

# **Transgressive Successions of the Mahakam Delta Province, Indonesia\***

Joseph J. Lambiase<sup>1</sup>, David Remus<sup>2</sup>, and Salahuddin Husein<sup>3</sup>

Search and Discovery Article #50257 (2010)

Posted April 30, 2010

\*Adapted from extended abstract prepared for AAPG Hedberg Conference, “Variations in Fluvial-Deltaic and Coastal Reservoirs Deposited in Tropical Environments,” April 29 – May 2, 2009, Jakarta, Indonesia.

<sup>1</sup>Lambiase Geoscience Pte. Ltd., Singapore ([joe\\_lambiase@yahoo.com](mailto:joe_lambiase@yahoo.com))

<sup>2</sup>Remus Energy Consultants Pte. Ltd., Singapore

<sup>3</sup>Gadjah Mada University, Indonesia

## **Abstract**

Traditional views of deltaic systems assert that progradational deposits comprise nearly the entire stratigraphic succession, with transgressive strata forming only a minor component. Similarly, progradational units generally are regarded as having the best reservoir potential, especially in topset beds, and transgressive units are viewed as shale-prone and therefore downgraded. However, integration of regional seismic mapping with well log and core data plus concepts derived from modern sedimentary processes indicate that transgressive successions are an important component of the mid-Miocene and younger stratigraphy of the Mahakam Delta province and that they have considerable reservoir potential.

## **Mid-Miocene and Younger Sequences**

Seismic mapping identified eight horizons of regional extent that correspond to the boundaries of stratigraphic sequences; seven sequences were deposited by successive deltas since formation of the 10.2 Ma mid-Miocene unconformity, with the axis of sedimentation shifting as each delta developed. Each sequence comprises progradational clastic successions at the axis of sedimentation, aggradational clastic successions deposited primarily during transgressive events and aggradational carbonate successions that developed along the shelf edge in areas with minimal clastic input. The present study focuses on the transgressive clastic successions; the carbonates are not discussed. The progradational areas of the mapped stratigraphic sequences have the lenticular shape of delta lobes and often exhibit clinoform packages, but adjacent areas are marked by parallel reflections indicating aggradational stratigraphic architecture ([Figure 1](#)). The thickness of the aggradational successions varies from sequence to sequence but it can be up to several hundred meters thick and occasionally is nearly as thick as the progradational component of the same sequence.

The mid-Miocene and younger succession of the Mahakam Delta province is shale-dominated with subordinate, relatively thin interbedded sandstones that are most common in progradational successions. Based on their sedimentary characteristics, most sandstones generally are interpreted as distributary channel or mouth-bar deposits regardless of their stratigraphic context. However, an assessment of the quantitative

sediment dynamics of the modern Mahakam Delta indicate that it presently is generating an aggradational, transgressive succession that is an exact analogue for the subsurface aggradational successions. The modern delta is in a transgressive phase; most fluvially-derived sediment is being stored in the distributaries and mud is accumulating in the shallow offshore. Sands are being deposited as aggradational distributary sands that are fluvial at the base and exhibit increasing tidal influence upward, and as transgressive shoreline sandstones by wave re-working of inter-distributary shorelines ([Figure 2A](#)).

There are some notable differences between transgressive and progradational distributary sands. Transgressive distributary sands are thicker than their progradational counterparts (and can be up to several times as thick); they tend to have sharp upper boundaries with an overlying estuarine mudstone rather than fining upward into a transitional contact with an overlying floodplain mudstone, and they exhibit moderate tidal influence near their tops ([Figure 2B](#)). The often substantially greater thickness and absence of a fining upward transition increases the reservoir potential of transgressive distributary sands so that it generally is better, and often much better, than that of progradational distributary sands.

