composition of oil and gas.
3. Link the burial and thermal histories of onshore/exhumed sedimentary basins to the temperature and pressure history of the source bed/reservoir.
4. Understand how organic matter quality kinetics control petroleum volumes and compositions expelled from organic matter.
5. Understand the roles of pressure and capillarity in creating an unconventional reservoir: that petroleum migration and accumulation are flip sides of the same coin, controlling reservoir saturation patterns.

6. Evaluate the strengths and weaknesses of current core analysis techniques and use geochemical concepts to differentiate between potentially producible fluid vs immobile sorbed petroleum in organic-rich reservoirs.
7. Identify sweet spots in well rate performance from a pressure and fluid perspective, and fluid prediction using advanced pyrolysis methods in well samples.
8. Understand the properties of produced fluids that contribute to/detract from well stream value.

Course Content

Course Details

This class uses modern and some all-new petroleum systems (geochemistry and thermal/fluid flow modeling) approaches, including modeling of petroleum saturation and composition in unconventional reservoirs. Prior knowledge of geochemistry and basin modeling is not required – although the class is advanced it contains the foundational information needed for a geoscientist or engineer to understand the "unconventional" petroleum system, building upon geology and reservoir engineering first principles. The class is primarily geological but is intended also to help reservoir engineers seeking to understand the fundamentals of unconventional reservoir performance.

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 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"

- 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.