Mesozoic 1st Order Sequences of the Sverdrup Basin and their Relationship to Sediment Supply and Petroleum Source Rocks

Ashton F. Embry*
Geological Survey of Canada, Calgary, AB, Canada
aembry@nrcan.gc.ca

The Mesozoic succession of the Sverdrup Basin of Arctic Canada is divisible into three 1st order sequences on the occurrence of four, large magnitude, 1st order sequence boundaries. These boundaries are of late Changhsingian (latest Permian), earliest Rhaetian (latest Triassic), early Hauterivian (Early Cretaceous) and late Maastrichtian (latest Cretaceous) age. Each of these sequence boundaries is characterized by a very widespread unconformity which truncates hundreds of metres of strata on the basin flanks. Notably there are major changes in the depositional and tectonic regimes of the basin across each of the boundaries. There is little doubt that these sequence boundaries were generated by tectonic uplift in concert with extensive subaerial erosion.

The three 1st order sequences, which grossly approximate the three Mesozoic periods, are, in ascending order, 47, 68 and 72 million years in duration. They are similar in their gross lithological and facies makeup with thick sandstone units predominating in the lower portion, thick shale and siltstone units with sparse sandstones dominating the middle portion and increased sand-prone units in the upper portion. Each sequence is divisible into a transgressive system tract and a regressive systems tract through the recognition of a maximum flooding surface which marks the horizon of lowest sediment input in the sequence. The MFS is usually located near the middle of each sequence. The ages of the MFSs are earliest Ladinian (Middle Triassic), early Bajocian (Middle Jurassic) and early Coniacian (early Late Cretaceous).

A major increase in sediment supply to the basin occurs directly above each 1st order boundary and large sandy deltas characterize the early deposits of each sequence. For each 1st order sequence, the first 2nd order sequence within it has thick sandstones with excellent reservoir characteristics. Sand supply rapidly decreases in the second 2nd order sequence and sediment supply continues to decrease to the MFS. Sediment supply then slowly increases again with substantial sandstone units appearing in the upper portions of each 1st order sequence. Petroleum source rocks occur in the shale-dominant, mid portion of each sequence and the best source rocks in the basin, with oil prone TOCs up to 10%, are found in strata close to the MFS in the oldest (“Triassic”) and youngest (“Cretaceous”) 1st order sequences.

The similar lithological and facies development of each sequence suggests a similar tectonic history for each. The tectonic episode which resulted in the creation of each 1st order sequence boundary must have generated substantial uplift of the craton which then led to greatly increased supply of sediment, especially the bedload portion. Sediment supply declined with reduced elevations and tectonically driven disruptions of supply systems and each sequence is

characterized by a time of very low sediment input. Eventually, increased tectonic activity and consequent increased sediment supply heralded the next 1st order tectonic episode. These major 1st order tectonic episodes which profoundly influenced the stratigraphic makeup of the Mesozoic succession of the Sverdrup Basin appear to be global in their effects and are interpreted to be related to mantle-driven, plate tectonic reorganizations. The similar tectonic evolution of the basin and its sources areas during each 1st order sequence suggests the existence of repetitive, and likely chaotic, changes in mantle-crust interactions on a 50 -100 MA time scale.