In core, transgressive shoreline sands are wave-dominated; wave ripples, parallel lamination and wavy bedding are the most common sedimentary structures, although they exhibit significant tidal influence as mud and organic matter flasers and drapes are common ([Figure 3A](#)). High-resolution biostratigraphic analysis indicates they develop during relatively short-lived, local high-order transgressive events that probably are related to subsidence following lobe abandonment ([Figure 3B](#)); without the high-resolution stratigraphic context, they could be mistaken for progradational mouth-bar deposits when they occur within larger-scale progradational units. This has significant reservoir implications as shoreline sands have markedly different sand body geometries than mouth-bar deposits. In the Mahakam Delta system, shoreline sands have irregular shapes that are mostly inherited from the pre-existing delta morphology ([Figure 2A](#)); they can be much larger than mouth bars which, by definition, are approximately the same width as their distributaries.

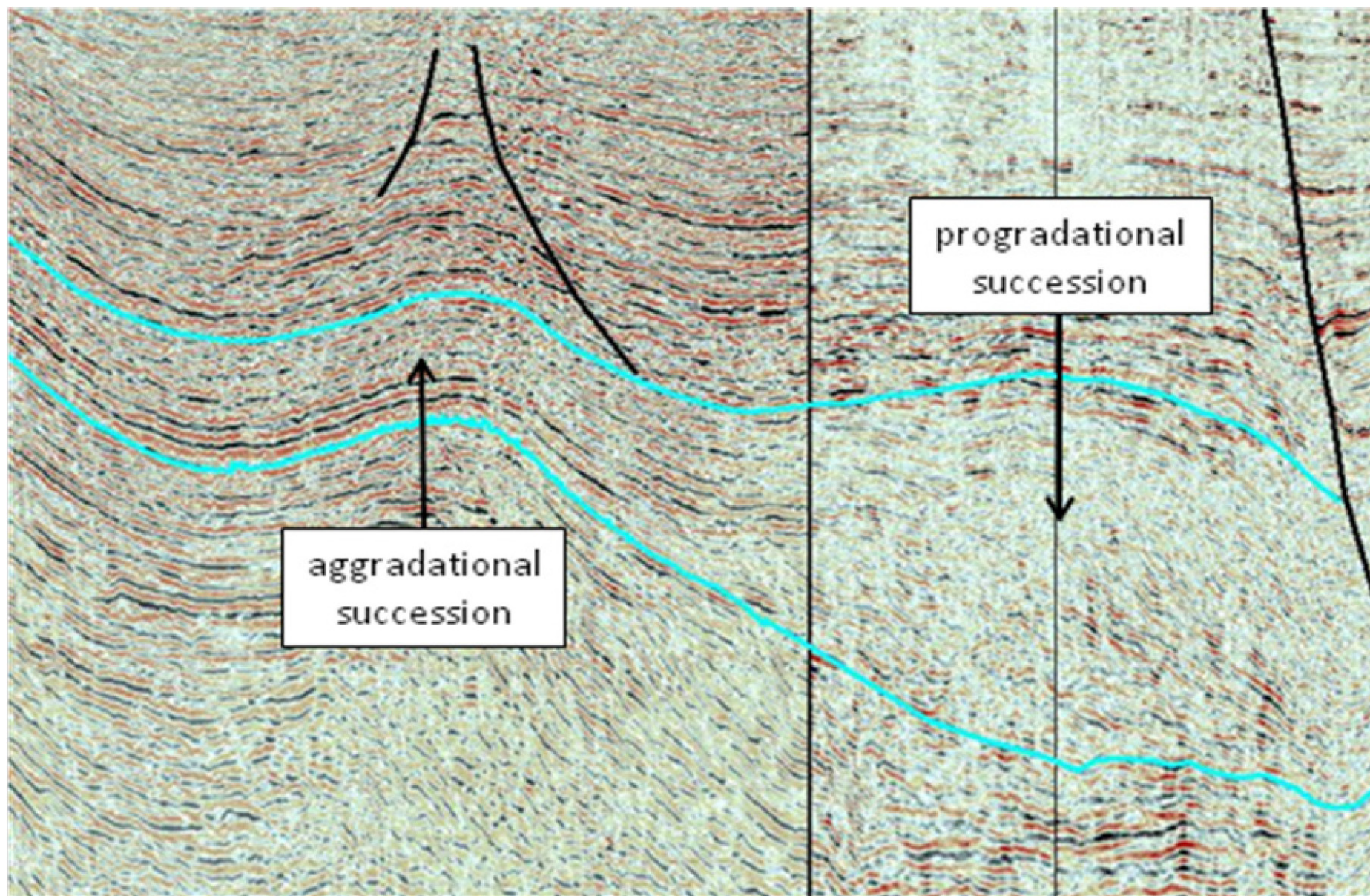


Figure 1. Seismic geometry of a stratigraphic sequence (light blue) comprising aggradational and progradational successions.

