



Morphodynamics and sedimentary structures of bedforms under supercritical-flow conditions: new insights from flume experiments

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Supercritical-flow phenomena are fairly common in modern sedimentary environments, yet their recognition remains subordinate in the rock record. This is commonly ascribed to the poor preservation potential of deposits from supercritical flows. However, the number of documented flume datasets on supercritical-flow dynamics and sedimentary structures is very limited in comparison with available data from subcritical-flow experiments, and our inability to identify and interpret such deposits might also be due to insufficient knowledge.

This article describes the results of systematic experiments spanning the full range of supercritical-flow bedforms (antidunes, chutes-and-pools, cyclic steps) developed over mobile sand beds of variable grain sizes. Flow character and related bedform patterns are constrained through time-series measurements of the bed configuration, flow depth, flow velocity and Froude number. The results allow the refinement and extension of current bedform stability diagrams in the supercritical-flow domain. The experimental dataset and the stability diagram clarify morphodynamic relationships between antidune and cyclic steps. The onset of antidunes is controlled by the flow passing a threshold value of the Froude parameter. The transition from antidunes to cyclic steps instead is completed at a threshold value of the mobility parameter, and this transition spans a wider range of values for the mobility parameter as grain size increases. Sedimentary structures associated with the development of supercritical bedforms under variable aggradation rates are revealed by means of a synthetic aggradation technique and compared with examples from field and flume studies.

Aggradation rate bears an important influence on the geometry of supercritical structures, and it should be held in consideration for the identification and mutual distinction of supercritical-flow bedforms in the stratigraphic record.