Paper 21

The influence of shallow marine depositional systems on deep water sand distribution in Brunei and the adjacent areas of Malaysia

JOSEPH J. LAMBIASE
Department of Petroleum Geoscience
Universiti Brunei Darussalam

The distribution and reservoir potential of deep water sandstones is strongly dependent upon the sediment supply systems that deliver sand to the shelf edge. Efficient delivery occurs on numerous margins where deltas prograde to the shelf edge during sea level lowstands. Middle Miocene to Recent sedimentation on the Brunei margin has been characterised as the product of two relatively large deltaic systems, the middle Miocene – Pliocene Champion Delta of northeastern Brunei and the Pliocene – Recent Baram Delta of southwestern Brunei and Sarawak (Sandal, 1996), and progradation of both deltas to the shelf edge during sea level lowstands has been invoked as a mechanism for supplying sand to the deep sea. A recent seismic study of the Pleistocene – Recent succession of the Baram Delta in southwestern Brunei confirms that the delta progrades to the shelf during sea level lowstands (Hiscott, 2001), suggesting that sand was indeed available for delivery to the deep sea at those times both in Brunei and Sarawak; this process almost certainly occurred during the Pliocene as well.

Although only 150 km away, northeastern Brunei is very different from the Baram Delta. Whilst the Baram River drainage basin consists of a single, relatively large river that empties directly into the South China Sea on an exposed coastline, several smaller rivers with a cumulative drainage area that is significantly less than that of the Baram River debouch into the protected waters of Brunei Bay. Depositional systems within the Brunei Bay drainage basin are varied and generally are segregated into wave-dominant shorelines and tide-dominant embayments by the coastal geometry that is a product of structurally generated topography. The geographic separation of wave- and tide-dominant areas is distinctly different from the mixed wave and tide system of the modern Baram Delta as described by Lambiase *et al.* (2002).

The Brunei Bay drainage basin now occupies the same part of the margin as the former Champion Delta and several lines of evidence indicate that the Champion system was not a simple delta. The Brunei Bay drainage basin is much smaller than the Baram River drainage basin and appears incapable of depositing a delta anywhere near as large as that interpreted for the Champion system. Similarly, there is no evidence that a large river ever existed within the Brunei Bay drainage basin; all the middle Miocene and younger fluvial outcrops are the deposits of several relatively small rivers. Also, integrated outcrop and subsurface studies indicate that the Champion system was a complex depocentre comprising the same wide variety of depositional environments, with the same wave-dominant and tide-dominant facies associations, as the modern Brunei Bay drainage basin and that, as in the modern system, structurally generated topography controlled facies distribution.

One aspect of the structural control on topography, and hence facies, is that the number of rivers reaching the shoreline, and their locations, changed frequently

because subsiding synclines, episodically active shale-cored ridges and growth faults created an evolving topography. This process is well illustrated by the Pliocene – Recent history of the Brunei Bay drainage basin. The distribution of fluvial outcrops within the drainage basin suggests that prior to the mid-Pliocene(?), two of the major rivers that now flow into Brunei Bay followed much different pathways. The Limbang River apparently flowed northward along the axis of the Berakas Syncline and, after depositing the fluvial sandstones that crop out along the Brunei coast, turned sharply to the east because it was captured by the onset of the latest, ongoing episode of subsidence in Brunei Bay. Similarly, the Padas River formerly flowed to the northwest across what is now the Klias Ridge and was deflected southward into Brunei Bay by a combination of renewed subsidence in the bay and uplift on the Klias Ridge.

The shifting sediment supply routes resulted in a highly variable sand supply to the shelf edge during sea level lowstands. At times when all the rivers in the drainage area coalesced before reaching the shore of the South China Sea, a delta smaller than the modern Baram Delta supplied moderate amounts of sand to one location on the shelf edge. At other times, multiple, but even smaller, deltas distributed an equivalent volume of sand over a wider area. During some lowstands, very little, if any, sand reached the deep sea because most was trapped in rapidly subsiding depocentres on the shelf. The present-day Brunei Bay is an example of this last scenario. If sea level were to fall, no sand could reach the shelf edge until the bay first filled with sediment. This appears unlikely because the bay is subsiding rapidly enough to maintain water depths in excessive of 50 m deep despite a relatively high sediment influx from several rivers. Consequently, all sand would be deposited within Brunei Bay, as apparently happened during the last Pleistocene sea level lowstand (Abdul Razak Damit, 2001). Consequently, the deep water sand accumulations sourced from the Champion system are expected to be smaller and more scattered, both spatially and temporally, than those deposited by a large shelf edge delta. Successful prospecting will require careful analysis of the supply system on the shelf.

In conclusion, the distribution and character of potential reservoir sands in the deep water areas of Brunei and immediately adjacent Malaysia is strongly controlled by sedimentary processes on the shelf. It is expected that progradation of the Baram Delta to the shelf edge sourced larger, more abundant accumulations of sand than the smaller, more complex supply systems of the Brunei Bay drainage basin and that this will be reflected in the relative reservoir potential of the two areas.