N309: Fluvial Reservoir Architecture From Modern and Ancient Systems *(Nebraska, USA)*

Instructor(s): Chris Fielding and Matt Joeckel

Format and Duration

Field - 5 Days
Low Physical Demand

Summary

This course combines field experience and classroom sessions to build an understanding of the sedimentology and stratigraphy of fluvial systems. Field visits will be made to modern rivers including the Platte and Missouri Rivers, pits exposing Holocene and Pleistocene alluvial deposits and cliff exposures of Pennsylvanian incised valley fill. Emphasis on process-product-preservation and utilization of outcrop, geophysical and drilling data will facilitate a fuller understanding of alluvial reservoir architecture.

Learning Outcomes

Participants will learn to:

1. Evaluate alluvial deposits in terms of formative processes and environments.
2. Reconstruct alluvial architecture from subsurface data by reference to Holocene systems.
3. Assess alluvial architecture in terms of the principal forcing mechanisms responsible for the succession.
4. Predict vertical and lateral variability in subsurface fluvial reservoirs based on the understanding of alluvial architecture and a knowledge of relevant correlation strategies.
5. Propose basin-scale predictions of reservoir geometry and connectivity based on an understanding of alluvial architecture.
6. Select realistic dimensional and other data to populate static and dynamic reservoir models of alluvial reservoirs, utilizing experience from the field excursions and elsewhere.

Training Method

A five-day field and classroom course comprising a mixture of field presentations, field exercises, and classroom sessions that include practical exercises on subsurface data. The proportion of field time to classroom time is approximately 50:50.

Physical Demand

The physical demands for this class are LOW according to the Nautilus field course grading system. Fieldwork is carried out in the essentially flat to mildly undulating agricultural landscape of Nebraska. Access to the field sites is easy, with vehicular access directly to most sites. Short walks up to 1.0 km (0.6 miles) are likely.

Who Should Attend

The course is aimed at experienced exploration and development geoscientists, petrophysicists and reservoir engineers who desire a fuller understanding of alluvial systems and their deposits, and a methodology for realistically characterizing subsurface alluvial reservoirs.

Prerequisites and Linking Courses

Participants are expected to have a basic understanding of sedimentology and stratigraphy. For those wanting an introduction to fluvial sedimentology and reservoir geology at the Basic Application Level,

consider taking the classroom course N155 (Introduction to Clastic Depositional Systems: A Petroleum Perspective), and the field course N156 (Clastic Depositional Systems in a Basinal Framework: Exploration and Reservoir Implications, Pyrenees, Spain). Ancient fluvial deposits are examined at the Skilled Application Competence Level in N027, (Reservoir Sedimentology and Stratigraphy of Continental Clastic Systems, Wyoming, USA).

Nautilus provides several classes that would be a good introduction to geocellular modeling (and its connection upstream to the rocks and downstream to flow simulation), in addition to reservoir development. N008 (An Introduction to Reservoir Appraisal and Development) is the introductory level classroom course for Reservoir Development at the Basic Application Level. N012 (Reservoir Modelling Field Class) visits several reservoir types in Utah and examines how to get the geology into the geocellular model and which parts of it are important for flow. Suitable follow-up field courses for those wishing to progress further with fluvial modeling and reservoir development include N108 (Exploration and Geological Model Development in Fluvial Reservoirs, Ebro Basin, Spain) and N215 (Advanced Techniques for Modelling Fluvial and Deltaic Architecture using Petrel, Utah, USA).

Course Content

Fluvial reservoirs are popularly thought of as “labyrinthine”, a term that epitomizes their complexity. Realistically predicting and incorporating such complexity into reservoir modelsnfor fluvial successions is very challenging. The successful characterization of alluvial reservoirs therefore relies upon an understanding of sedimentology and stratigraphy, including the processes by which alluvial stratigraphic successions are formed and preserved.

This course will firstly provide participants with an understanding of the physical processes that lead to the formation of alluvial channel and overbank sediments (including paleosols). The course will then explore how these alluvial sediment products are transformed into subsurface geobodies by selective preservation during burial. The role of both downstream (sea-level, or base level) and upstream controls (including climate changes, tectonic processes, variations in sediment supply) on alluvial architecture will then be evaluated to allow a fuller understanding of cross-sectional reservoir geometry at various scales. The course will emphasize recent developments in the understanding of both modern systems and ancient successions, utilizing experience from scaled experiments.

Participants will benefit from new research data on the Platte River in Nebraska, a classical sandy, braided river system that was used as a key exemplar to formulate facies models for braided alluvium, and the Missouri River, a large meandering stream that is a major tributary of the Mississippi. We will also utilize exposures of Holocene and Pleistocene alluvium in commercial sand and gravel pits to illustrate the products of alluvial sedimentation. Our new data (including cores, wireline logs and ground-penetrating radar cross-sections) allow us to characterize the sedimentology of these excellent reservoir analogues more fully and to illustrate theirsubsurface geometry and lithological heterogeneity at a variety of scales. The Platte River system has in recent years experienced a massive drop in water and sediment discharge along parts of its course, leading to contraction of its channel belt into a series of anabranches. An appreciation can therefore be gained of the timeframes and consequences of abandonment of a large

fluvial system. Collectively, the insights into alluvial architecture to be gained from the Platte and Missouri Rivers, and their precedents, are unparalleled.

The sedimentology of the modern rivers will be compared to that of Holocene and Pleistocene alluvial deposits of precursor streams, and Pennsylvanian alluvial sandbodies that are productive hydrocarbon reservoirs in nearby Kansas. The experience gained in the field will be applied in the classroom. Effective strategies for subsurface correlation of alluvial deposits will be discussed in order to facilitate a broad understanding of alluvial stratigraphy. This understanding will then be used to address issues of upscaling from local data to larger dimensions in reservoir modeling and in exploration. Practical exercises will explore these concepts and illustrate both the opportunities and uncertainties in modeling subsurface fluvial reservoir successions.

Course itinerary (Subject to Revision)

Day 0
• Arrive in Omaha. Nebraska and transfer to hotel.
• Evening course safety brief, introductory lecture, and group dinner in the hotel.

Day 1
• Classroom sessions. Field excursion to the Missouri River in the Fort Calhoun area to view the modern river and Holocene alluvium exposed in quarry walls.

Day 2
• Classroom sessions. Field excursion to the Platte River in the Plattsmouth area, and the Elkhorn River near Gretna, to examine processes of alluvial bar construction. (If river conditions permit, an airboat will transport participants to an emergent sand bar in the middle of the Platte River.)

Day 3
• Field excursion to sand and gravel pits near Fairbury to view Pleistocene precedents of modern large, incised river deposits and to a nearby modern stream (Little Blue River).

Day 4
• Classroom sessions. Field excursion to view Pennsylvanian incised valley fill deposits (productive hydrocarbon reservoirs in nearby Kansas).

Day 5
• Classroom sessions. Final course dinner in Omaha.

Day 6
• Departure at leisure from Omaha.