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First measurement of a flow mechanism responsible for enhanced erosion in channel-lobe-transition zones

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In the ocean, sediment is transported by sediment-laden gravity flows, called turbidity currents, which flow in river-like channels on the ocean floor. These submarine channels funnel sediment from the continental coasts into the deep ocean and can extend for 1,000's of kilometers. At the end of these channels, turbidity currents lose their confinement and are therefore expected to deposit their sediment load. Yet seafloor observations have shown that, in strong contrast to the expectation, the turbidity currents are prone to eroding the seafloor in so called channel-lobe transition zones, forming large scour fields, instead of depositing sediment there. Research to date provides no direct measurements of a flow mechanism that can explain the observed scour fields.
Here we present measurements of the flow structure, along with the erosional/depositional patterns, from experimental turbidity currents that leave a channel. Downstream variations in the flow field is mapped with an array of ultrasonic-Doppler-profilers and erosional/depositional patterns are mapped using a laser scanner. We observed an increase in erosion by the turbidity current upon leaving the channel due to a newly discovered flow mechanism that we call "flow relaxation". Flow relaxation describes the deformation of the flow upon lateral spreading, which increases the basal strength of the turbidity current, leading to erosion.
The results are the first measurements of a flow mechanism that is responsible for the erosional features often observed in channel-lobe transition zones. Furthermore, flow relaxation provides a new explanation for the efficient propagation of submarine channel systems. Understanding these channel systems is important as they rival rivers in the capacity to transport sediment, nutrients, pollutants, and organic carbon across the Earth.