

N342: Compartmentalization and Connectivity in Sandstone Reservoirs

Instructor(s): John Snedden

Format and Duration

Classroom - 5 Days

Virtual - 10 Sessions

Summary

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.

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.

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. Employ excel spreadsheets to work with subsurface pressure data including excess pressure methods
4. Evaluate static & dynamic pressure data to evaluate shale barriers, baffles, channel scours.
5. Characterize controls upon shale bed continuity (2D/3D).
6. Evaluate isopach maps to identify potential underdepleted field compartments.
7. Predict compartmentalization caused by interaction of faults and reservoir sand bodies.
8. Select and utilize concepts like the breakover point and other topologic controls on fluid contacts.
9. Characterise differing GOC/OWC's and differentiate from perched water.
10. Evaluate discovery and appraisal wells and use data to construct a set of plausible reservoir connectivity scenarios.
11. 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.
12. Appraise differing connectivity challenges of fluvial, shoreline, deltaic, and deepwater reservoirs.
13. 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.

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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.

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), spill points, 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
- Topological controls on fluid distributions in fluvial and deepwater channelized systems
- Exercise: Fluid contact scenarios
 - Two- and three-fluid compartments, compartment diagrams, fault plane profiles

2. Static Connectivity

- Understanding subsurface pressure data from MDT, RCI, RFT, SFT measurements etc Exercise: Excel spreadsheet excess pressures to identify compartments, barriers & baffles
- 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 RFT pressure data to evaluate shale continuity, erosion by scour
 - Construction of isopach maps, evaluate underdepleted field compartments, infill well planning

3. Dynamic Connectivity

- The effect of channel base scours on fluid communication Barrier breakthrough: myths and reality: numerical models

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- 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