
N352: Sedimentology and Reservoir Characterisation of Fluvial and Shallow Marine Reservoirs (*Queensland, Australia*)

Instructor(s): Ian Moffat and Mark Reilly

Format and Duration

Field - 6 Days
Moderate Physical Demand

Summary

The course examines the depositional characteristics and architecture of fluvial to shallow marine deposits emphasizing aspects that affect reservoir quality and behaviour. Participants examine, interpret and compare fluvial to shallow marine successions (Permian to Jurassic) through exercises and discussion, focusing on the facies, heterogeneity, geometry, stacking and connectivity of potential reservoir units. A final core store visit illustrates the advantages and disadvantages of 'one dimensional' data and consolidates concepts learnt during the course.

Learning Outcomes

Participants will learn to:

1. Interpret fluvial, deltaic and shallow marine depositional processes based on outcrop observations.
2. Assess the reservoir properties of tidal and wave influenced facies developed in deltaic and shoreface environments.
3. Evaluate sand-body architecture, distribution, stacking and connectivity in meandering and braided fluvial systems.
4. Characterise ichnofacies and their use in constraining sedimentary environments.
5. Construct sequence stratigraphic schemes for fluvial and shallow marine deposystems, apply these in both reservoir and exploration contexts.
6. Appraise the porosity distribution and vertical and lateral permeability in a variety of fluvial and shallow marine reservoir types, predict major baffles and barriers to fluid flow in analogous systems in the subsurface.
7. Assess and integrate outcrop and core observations for use in reservoir models.

Training Method

A six-day field course, with one day spent in the core store facility and some short lectures.

Physical Demand

The physical demands for this course are MODERATE according to the Nautilus field course grading system. Central Queensland has a humid subtropical climate with typically dry and warm winter conditions. Likely daytime temperatures for August are around 24°C, with maximums of up to 30°C, while at night it may be as low as 7°C. Rainfall average for August is 20 mm with around 4 rainy days per month. Therefore participants need to be prepared for warm conditions during the day but cooler at night. A moderate level of fitness is required as there are two day-long hikes of around 4 and 7 km, with elevation changes of about 100 and 200 m, respectively. The 7 km walk is on good, even trails through Canarvon National Park. The 4 km walk involves 1-2 km of good trails, with the remainder on a boulder-strewn ephemeral stream bed. Other localities are situated along roadsides at a few hundred metres above sea

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level and there is a final day in the core store in Brisbane. Please refer to the Nautilus website (www.nautilusworld.com) for a detailed explanation of the Nautilus Physical demand grading system.

Who Should Attend

Learnings are of a generic nature applicable to analogous clastic systems worldwide and should be of interest to exploration and development personnel, geologists, geophysicists and engineers.

Prerequisites and Linking Courses

There are no formal prerequisites for this class but participants are expected to have a basic understanding of sedimentology and sequence stratigraphy. Related courses that examine clastic depositional systems on the Nautilus Australia Asia Pacific programme are: N195 (Deltaic to Deepwater Depositional Systems of NW Borneo – Concepts and Models for Reservoir Prediction) and N395 (Essentials of Deepwater Clastic Systems). A wide range of clastics courses worldwide are also available through the Nautilus Training Alliance – please check the website for further details at training.rpsgroup.com

Course Content

The field course works through the Permian, Triassic and Jurassic stratigraphy of the Bowen and Surat Basins. This area provides excellent outcrop in easily accessible locations and has been the focus of extensive investigation for analogues for petroleum exploration and production as well as the well-known coal resources in the basin. The course itinerary broadly follows the depositional history of the basins, beginning in the Permian and working up to the Jurassic.

Day 0: Participants arrive Emerald, Central Queensland from Brisbane, will be picked up by coach and taken to the Emerald Maraboon Hotel. Course Summary, Introductions and H&S Briefings will be undertaken prior to dinner.

