Modelling Paleo-Tides and Bed Shear Stress in an Ancient Epicontinental Sea: The Laurasian Seaway

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Much of the marine stratigraphic record was deposited in expansive epicontinental seas. They were typically shallow, on the order of 10 to 200 m deep, but of vast extent, covering areas of up to a million square km. Modern seas such as the Baltic are of similar depths but are considerably smaller. Without suitably scaled modern analogues our understanding of these important water bodies is handicapped. It has been argued that tidal energy was either attenuated in ancient epicontinental seas by the large distances traveled by the tidal wave or amplified on large shelves. Numerical models however, have shown that at least some ancient epicontinental seas were likely to have been microtidal (tidal range of up to 2 m) with local amplification due to local funneling or resonance.

Herein, we use the we use the Imperial College Ocean Model (ICOM), a fully hydrodynamic, finite element ocean model, to model tides and tidal bed shear stress in the Lower Jurassic Global ocean, Tethys, and the Laurasian Seaway.

Tidal modeling with ICOM has been extensively validated against satellite altimetry and tide gauge data from modern oceans and seas. Bed shear stress output has been validated against existing model output and grain-size data from the tidally-influenced North Sea (Mitchell et al., 2010. Sedimentology, In Press). Our palaeogeographic base maps are largely a synthesis of previously published work.

Results show that the tidal range of the seaway was largely micro-tidal but that bed shear stresses are highest around shallow platforms and within straits where the tidal currents are amplified by flow constriction. Even though the tidal wave height may have been slight the shear stress was enough to transport sand.

We note that a similar situation occurs in the Western entrance of the modern Gulf of Corinth in the Mediterranean Sea. In this case a tidal range of 15 cm is associated with tidal flows of 100 cm/sec in narrow shallow straits. We hypothesise that such flow constriction in ancient seaways may have been sufficient to promote the formation of sand bodies and influence local waterbody mixing and productivity.