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First field test of the theory of ignition and dissipation in sediment density currents – results from Squamish prodelta, British Columbia, Canada.

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Turbidity currents are one of the most important sediment transport processes on Earth and pose a potential hazard to seafloor infrastructure. These flows are driven downslope due to the collective density of their suspended sediment and are hypothesised to either entrain more sediment, causing them to erode sediment and accelerate (‘ignition’), or deposit sediment, causing them to decelerate (‘dissipation’). This paradigm has major implications for geohazard assessments and protecting seafloor infrastructure. We present the first field-scale study to test the ’ignition-dissipation’ hypothesis and to analyse how turbidity currents evolve through erosion and deposition of sediment from the seafloor. A dataset of 93 near-daily bathymetric surveys was collected by John Hughes Clarke et al., in 2011 of the Squamish delta in the Howe Sound, BC, Canada. The near-daily resolution of the dataset is the first of its kind, and contains 106 mass wasting events and 30 turbidity currents. The data enables the analysis of the volume and location of sediment erosion and deposition along the full length of the flow path for three different turbidity currents.

The three flows in this study originated in different ways: a small delta lip failure; a large delta lip failure; and an event with no discernible head scarp. The small lip failure transformed from a dissipative flow into an ignitive flow midslope, entraining 470 m3 of sediment during ignition, before dissipating once again. The large lip failure remained a dissipative flow, entraining relatively little sediment, blanketing the upper Southern channel with sediment. On the day following the large lip failure, a flow was initiated in in ∼60 m water depth that could not be linked with a delta lip failure or other obvious source. The flow ignited and eroded the entirety of the upper channel to reach a flow volume of ∼8200 m3. The dissipative or waning phase of both the small lip failure and event of unknown origin occur when the seafloor gradient falls below 3o; causing the flow to wane before reaching the lobe.

Two of the three turbidity currents analysed ignite thus supporting the ‘ignition-dissipation’ hypothesis. The present analysis shows that ignition is not related to the flow trigger and that relatively large failures do not necessarily result in long run out flows. Perhaps it is the case that the largest dissipative flows lead to the largest ignitive flows, resulting from a greater supply of unconsolidated sediment for the ignition process. Completion of the analysis of the remaining 133 flows in this dataset will enable a more thorough test of the ‘ignition-dissipation’ hypothesis.