Determining the Spectrum of Tidal Influence on Heterolithic Deposits: a Focus on Mudstone Layers and their implications for reservoir Characterisation

ABSTRACT

Much of the heavy oil produced in the Western Canadian Sedimentary Basin is from heterolithic sandstone deposits that have some degree of tidal influence. Tidal influence is commonly determined from the presence of classically cited tide-generated sedimentary structures that include: double mud drapes; tidal bundling / rhythmicity in sandstone layers and mudstone layers; bi-directional cross-stratification; trace-fossil assemblages that indicate salinity stress on biota, and; inclined heterolithic cross-stratification.

The Bluesky Formation, in the Peace River area of Alberta, is interpreted from core within the study area to be strongly tide-dominated, likely deposited in a macrotidal setting. And yet, the Bluesky Formation rarely displays any of the aforementioned characteristics that are classically associated with tidally influenced deposits elsewhere in the basin. This seemingly paradoxical lack of classic tidal indicators in a setting interpreted as macrotidal can be explained by the persistently high energy that is present in macrotidal environments (subtidal and intertidal) and the common presence of very high turbidity: these conditions tend to, respectively, destroy rhythmic signals in bedding and generate a spectrum of mudstone types that are uniquely present in very turbid macrotidal settings.

Mudstone types in the Bluesky Fm are classified here based on their thickness and internal stratification, which reflect the turbidity levels and the velocity of the fluid column in which they formed. In turn, these influencing factors serve as proxies for paleogeographic location, water depth and architectural element. In tandem with the interpretation of sandstone layers, this
mudstone classification system can be used as a tool for recognizing macrotidal depositional settings, for understanding reservoir flow-unit geometries and for predicting longer-distance (kilometres-scale) lateral changes in reservoir quality.

The suite of mudstone layer types observed in the Bluesky Formation and, particularly presence of thick fluid muds in excess of 2 cm, should likely be considered a key indicator of macrotidal depositional conditions, which invariably occur in tide-dominated depositional settings.