

## Reducing Reservoir and Source Rock Risk in Deepwater Plays: Examples from Southeast Asia

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Deepwater exploration efforts require means of reducing pre-drill reservoir risk. In Southeast Asia, additional risk pertains to increased distance from Type III coaly source rocks formed in updip coastal-plain palaeoenvironments. Lessons drawn from exploration in the Sarawak and Kutei (Mahakam delta) deepwater regimes provide an understanding of how to reduce these two key risk elements of the petroleum system.

In Sarawak (northern Borneo), successful pre-drill prediction of reservoir type and content in deepwater blocks was based upon regional sequence stratigraphic correlation and seismic facies calibration. Previous stratigraphic schemes had emphasised palynologically-defined flooding surfaces, similar to the genetic stratigraphic system advocated by some workers. Comparison of well correlations within this system with that of the sequence stratigraphic methodology, which emphasises unconformities, resulted in significant differences in pre-drill predictions of reservoir type and distribution. For example, the genetic stratigraphic approach predicted a NW-SE trending strandplain system. By contrast, a NE-SW trending fluvial-dominated delta model resulted from the sequence stratigraphic analysis. Calibration of seismic response within the sequence stratigraphic framework allowed highstand reservoirs to be identified with some certainty. Abundant, thick deltaic siliciclastic reservoirs were penetrated in the



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Mulu-1 and Bako-1 wells drilled in the deepwater blocks. This confirmed predictions made with the sequence stratigraphic analysis. However, less success was experienced with predicting hydrocarbon charge, which post-drill studies indicate are related to maturity and the distance (10 km) from coeval coastal-plain coals.

In the Mahakam delta (southeast Borneo), regional mapping of Miocene and Pliocene shelf sequences proved critical to identifying sand-prone fairways for deepwater lowstand reservoirs. Prior drilling, made without the benefit of regional sequence stratigraphic studies, had found limited reservoir volume. New maps constructed from seismic, cores, and logs pointed to key canyon system entry points and adjacent sand-prone highstand deltas. Defining the location of lowstand depocenters also reduced risk regarding source rock, as these provide the major kitchens for hydrocarbon migration. Recent drilling has validated the reduction in reservoir and source rock risk, with discoveries flowing gas, condensate, and oil in thick Upper Miocene and Pliocene deepwater sandstone reservoirs. Channel-levee systems on the upper slope are the active targets, but downdip drilling will focus upon probable sheet turbidite reservoirs. Geochemical analysis of discovered oils

has also confirmed the pre-drill lowstand source kitchen model.

### Career Summary

Ph.D., Geology, University of Wisconsin, Madison, 1976. MS (1971) and BS (1969) in Geology, University of Pittsburgh, Pittsburgh, PA. Twenty-two years petroleum exploration and production experience in research, supervisory, and operational assignments with Mobil (1976), Exxon (1976-90); as an Independent Consultant (1990-92), and currently with Mobil Technology Company (1992-present). Member of the exploration research group at Exxon that developed seismic/sequence stratigraphy, with an emphasis on carbonate sequence concepts. Worldwide experience in integrated seismic-well-outcrop interpretation of siliciclastic and carbonate sequences. Current research interests include development of a 3-D, process-based forward stratigraphic modeling program that will be linked to seismic inversion and reservoir simulation; and integrating outcrop sedimentology with seismic and forward stratigraphic modeling to improve lithofacies prediction. Authored or co-authored 22 papers on carbonate sedimentology, stratigraphy, and applications to exploration and production. Co-editor AAPG Memoir 57, *Carbonate Sequence Stratigraphy*, and SEPM Special Publication 44, *Controls on Carbonate Platform and Basin Development*. Prepared, coordinated, and presented seismic and sequence stratigraphy seminars to industry for twenty-one years. Member AAPG, SEPM, and a GSA Fellow. Associate editor AAPG Bulletin, 1985-1993. AAPG Distinguished Lecturer, 1988-89. Member Ocean Drilling Program, Sediments and Geochemical Processes Panel, 1993-95. Currently Secretary-Treasurer of SEPM, 1998-2000.

