Gravity Flow Bedforms and Associated Sedimentary Structures

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Abstract

Different types of bedforms develop under quite specific combinations of flow conditions and sediment properties, and so their associated sedimentary features have been commonly used to aid interpretations of paleo-hydraulics and infer the nature of depositional environments from the rock record. Subaerial (fluvial) bedforms have been studied extensively and are in general well understood but their subaqueous counterparts (turbidity or other dense undercurrents) remain largely elusive. In particular, the links between hydrodynamic processes and resulting sedimentary bedforms in deepwater settings remain poorly understood due to difficulties of direct observations in their natural environments of occurrence, and limited number of reported experimental studies. Although still widely practice, the extrapolation and use of fluvial bedform phase diagrams for deepwater cases are now highly questionable, in light of evidence coming from recently developed experimental work and field observations that suggests departures in both processes and products from the fluvial realm.

Results from experimental work performed using both laboratory dense saline and turbidity currents, and observations from rock outcrops and other field datasets (e.g. modern sea-floor bathymetry; subsurface seismic; core), along with a newly proposed deepwater bedform phase (regime) diagram are presented and will be discussed with emphasis in observed differences (and some similarities) to the fluvial counterpart. For example, laboratory detailed hydraulic measurements highlight the importance of dense underflow internal stratification and concentration, the interplay of the components of the flow driving force (reduced gravity, topographic gradient), and the hydrodynamic nature of the flow interface, in determining ranges of specific sediment transport conditions and thus bedforms and associated sedimentary structures. Spanning a very rich spectrum of bed states: from ripples at the smaller scale, to supercritical dunes, and onto the large (upstream-migrating) so-called sediment waves (antidunes, cyclic steps) than can form and maintain stably under flow and sediment transport conditions very different than their open-channel flow analogs, deepwater bedforms and their characteristic sedimentary deposits are in part a testimony of the sedimentologic complexity of gravity flows that still resist fully unravelling.