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Modelling tides in isolated seas: Application of the Imperial College Ocean Model and implications for epi-continental sea deposits

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In the absence of analogical reasoning, numerical models can provide a quantitative means of investigating tidality in ancient epeiric seas. A combination of validation tests on present day isolated seas and a Namurian epeiric sea case study lead us to propose many ancient epeiric seas were micro-tidal.

The Imperial College Ocean Model (ICOM) uses finite element methods and a tetrahedral unstructured mesh enabling the next advance in palaeo-ocean modelling. ICOM is validated using present day shallow and deep isolated seas (the Baltic and Mediterranean Seas respectively). Both these seas are micro-tidal. Minimal differences in maximum predicted tidal range are observed between (i) ICOM and other tidal model results and (ii) ICOM sensitivity tests to half times true water depth and twice times true water depth.

A Namurian (early Pennsylvanian) case study from NW Europe predicts a micro-tidal regime, which is supported by geological data. Putative tidal deposits described from rocks of this age in the UK are subtle and confined to palaeo-estuaries where highly localised amplification effects were important.

Micro-tidality in ancient epeiric seas has many important implications. In the absence of tidal–mixing, these seas would have been prone to stratification, oxygen depletion, mass mortality and organic carbon preservation. Tidal deposits in such seas would be rare and confined to localised areas of tidal amplification. Wave- and fluvial- dominated coasts would predominate with sand grade sediment trapped along the littoral zone leaving a mud blanket (frequently black shale) in the basin centre.