N342: Compartmentalization and Connectivity in Sandstone Reservoirs

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Format and Duration

Classroom - 5 Days
Virtual - 10 Sessions

Summary

Business Impact: The reservoir connectivity workflow taught in this course has proven successful in **increasing field reserves** by **identification** of **new** or **underdepleted compartments**, **deeper oil/water contacts**, **oil columns in gas-dominated closures,** and **cross-fault flow** or **channel to channel reservoir flow** that increases overall activity.

The complex interplay of fluids and rock architecture controls efficient depletion of conventional sandstone reservoirs. Stratigraphic and structural analyses often provide much detail, but static and dynamic connectivity information reveal the elements that really matter to flow. This course uses fluid, pressure, log, seismic, and core data to examine the movement of reservoir fluids (oil, gas, water) over geologic and production timescales and determine which factors are critical in the development and exploitation of siliciclastic hydrocarbon reservoirs.

Learning Outcomes

Participants will learn to:

1. Assess "what really matters to flow" at geologic and production timescales.
2. Select potential reservoir compartments from analysis of structure contour maps.
3. Evaluate static and dynamic pressure data to evaluate shale barriers, baffles, erosion by channels and scours.
4. Characterize controls upon shale bed continuity (2D/3D).
5. Evaluate isopach maps to identify potential underdepleted field compartments.
6. Predict compartmentalization caused by interaction of faults and reservoir sand bodies.
7. Select and utilize concepts like the breakover point and other topologic controls on fluid contacts.
8. Characterise differing GOC/OWC's and differentiate from perched water.
9. Evaluate discovery and appraisal wells and use data to construct a set of plausible reservoir connectivity scenarios.
10. Understand how dynamic field changes as determined from 4D seismic, PLT's, pressure buildups, downhole pressure gauges, and time-lapse geochemistry are used in production.
11. Appraise differing connectivity challenges of fluvial, shoreline, deltaic, and deepwater reservoirs.
12. Evaluate key sedimentological and geologic factors controlling porosity, permeability, net to gross, and sand body and shale bed continuity.

Training Method

This is a classroom or virtual classroom course comprising a mixture of lectures, discussion, case studies, numerical simulations and practical exercises.

Who Should Attend

This course has been designed for geoscientists and petrophysicists, as well as reservoir and completion engineers, who wish to develop a broader understanding of controls on reservoir performance.

Prerequisites and Linking Courses

A familiarity with development geology, reservoir engineering concepts and geological analysis of well logs is assumed, such as offered in N006 (An Introduction to Reservoir Engineering for Geoscientists) and N003 (Geological Interpretation of Well Logs).

Course Content

1. Introduction

- Beyond "Dry Rock" reservoir architecture: geofluid distribution as an indication of what really matters to flow
- Reservoir Properties: Why depositional environment really matters
- Exercise: Reservoir properties and impact on exploration prospect risking
- Static (geologic) connectivity versus Dynamic (production-time scale) connectivity
- Understanding reservoir connectivity from a joint rock and fluid perspective
    - Traps, compartments (versus flow units), breakover, aquifer separation
    - Connectivity concepts in two- and three-fluid systems
- Exercise: Compartment identification in mixed-influence deltaic reservoir
    - Identification of reservoir compartments from structure contour maps
- Exercise: Fluid contact scenarios
    - Two- and three-fluid compartments, compartment diagrams, fault plane profiles

2. Static Connectivity

- Topological controls on fluid distributions in fluvial and deepwater channelized systems
- Perched water versus separated aquifers
- The hierarchy of shale barriers and baffles in distributive deltaic and shore zone systems
- Top seal control on fluid contact elevation: three classes of capillary seals and traps
- Exercise: Classification of oil and gas compartments by Sales (spill vs. leak) and Sneider (top seal character) parameters (spreadsheet)
- Scours: fluvial versus deepwater types; 3D seismic, forward seismic models, physical experiments
- Shale bed continuity in 3-dimensions
- Exercise: Fluvial channel reservoir connectivity
    - Correlation of High NTG channels in a large field in the North Sea
    - Recognition of sequence boundaries using core and log data
    - Use of MDT pressure data to evaluate shale baffles, barriers, erosion by scour
    - Construction of isopach maps, determination of underdepleted field compartments, planning infill drilling

3. Dynamic Connectivity

- The effect of channel base scours on fluid communication
- Barrier breakthrough: myths and reality: numerical models
- Fluid cusping vs. fluid coning: why these are often confused; case study
- Investigating connectivity with 4D seismic and PLT's
- Exercise: Construction of connectivity scenarios: fluvially-dominated delta
  - Fault-bounded compartments versus delta lobe compartments
  - Construction of connectivity scenarios
  - Use of static and dynamic data in discriminating between three connectivity scenarios
  - Understanding hierarchy of shales and its role in modeling of deltas and deepwater distributive systems
- Fault connectivity (cross-fault flow) at geologic and production time scales
  - Use of fault plane profiles to identify cross fault flow
  - Importance of delta throw/shale bed ratios
  - Clay smear vs. SGR: field observations and experimental models

4. Connectivity Input to reservoir engineering and simulation models

- Fault dip and bed dip: parallel versus divergent trends and effect on water and gas flooding
- Placing scours and shales in geological models: stochastic versus deterministic
- Exercise: Fault and deepwater sand body interaction
  - See production differences between amalgamated channel and channel-levee reservoirs
  - Observe separate oil-water contacts and dynamic connectivity not predicted by static data
  - Explain compartmentalization created by interaction of faults and channels
  - Construct static connectivity diagram and use to understand dynamic performance trends
  - Evaluate development and post-production startup results from connectivity models