How Is Sediment Transported through Submarine Channels and onto Lobes? New Insights from Turbidity Current Monitoring and Repeat Seafloor Mapping

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Submarine channels can extend for thousands of kilometres, and are the primary conduit for sediment transport to deep-water. The turbidity currents that travel through these systems deposit the most voluminous sediment accumulations on our planet. These often-powerful flows pose a hazard to important seafloor infrastructure, such as pipelines and cables. The depositional termini of channel systems (submarine lobes) hold valuable archives of Earth's history to reconstruct past earthquakes, marine geohazards, or palaeoenvironments, and can contain major hyrdrocarbon reserves. Despite their global importance, our understanding of how sediment is transported through submarine channels and how lobes are built remains unclear. This knowledge gap is largely due to the lack of direct observations of active submarine channel-lobe systems from source to sink. Therefore, we rely upon scaled-down experiments to calibrate interpretations made from ancient deposits. Here we present a unique monitoring dataset collected in a 40 km long submarine channel-lobe system in Bute Inlet, British Columbia (Canada). This dataset comprises: i) detailed time-lapse seafloor surveys performed along the full-length of the submarine channel-lobe system to reveal its evolution over a decade; ii) direct measurements of turbidity currents made over two years at multiple locations down the system; and iii) discharge from the river that feeds the system. We show that tens of flows occur yearly in the upstream domain of the channel. However, most turbidity currents do not contribute to lobe-building, and instead dissipate within the channel. In contrast to conventional models of channel erosion, bypass and deposition, we observe an alternating pattern of erosion and deposition along the channel. These alternations are due to the upstream migration of steep-faced knickpoints, which rework channel deposits and transport sediment step-wise downstream. Sediment delivery to the lobe is episodical and does not necessarily relate to a strong external trigger. This implies that submarine lobes partly preserve a record of internal perturbations, rather than the upstream flow events and their external triggers. This has implications for how to interpret lobe deposits and their use in reconstructing Earth's history and geohazard assessments.