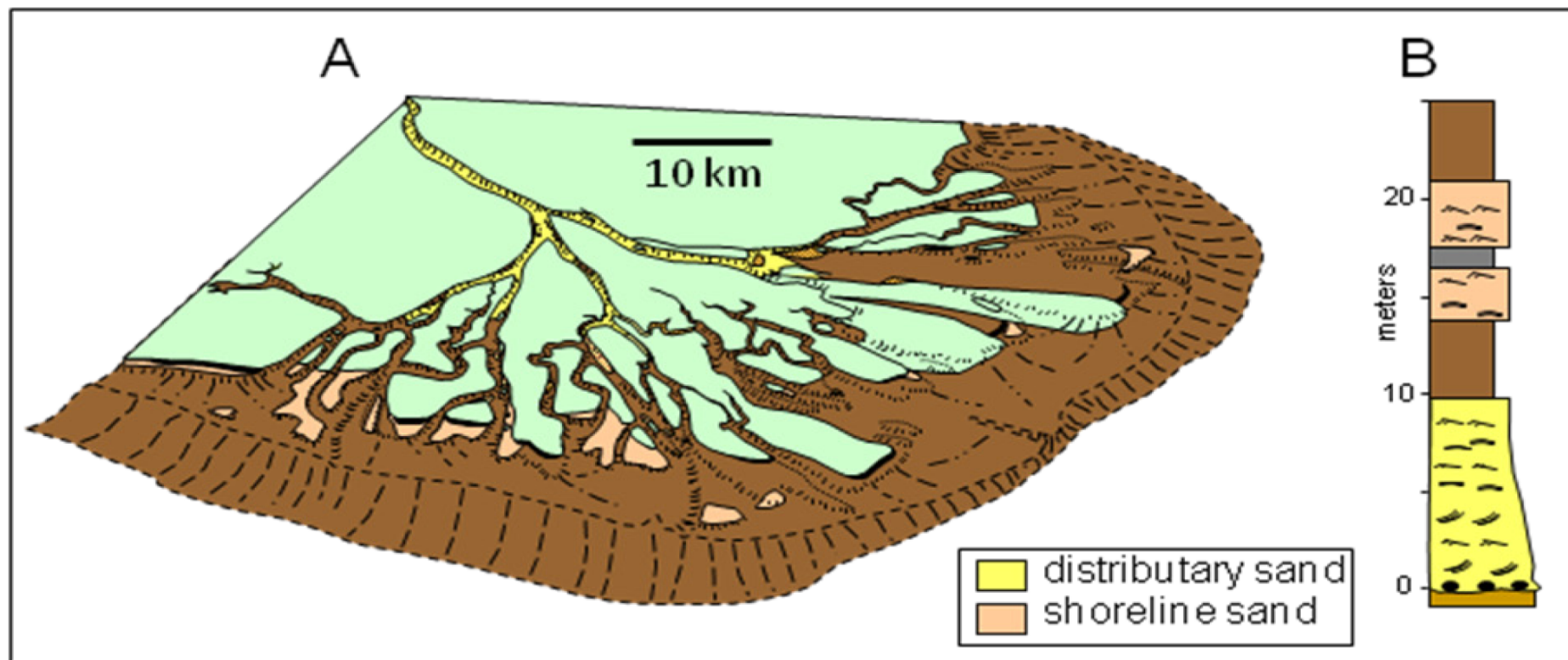


Figure 2: A) Distribution of aggradational distributary sands and transgressive shoreline sands on the modern Mahakam Delta, and B) the stratigraphic succession that is presently being deposited.

