N195: Deltaic to Deepwater Depositional Systems of NW Borneo - Concepts and Models for Reservoir Prediction *(NW Borneo, Malaysia)*

Instructor(s): Howard Johnson

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

Summary

This field course examines Oligo-Miocene outcrop successions of NW Borneo which are the equivalents of major petroleum-bearing accumulations in the adjacent offshore. A range of sedimentary facies and reservoir types will be investigated in a regional-scale traverse from deepwater, through shelfal, deltaic and coastal plain environments. The E&P implications will be referenced to adjacent oilfields with examples of core and well log expressions of different reservoir/trap configurations.

Learning Outcomes

Participants will learn to:

1. Appraise the tectonic and sedimentary evolution of the NW Borneo margin since the Oligocene and distinguish the principal reservoir units and play types.
2. Fomulate an interpretion of sand-rich deepwater sedimentary facies and recognize the depositional products of high-density turbidity currents.
3. Assess the position of successions within a basin floor fan system based on their cyclical stacking patterns.
4. Evaluate slope depositional environments and recognize shelf-edge failure events through interpretation of facies including Mass Transport Complexes and low-density turbidity deposits.
5. Characterise the outcrop expression of the Deep Regional Unconformity and debate its sequence stratigraphic significance.
6. Compare the depositional products of tropical deltaic systems from pro-delta slope through shoreface environments.
7. Interpret the sedimentary expression of a variety of coastal plain deposits including mangrove swamps, tidal bars, tidal channels and braided to meandering fluvial systems.
8. Assess the reservoir characteristics of coastal plain deposits and recognise key ichnofacies and their environmental and temporal significance.

Duration and Training Method

A six-day field-based course, supplemented by short lectures in order to introduce key generic themes during the course of the field trip. The proportion of field to classroom time is approximately 90:10

Physical Demand

The physical demands for this course are MODERATE according to the Nautilus Training Alliance field course grading system. The field stops are not strenuous. There is no ascent more than 10 m (30 ft) and no walks longer than 2 km (1.25 miles) at sea level. However, the environment in north Borneo is

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tropical, hot and humid and this elevates the grading from LOW to MODERATE. Participants should be prepared for temperatures over 30°C (85°F) and 100% humidity - such tropical conditions are not tolerated well by some people. Lightweight loose clothing is recommended and long sleeves and trousers will protect against biting insects.

Who Should Attend

This course is relevant to all geoscientists and petroleum engineers who are involved in the subsurface analysis of Tertiary sedimentary basins and reservoirs, either in relation to basin-scale geology or reservoir-scale field development activities. Examination and discussion of the controls on deltaic sedimentation are relevant to those working on tropical (and non-tropical) deltaic systems elsewhere in the world. Regional themes will be of particular help to E&P professionals working in SE Asia.

Prerequisites and Linking Courses

None, although a fundamental understanding of the tenets of sedimentology and depositional systems are useful. For those with little experience of sedimentology, attendance on an introductory sedimentology course such as N155:Introduction to Clastic Depositional Systems: A Petroleum Perspective, would be useful.

Course Content

This field course will examine outcrop successions of Oligo-Miocene rocks that are the time and facies equivalents of major petroleum-bearing accumulations located in the adjacent offshore areas of Sarawak, Sabah and Brunei. A wide range of sedimentary facies, environments and reservoir types will be investigated in a regional-scale traverse through different palaeo-environments, starting in deepwater, moving upslope through various deltaic and coastal deposits and terminating in coastal plain environments. Modern fluvial, deltaic and coastal depositional systems are examined and compared with their Oligo-Miocene equivalents seen at outcrop.

The E&P implications of the outcrops will be discussed by reference to adjacent subsurface petroleum systems, reservoir characteristics and trap types, with examples of the seismic, core and well log expression of different reservoir/trap configurations.

The fieldtrip will examine a range of deep- to shallow-water depositional and tectono-stratigraphic features, approximately in the following chronological order:

1) A major, unconfined, sand-rich, basin floor submarine fan complex (West Crocker Formation), which contains a thick (several km) succession of high- and low-density turbidites, linked debrites, mass transport deposits and basinal mudstones. Facies successions comprise channel-levees, fan lobe systems and other sub-environments of the West Crocker fan.

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2) Sand-poor confined basin floor, slope and shelf-edge delta systems (Temburong, Setap and Belait Formations), where sediment dispersal was influenced by a tectonically-active basin margin characterised by growth faulting, slumping and other related soft sediment deformation processes. Associated sequence boundaries and shelf bypass systems, including lowstand shoreface and incised valley systems will also be investigated.

3) Present-day humid-tropical environments NW Borneo illustrating the following: (i) an uplifted hinterland with tropical karst landscape, (ii) alluvial to coastal plain environments with different fluvial channel styles, (iii) a drowned coastal embayment (Brunei Bay) characterised by minor (bayhead) delta lobes and estuaries, and (iv) a major fluvial-delta system (the Baram Delta).

4) Examples of different Miocene deltaic depositional systems showing the interaction of fluvial, tide and wave processes within distributary channels, mouth bars, shoreface and estuarine sand bodies (Lambir, Miri and Belait Formations). An exhumed growth faulted oil field (Miri) will be studied to illustrate the range of reservoir types and structural styles that is common in the adjacent Baram Delta Province. Other deltaic depositional systems (Belait Formation) demonstrate how tide- and wave-dominated shorelines were locally affected by the growth of shale diapirs and the development growth faults and later inversion structures.

5) The facies and reservoir characteristics of different coastal-deltaic sand bodies will be analysed, with emphasis on their heterogeneities and effective reservoir properties. A wide-range of bedding styles, biogenic fabrics and vertical facies successions will be used to distinguish fluvial-, tide- and wave/storm-influenced sand body types (e.g. mouth bars, shoreface, distributary and coastal plain channels, estuaries, etc.).

6) Larger scale stratigraphic successions provide a history of km-scale sedimentation patterns through several depositional cycles, with preserved examples of sequence boundaries and major flooding surfaces. Other outcrops will be used to demonstrate high-frequency accommodation patterns. Hence, reservoir development at both the seismic- and core-/well log-scales will be discussed and compared to equivalent scales in the subsurface.

Itinerary

Day 0:

Participants arrive in Kota Kinabalu, Sabah. Evening introduction to the course. Overnight KK.

Day 1:

Field excursions around KK to examine the deepwater Crocker Formation. Overnight KK.

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Day 2:

Fly to Labuan Island. Field excursions to examine slope and shelf depositional systems. Overnight Labuan.

Day 3:

Shallow marine/paralic to fluvial depositional systems. Deep regional unconformity and sequence stratigraphic implications. Overnight Labuan.

Day 4:

Depart Labuan for Miri, Sarawak. Discussion and examination of the modern tropical deposystems of NW Borneo. Lunch. Field excursion to the Lambir Hills to examine the onset of deltaic deposition in the area. Overnight Miri.

Day 5:

Field excursions to examine shoreface, estuarine and distributary channel systems in the Lambir Hills south of Miri. Overnight Miri.

Day 6:

Visit to the Miri Museum and No. 1 Well. Tidally-influenced coastal plain depositional systems around Miri. Return to hotel for wrap-up session, course evaluations. Participants free to depart late afternoon.