Day 1: Freitag Formation, Emerald, Central QLD

Field excursions to examine a superbly exposed and somewhat cryptic coastal succession of the Permian Freitag Formation which contains abundant well preserved sedimentary structures including trace fossils, excellent examples of various interlamination structures as well as HCS and load casting features. A major focus of this day is developing the skills of course participants in recognising these features and using them to inform their facies interpretations. Discussions at this outcrop emphasise the importance of integrating ichnological and sedimentological observations. We will return to the Emerald Maraboon Hotel and undertake an informal summary briefing on coastal successions and review the key learnings from the Freitag Formation.

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Day 2: Staircase Sandstone, Springsure, Central QLD

This field day examines Permian deltaic and shoreface facies, in an overall coarsening-upward succession within the Staircase Sandstone Member, located approximately 1 ½ hours south of Emerald. These outcrops include storm, wave and tide influenced marine facies. The focus of this exercise will be on recognising the various components of deltaic sediments, examining reservoir geometry, and considering the sequence stratigraphic framework of these sections. After lunch we will travel approximately 2 hours south to Carnarvon Gorge, stopping occasionally to examine key outcrops and to discuss the middle-upper Permian stratigraphy of the Bowen Basin. We will stay in safari tents at Takarakka Bush Resort. Before dinner we will informally review the key learnings from the Staircase Sandstone and undertake a summary briefing on fluvial successions.

Day 3: Clematis Group/Moolayember Formation, Mickey Creek Gorge, Central QLD

Exercises in the Mickey Creek Gorge area are focused on low net to gross fluvial/lacustrine Triassic aged sediments located a 10 minute drive from Takarakka Bush Resort. Students will log a large continuous section through this gorge, interpret the depositional environments present, discuss the expected lateral continuity of the units and be asked to place their observations within a sequence stratigraphic framework. We will return to Takarakka Bush Resort in the evening where we will informally review the day's key learnings.

Day 4: Precipice Sandstone, Carnarvon Gorge Central QLD

The Jurassic Precipice Sandstone at Carnarvon Gorge, located a 15 minute drive from Takarakka Bush Resort, is interpreted as a multi-storey, braided stream deposit. Outcrop of this unit is excellent and elevated positions nearby provide opportunities for regional scale examination of these packages. Participants are asked to make a stratigraphic log of this outcrop and present their observations to their peers. The learning objectives are to examine the facies stacking patterns of fluvial sandstones, understand the possibility of regional heterogeneity and to become aware of the possible lateral connectivity of similar units elsewhere.

Day 5: Precipice Sandstone and Hutton Sandstone, Carnarvon Highway, Injune, Central QLD

This field day examines outcrops of the Precipice Sandstone and Hutton Sandstone located approximately 1 ½ hours and 2 ½ hours from Carnarvon Gorge. The Jurassic Precipice Sandstone on the Carnarvon Highway is interpreted as mouthbar and delta front deposits of a braided delta. The outcrop of the Jurassic Hutton Sandstone on the Carnarvon Highway contains evidence of an aggrading fluvial system comprising meandering pointbar successions that cut erosively into adjacent pointbar deposits. Participants are asked to make a composite stratigraphic log and discuss the implications for lateral connectivity of the facies present at these outcrops with their peers. A review session will compare the different styles of fluvial systems examined during the course and discuss the implications for reservoir quality and connectivity. Following this discussion we will travel from Injune to Roma (approximately 1 hour), fly to Brisbane and transfer by coach to the Point Hotel.

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Day 6: Core Store visit, Zillmere, Brisbane

Participants will spend the day in the Queensland Government Exploration Data Centre reviewing core from the Freitag Formation, Staircase Sandstone, Precipice Sandstone, Clematis Group, Moolayember Formation, Evergreen Formation and Hutton Sandstone. The aim of this day is: 1) consolidate skills in making sedimentological observations, 2) to provide a comparison between the amount of detail that can be observed from core and outcrop of the same units and 3) to review what has been learnt throughout the field course. Participants may choose to depart from Brisbane after 5pm or return to the Point Hotel.

Day 7: Depart Brisbane.