Depositional Facies of a Modern Coarse-Grained Marginal Marine Complex: insights and Applications

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ABSTRACT

Coarse-grained marginal to shallow marine deposits of the Western Canada Sedimentary Basin (WCSB) are valued exploration targets and form many of the major producing reservoirs, most notably those within the Cretaceous Viking and Cardium Formations. Facies models for coarse-grained deposits of the WCSB have evolved significantly in recent years through intensive core and log studies, aided by advances in ichnology and stratigraphic analysis. Coarse-grained marginal marine systems are however inherently complex, and there continues to be vigorous debate in the literature as to the genetic and stratigraphic interpretations of key deposits. Further advances in facies models are needed to help guide future exploration activities and to develop improved reservoir depletion strategies. This talk presents the results of a recent industry-funded doctoral study designed to address the need for modern analogues for ancient coarse-grained deposits.

Flat Island, situated on the southern margin of St. George's Bay, Newfoundland, Canada, is a 12-km long coarse-grained barrier fronting a microtidal estuarine embayment and bayhead delta complex. The barrier evolved during regional Holocene transgression due to high rates of alongshore sediment supply associated with coastal ravinement of Pleistocene glaciogenic deposits. The barrier is responding to ongoing regional transgression through processes of episodic shoreline erosion, lateral accretion, and in-place drowning.

The dataset on which the study was based included 17 shallow core collected along the barrier and within the embayment, pit and outcrop observations, aerial and ground photography, seabed video and sampling transects, shallow reflection seismic, sidescan and multibeam sonar bathymetry data.

The coarse-grained Flat Island barrier consists of aggradational to progradational beach ridge complexes that form broad strandplains with isolated tidal swales deposits and active tidal re-entrants. The barrier is naturally segmented along strike into three parts, proximal, middle and distal. The narrow (<0.5km) proximal barrier is shore-attached and consists of coarse-grained (cobble-pebble) beach

ridges with intervening tidal swales and large coarse clastic overwash fans. The middle barrier is punctuated by tidal inlet channels and fronts a broad washover fan complex that extends 1 km into the back-barrier embayment, becoming intrastratified with embayment sands and silts. The 1-km wide distal barrier is comprised of discordant sets of pebble-cobble beach ridges with tidal swales and back-barrier tidal re-entrants. Sediment supply from the landward side derives from fluvial fan-delta accretion.

Tidal inlet and swale deposits occur as isolated sand bodies bounded by coarse-grained beach ridge complexes. Washovers show distinct facies characteristics in proximal and distal positions. Proximal washover deposits are conglomeratic, and display grading and facies characteristics distinct from ridge deposits. Distal washovers are sand prone, and are subject to phases of ‘quiet water’ post-depositional modification as fronting spits are successively built and destroyed. Marginal marine deposits of the Flat Island complex overlie seaward-prograded sandy shoreface sediments.

This talk provides an overview of depositional environments and facies within the Flat Island barrier-embayment complex, with emphasis on facies diagnostics and considerations for the interpretation of analogous ancient systems. The influences of sediment supply (rate and grain size), energetics, and allocyclic and autocylic processes in the development of coarse-grained marginal marine systems are also highlighted. The talk concludes with brief comparisons to ancient deposits of the WCSB.