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FACIES SUCCESSIONS AND DEPOSITIONAL ELEMENTS WITHIN THE OLIGOCENE-MIOCENE, CROCKER SUBMARINE FAN SYSTEM, NW BORNEO, SABAH, MALAYSIA

A. Adli Zakaria[1], H.D. Johnson[1], C.A.L. Jackson[1], F. Tongkul[2] , P.D. Crevello[3] and M.B. Madon[4]

[1]Department of Earth Science & Engineering,
Imperial College, Prince Consort Road,
London SW7 2BP, UK

[2]School of Science & Technology,
University of Malaysia Sabah,
Sepangar Bay, Kota Kinabalu, 88502, Malaysia

[3]Petrex Asia Reservoir & Stratigraphy Group,
PETRONAS Twin Towers Level 40, Tower 2,
Kuala Lumpur, 50080, Malaysia

[4]Geoscience Section,
Group Research, Research and Technology Division,
PETRONAS, 43000, Bangi, Malaysia

The Oligocene to Early Miocene West Crocker Formation of Northwest Borneo represents a widespread, an unconfined basin-floor submarine fan complex that was deposited in an accretionary foredeep basin. The system covers more than 25,000 sq km, therefore rivals in terms of size and sediment volume many of the worlds largest modern and ancient turbidite-fan systems. The West Crocker Fm comprises at least 1,000 m of sandstone-dominated succession constructed of higher-frequency sequences.

Road cuts and construction areas provide exceptional vertical, but limited strike-extent exposures of the turbidite fan system, and provide the framework for interpreting the depositional mechanisms and elements. Vertical facies successions logged from key outcrop exposures record a complex basin-floor submarine fan system constructed of end-member deepwater depositional facies.

1) Sand-rich leveed channels transitional to low-sinuosity, sand-dominated channelised sheets/lobes and 2) mixed sand-rich to mud-rich leveed-channel, which may serve as updip feeder or bypass systems.

The channel lobe complex is characterized by laterally shifting shallow channels, fining or thinning-up (FU/TnU) sequences and by progradational, non-channelised lobe deposits, coarsening or thickening-up (CU/TkU), sequences. The resulting sandstone body is stacked multi-story and multi-lateral. Vertical facies successions are dominated by 5-15m-thick, FU/TnU sequences and, less commonly, by thinner 2-10m-thick, CU/TkU sequences. The major sandstone bodies are sharp-based, locally erosive and in places loaded. Facies are mainly S3-Ta turbidites of fine- to medium-grained sandstone, which are medium- to thick-bedded (up to 3m-thick), internally structureless or with a feint horizontal stratification, sometimes graded and occasionally associated with thin muddy debrite (debris-flowed) units. Slumps are present but rare.

Leveed channel systems are recognized by overall fining or thinning-upward (FU/TnU) successions of aggradational/fill and lateral/spill of channel axis and margin facies, proximal levee and distal overbank levee facies; clay plugged avulsed channels and splays. These are resulted from the gradual lateral migration of a major, meandering channel system. The vertical facies trend reflects a gradual migration away from the sand supply system and displays a vertical stack of FU/TnU bed sets, with each succession displaying increasing distal characteristics upwards in parallel with decreasing in sand content and a general reduction in bed thickness towards the top.

Individual channel complexes are between 15-60 meters thick and display net-to-gross of more than 80% sand. Sand-rich leveed-channel axis and terminal braid-plain channel facies consist of S3-Ta turbidite mega-beds (2-3.5 meters thick) of medium to very coarse sand in massive poorly sorted, erosive bases, trough cross bedded, diffuse wavy parallel layered, hummocky aggradational in-phase bedforms, internal erosional surfaces or bed boundaries, planar grain-sorted parallel layered sheet bedforms with dewatering structures.

The channel margin facies and braid-plain sheet facies consists of massive to diffusely laminated, coarse to medium sands with flow-stripped, ripple-laminated to debrite caps. Inter channel braid plain bars are constructed of shingled, lenticular bedforms and common debrite beds.

Mixed sand-mud leveed channel complexes, up to 60 meters thick, grade upward from stacked multi-story channel mega-beds to thinning and fining-upward proximal and distal levee facies characterized by flow-stripped ripple laminated (climbing and in-phase ripples).

The outcrops under investigation provide a rare opportunity to study the detailed facies characteristics, sand body types and reservoir architecture within a Tertiary deepwater succession from SE Asia. They offer valuable insight into deepwater depositional systems during the early Tertiary evolution of NW Borneo. They may also serve as partial outcrop analogues for other deepwater, hydrocarbon-bearing reservoir systems, including some of those found in younger (Miocene-Pliocene) deepwater successions in both offshore NW Borneo (Sarawak, Brunei and Sabah) and E Borneo (Kalimantan).