N442: Reservoir Architecture of Deep Water Systems *(California, USA)*

Tutor(s): Vitor Abreu

5 Days	Competence Level: Skilled
Field Course	
Classroom Elements	
MODERATE	Moderate Physical Demand

Summary

Submarine canyons and deep water channels are the primary conduits for the transfer of coarse sediments from the shelf to deep water fans and are major exploration targets. The evolution of southern California included many episodes of deep water sedimentation in settings ranging from a Paleozoic cratonic passive margin to Mesozoic forearc and arc settings to Cenozoic transform, pull-apart, and continental borderland basins. This course will examine six deep water systems in which large and small submarine channels and fans played major roles as sediment transport routes and sites of sedimentation.

Learning Outcomes

Participants will learn to;

1. Assess sedimentological processes of deep water deposition and erosion and their impact in reservoir architecture.
2. Interpret cores, well logs and outcrops using appropriate deep water lithofacies nomenclature and definitions.
3. Describe deep water lithofacies in cores and relate them to stratal geometries.
4. Interpret key stratigraphic surfaces based on changes in lithofacies stacking and associations.
5. Interpret deep water environments of deposition based on lithofacies associations, stacking and diversity.
6. Use outcrop analogues and depositional models to better understand 3-D distribution of reservoir facies.
7. Tie rock properties to facies in building geologic models.
8. Perform environment of deposition mapping, emphasizing impact on reservoir performance and behavior.
9. Evaluate core, well-logs and seismic data to describe the reservoir in 3 dimensions.

Duration and Training Method

This 5-day course combines field activities with class lectures and exercises, with 80% of the time spent in the field. Exercises in the field will focus on description of deep water lithofacies, stratal geometries and recognizing key stratigraphic surfaces, emphasizing practical applications. Participants will also learn to describe cores, integrate core and well-log information with seismic to generate high-resolution environment of deposition maps of reservoirs in different settings. Engineering data are used to demonstrate how to improve prediction of reservoir performance. Cores, well-logs and seismic examples are compared to and contrasted with outcrops to help participants to extrapolate 2-D outcrop information to 3-D views of reservoir scale depositional systems.

Physical Demand

The physical demands for this class are MODERATE according to the Nautilus field course grading system. The field areas are at sea level in and around San Diego and La Jolla, California, where

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temperatures range from cool and damp to warm and humid. There will be walks of up to 1 km (0.6 miles) most days, with some wading on a sandy beach required to visit some outcrops. The longest walk on the class is 4.5 km (3 miles) with an ascent of 100 m (300 ft). Transport on the course is by bus.

Who Should Attend

Geologists, geophysicists, petrophysicists and reservoir engineers working on deepwater reservoirs from exploration to production. The course is also suitable for managers seking an understanding of these reservoirs.

Prerequisites and Linking Courses

A familiarity with clastic depositional settings and terminology, as presnted in N155 (Introduction to Clastic Depositional Systems: a Petroleum Perspective) is assumed.

Other field courses that explore deep water settings include N292 (Deepwater Depositional System Stratigraphy for Exploration and Development (Arkansas)) and N302 (Deepwater Reservoir Presence and Architecture: Permian Brushy Canyon Formation, Guadalupe and Delaware Mountains (West Texas)) in North Ameriuca and N009 (Sedimentology, Stratigraphy and Reservoir Geology of Deepwater Clastic Systems (County Clare, Ireland)) and N033 (Characterisation, Modelling, Simulation and Development Planning in Deepwater Clastic Reservoirs (Tabernas, Spain)) in Europe. A linking classroom course is N072 (Workshop in Geological Seismic Interpretation: Deep Marine Systems).

Course Content

Submarine canyons and deep-water channels are the primary conduits for the transfer of coarse sediments from the shelf to deep-water fans and they are today major targets for petroleum exploration. Southern California has had a long and complex geologic history that has involved many episodes of deep-water sedimentation in a variety of settings ranging from the Paleozoic passive margin of the North American craton to Mesozoic forearc and arc settings to Cenozoic transform, pull-apart, and continental borderland basins. These settings feature deep-water deposits in which both large and small submarine channels and fans played major roles as sediment transport routes and sites of sedimentation.

Six deep water systems will be examined in this field course. These include in the order that we will examine them: (1) Miocene-Pliocene Capistrano Formation at San Clemente State Beach, (2) Capistrano and Monterey sediments cropping out at Dana Point Harbor, (3) Cretaceous strata in coastal exposures in La Jolla, (4) Eocene strata in sea cliffs north of Scripps Institute of Oceanography, (5) Point Loma and Cabrillo Formations in the Tourmaline Surfing Beach and (6) Cretaceous Point Loma Formation exposed at the Point Loma Peninsula.

Course activity will include:

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- Review of deep water lithofacies nomenclature and definitions, common lithofacies associations, and interpret lithofacies in outcrops and cores
- Interpretation of EoD's and related reservoir architecture, lithofacies associations, and diversity
- Interpretation of sequence stratigraphic surfaces in outcrop, logs, and seismic in deep water settings and related to vertical stacking of facies
- Use of core and well-logs to interpret EoD's
- Evaluaion ofe reservoir geometry and connectivity in different EoD's
- The do's and don'ts of using outcrops as reservoir analogs
- Use of outcrop information as analog for reservoir model building
- Evaluating seismic response, including geometry, facies, and acoustic response in deep water EoD's
- Recognizing criteria for the identification of composite sequences, sequence sets, and depositional sequences and their components in outcrops, cores, well logs, and seismic
- Interpretation and mapping techniques for cores, well-logs, and seismic lines in deep water settings, from exploration to production business scales
- Recognition criteria and mapping strategies for play elements in deep water depositional settings
- Play fairway identification and mapping

Itinerary

- Day 0
  - Arrive San Diego
  - Late afternoon classroom session: field course introduction, safety presentation, deepwater lithofacies and depositional models
  - Overnight Carlsbad Beach
- Day 1
  - 8 AM classroom session: discussion on deepwater channel systems, safety briefing
  - 9 AM depart for field: spend the day at the San Clemente sea cliffs
  - Overnight Carlsbad Beach
- Day 2
  - Check out from the hotel
  - 8.30am depart for field: spend the morning and part of the afternoon at Dana Point Harbor outcrops and mid-afternoon at Scripps Park outcrops (San Diego)
  - Overnight in La Jolla Torrey Pines
- Day 3
  - 8 AM classroom session on deepwater channel systems, safety briefing
  - 9:30 AM depart for field: Blacks Beach sea cliffs
  - Overnight La Jolla
- Day 4
  - 8 AM classroom session on deepwater distributive systems, safety briefing
  - 9.30 AM.deoart for field: Point Loma sea cliffs
  - Overnight La Jolla

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- Day 5
  - Check out from the hotel
  - 8:30 AM depart for field: morning at Tourmaline Beach
  - Late afternoon flights home