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Oscillatory and Combined Flow Bed Forms Produced in the Laboratory: Implications for the Shallow Marine Rock Record

The response of cohesionless sediment to oscillatory and especially combined flow conditions is still poorly understood. Consequently, a number of important aspects of the shallow marine sedimentary record remain unresolved. In particular, the origin of hummocky cross-stratification (HCS) and the nature of combined flow bed forms and stratification are two of the most fundamental issues.

This experimental study investigates equilibrium bed forms produced under oscillatory and combined flow conditions. Numerous runs were conducted in a 15 m long, 1.25 m wide, 0.65 m deep wave tunnel while adjusting sediment and fluid-flow conditions. Conditions explored are: oscillatory velocities (Uo) ranging between 20-125 cm/s, unidirectional velocities (Uu) ranging between 0-25 cm/s, oscillation period of 10.5 sec and 8 sec, and grain size of 0.14 mm and 0.22 mm. Waves and currents are colinear. Variables are scaled to 10ºC.

Results are generally consistent with existing phase diagrams. With increasing Uo bed phases are: small-scale suborbital ripples, large-scale orbital ripples, and plane bed. For a given Uo and increasing Uu, the bed generally becomes progressively more asymmetrical and eventually is planed flat. Unequivocal downstream migration occurs when Uu exceeds 10-12 cm/s. A hummocky bed surface develops under Uo of 50-90 cm/s and Uu of 0-15 cm/s. This bed phase overlaps the large-scale ripple and combined flow "dune" phases, and its extent is affected by variations in grain size and wave period. Conceivably these hummocks would produce HCS if the bed was aggrading.