recovery energy environment economy
2011 CSPG CSEG CWLS Convention

Modern Estuarine Facies are Not Useful Analogs for Most Mesozoic Incised Valley Fills

Doug Cant
Doug Cant Geological Consulting
38 Redwood Meadows Drive
Redwood Meadows AB T3Z 1A3
dcant@personainternet.com

Modern estuaries and the depositional facies within them have been used as analogs for ancient valley fills, an extremely important type of hydrocarbon reservoir. In particular, the tri-partite estuary-fill model (bay-head delta, central basin muds, and bay-mouth barrier sand) is widely touted as a useful model for "channel" reservoirs. Modern estuaries are the result of the Pleistocene and post-Pleistocene sea-level fall and rise in sea level. This fluctuation was glacially generated, with an amplitude of about 125 metres at the glacial maximum of 20000 years bp. Between 20000 and 7000 years bp, sea level recovered from this lowstand condition, and has remained relatively static since. Rivers, of course, responded to lowered base-levels by incising and cutting valleys from non-marine areas, through shorelines, and across modern shelves to the lowstand shorelines. After sea level began to rise, rivers aggraded within the valleys and the coastline transgressed. This very high amplitude (125m), very short-period (13K years) transgression has generated unfilled river valleys on modern shelves and along modern shorelines because sedimentation rates in the valleys were inadequate to keep up with the transgression. Where the unfilled valleys are flooded by marine water inland of modern shorelines, they form estuaries extending tens to hundreds of kilometers from modern shoreline.

The body of water in the unfilled valley is the estuary into which the river dumps the bay-head delta, some of the central-basin muds, and longshore sand transport forms a shoreface sand at its distal end. It should be noted that the distal bay-mouth barrier is not really part of the estuarine package; it results from processes outside the estuary and is not present where no regional shoreface sand occurs, or if the estuary is too large to be filled by the longshore drift. The tripartite model predicts that the upper part of a valley fill should be part of the regressive system, and that lithologies should vary markedly along the trend of a channel deposit.

Mesozoic valley fills rarely, if ever, show lower transgressive and upper regressive facies tracts; most examples show a simple, slightly fining-upward transgressive facies succession which appears to grade from fluvial deposits (commonly very sandy) at the base of the incised channel fill up to muddier estuarine to virtually open marine deposits at the top. Nikanassin, McMurray, Upper Mannville, Dunvegan, Belly River, and other examples have been observed, and many have been described in the literature from other. stratigraphic units of different ages and basins. In Mesozoic valley fills, sediment infill did not quite keep up with sea-level rise, with the result of an overall transgression. However, the rates of sedimentation were adequate enough that large areas of the valleys were not flooded by marine water, with the result that regressive facies successions did not form in the upper parts of the valley fill. While the origins of Mesozoic sea-level fluctuations are not clearly known, the depths of erosion of these valleys appear to range from about 8 metres to about 60 metres, but most commonly are in the range of 15 to 40 metres, considerably less than the depths of erosion under some modern estuaries. In addition, in depositional basins flanked by active orogenic belts, sediment supply rates were probably higher than those in Pleistocene and modern river valleys, particularly in unglaciated areas.

The open estuaries so common on modern coastlines do not seen to have formed in a majority of Mesozoic valleys. The Mesozoic was a period of warm greenhouse conditions, so glacial sea-level fluctuations on the scale and perhaps the rate of the Pleistocene fluctuation are not expected. In conclusion, the difference in the sea-level history of the two periods make simplistic modern analogues for valley fill successions largely invalid.