



Temporally Dynamic, Spatially Static, Cobble Bedforms In Reversing Subtidal Currents

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Cobble bedforms, transverse to the reversing tidal currents, are exposed at extreme low-water Spring tides on an inter-tidal bedrock shelf in the macro-tidal Severn Estuary, UK. Near-bed flow velocities during Spring tides can exceed 1.5m/s, with water depths varying from zero to in excess of 10m. During neap tides the bedforms are not exposed, and sediment is expected to be of limited mobility. When exposed, the bedform geometry tends to be asymmetric; orientated down estuary with the ebb current. During Spring tides, vigorous bedload transport of gravel (including large cobbles) occurs during both flood and ebb over the crests and yet, despite this temporal dynamism, the bedforms remain spatially static over long time periods or show weak down-estuary migration. Stasis implies that the tidal bedload transport vectors are essentially in balance. Near-bed shear stress and bed roughness values vary systematically with the Spring-tide current speeds and the predicted grain-size of the bed load using the Shields criterion is in accord with observed coarser grain-sizes in transport. These hydrodynamic data, delimited by estimates of the threshold of motion, and integrated over either flood or ebb tides are being used to explain the apparent stability of the bedforms. The bulk hydraulic data are supplemented by particle tracer studies and laser-scanning of bed configurations between tides. The high-energy environment results in two forms of armouring. Pronounced steep imbrication of platy-cobbles visible on the exposed up-estuary side of dunes is probably disrupted during flood tides leading to rapid reworking of the toe deposits facing up-estuary. In contrast, some crest and leeside locations have been stable for prolonged periods such that closely-fitted fabrics result; these portions of the bedforms are static and effectively are 'armour-plated'. Ebb-tide deposits of finer, ephemeral sandy-units occur on the down estuary side of the bedforms. Sandy-units (although not observed at low tide) presumably also are deposited on the up estuary side during flooding tides but these deposits are destroyed by ebb flows. The implication of these sediment transport processes on the stratification of the bedforms is considered.