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Sedimentary structures formed under water surface waves: examples from a sediment-laden flash flood observed by remote camer

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On 13-14 October 2012, Tropical Storm Rafael triggered sediment-laden flash floods in the Belham Valley on Montserrat, West Indies. Rainfall was continuous for ∼38 hours and intensity peaked at 48 mm/hr. Flow was strongly unsteady, turbulent with sediment concentrations varying up to hyperconcentrated. Time-lapse images captured at >1 frame per second by remote camera overlooking a surveyed valley section show the development of trains of water surface waves at multiple channel locations during different flow stages.

Waves grew and diminished in height and remained stationary or migrated upstream. Trains of waves persisted for <5 minutes, until a single wave broke, sometimes initiating the breaking of adjacent waves within the train. Channel-wide surges (bores) propagating downstream with distinct turbulent flow fronts, were observed at irregular intervals during and up to 7 hours after peak stage. These bores are mechanically similar to breaking front tidal bores and arid flood bores, and resulted in a sudden increase in flow depth and velocity. When a bore front came into close proximity (within ∼10 m) upstream of a train of water surface waves, the waves appeared to break simultaneously generating a localised surge of water upstream, that was covered by the bore travelling downstream. Those trains in which waves did not break during the passage of a bore temporarily reduced in height. In both cases, water surface waves reformed immediately after the surge in the same location.

Deposits from the event, were examined in <4 m deep trenches ∼0.5 km downstream of the remote camera. These contained laterally extensive lenticular and sheet-like units comprised of varying admixtures of sand and gravel that are attributed to antidunes, and associated transitions from upper-stage-plane-beds. Some of the structures are organised within concave upward sequences which contain downflow shifts between foreset and backset laminae; interpreted as trough fills from chute-and-pools or water surface wave breaking. At least 90% of the deposit is interpreted upper flow regime origin. The sequence, geometry and lamina-scale texture of the sedimentary structures will be discussed with reference to remote camera images of rapidly varying, unsteady and pulsatory flow behaviour.