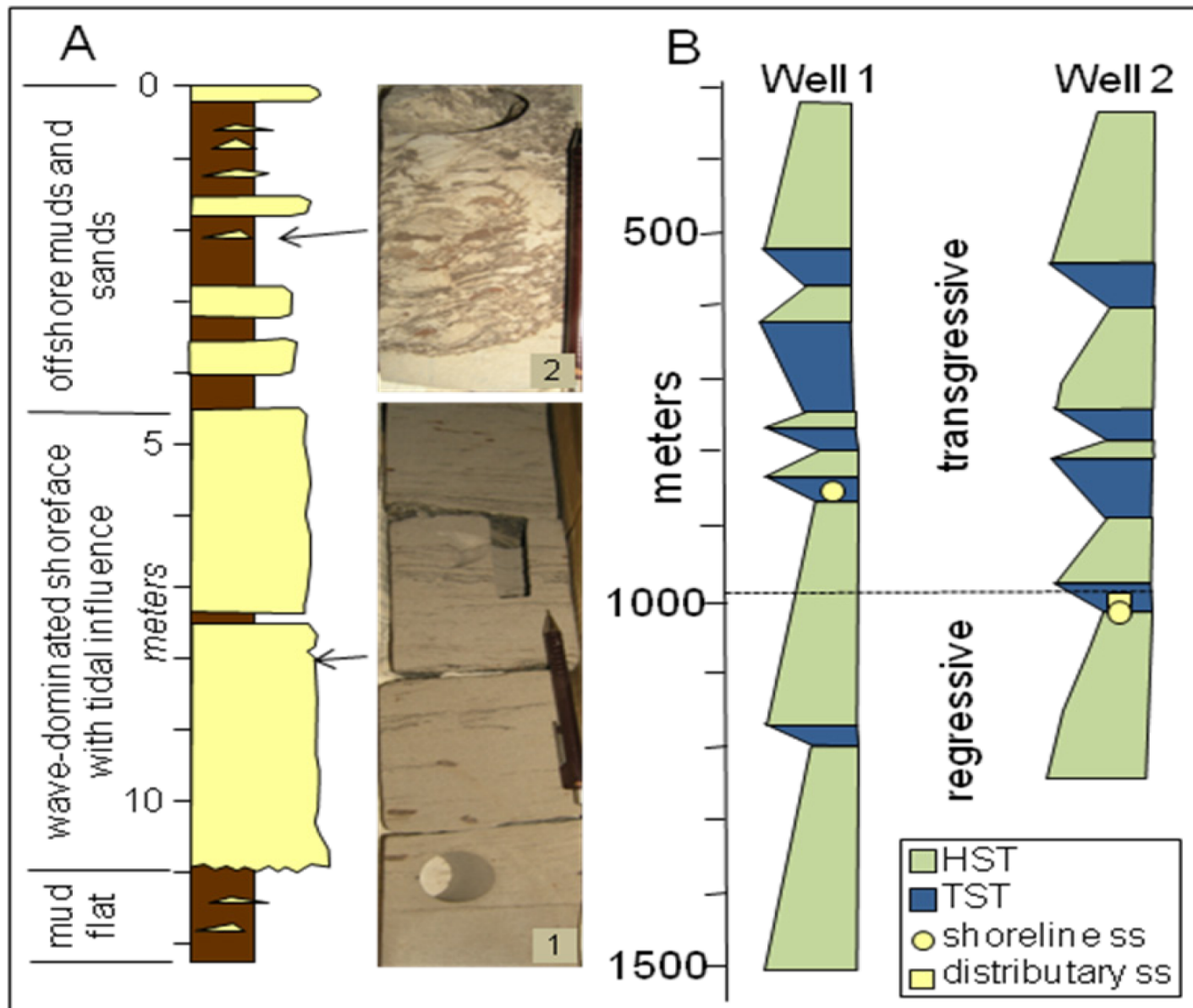


Figure 3: A) A transgressive shoreline sand with (1) wave rippled sand with flasers and drapes and a few mud-filled burrows, and (2) intensely bioturbated muds and sands above, and B) the stratigraphic context of transgressive shoreline distributary sands within local, high-order transgressive systems tracts. The wells are 1.1 km apart.