

Predicting Shoreline–Shelf Processes: Insights from Numerical Modelling of Ancient Tides

*Daniel Steven Collins^{1,2}, Alexandros Avdis², Peter A Allison², Howard D Johnson², Martin R Wells³, Jon Hill⁴, Gary J Hampson², Matthew D Piggott², Toru Tamura¹

1. Geological Survey of Japan, AIST, Japan, 2. Department of Earth Science and Engineering, Imperial College London, UK, 3. BP, UK, 4. Environment Department, University of York, UK

Waves, tides, rivers and storms control shoreline–shelf sediment transport and sediment supply to slope–basin floor systems. Predictive decision trees and classifications for ancient shoreline–shelf processes conceptualise the importance of palaeogeography, especially the influence of shelf width on tidal resonance potential. However, multiple palaeogeographies can invariably be constructed for a given region and time, even in relatively data-rich basins. This study synthesises the geographic controls on tides by comparing modern tides with numerically modelled tides and preserved sedimentary records in three ancient case studies: 1) Oligocene–Present, South China Sea, SE Asia; 2) Early Cretaceous (Aptian–early Albian) Lower Greensand Seaway, NW Europe; and 3) Late Pennsylvanian (Carboniferous) Midcontinent Seaway, North America.

On a regional scale (100–1000s km), tidal processes within partly-enclosed basins are controlled by: 1) tidal inflow and outflow, which is determined by the number, position and physiography (shape and bathymetry) of inflow and outflow areas; 2) basin physiography, including embayments, which influences tidal resonance; and 3) partitioning of tides by flow constrictions (islands and bathymetric highs). Tidal resonance also depends on the relative strength of diurnal versus semi-diurnal tidal constituents. On a local scale (1–100s km), tides are largely controlled by the relative strength of tidal amplification, due to funnelling and shoaling effects, and frictional damping on the continental shelf and within embayments and gulfs.

Our results suggest that regional-scale palaeogeography is the primary control on tidal processes within partly-enclosed basins. Tidal resonance potential is a secondary control that is influenced by several factors, including shelf width. However, overprinting of tidal sediments by lower frequency-higher magnitude storm and fluvial processes complicates process reconstruction of ancient shallow-marine deposits. This is addressed in a series of modified decision trees and classifications that increase the confidence in predicting ancient shoreline–shelf processes based on palaeogeographic reconstructions.

Keywords: Shoreline–Shelf, Tidal Modelling, Process Prediction