How is sediment transported through submarine channels and onto the lobe? New insights from time-lapse bathymetry monitoring of an active channel

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Submarine channels are the primary conduit of sediment transport to deep-water, sometimes extending for hundreds to thousands of kilometres. 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 these channel systems (submarine lobes) have been proposed to hold valuable archives of Earth's history to reconstruct hazard frequency, palaeoclimates, and earthquake recurrence. Despite their global importance, our understanding of how submarine 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 small-scale observations and scaled-down experiments to calibrate interpretations made from ancient deposits.

Here we present a unique monitoring dataset comprising: i) the first ever detailed time-lapse seafloor surveys performed over a decade along the full-length of an active submarine channel-lobe system (in Bute Inlet, British Columbia) to reveal its architectural evolution; ii) direct measurements of turbidity currents made over two years at multiple locations down the system; and iii) measured discharge from the river that supplies sediment. The integration of these three datasets gives an unprecedented insight to the dynamics of submarine channel-lobe systems on short timescales. We show that tens of flows occur annually in the upstream domain of the channel, coincident with periods of elevated river discharge. Most turbidity currents do not directly contribute to lobe-building, and instead dissipate

within the channel. In contrast to conventional models that assume proximal channel erosion, medial bypass and distal deposition, we observe an alternation of zones of erosion and deposition down the channel length. These alternations are due to the upstream migration of steep-faced knickpoints, which erode sediment while migrating upstream and deposit this sediment further downstream of the knickpoint. This suggests that the sediment deposited by most flows is reworked several times and is transported step-wise downstream before reaching the lobe. Sediment delivery to the lobe is much more episodic than that deposited in the proximal parts of the system and does not necessarily require a strong external trigger. Periods of rapid aggradation on the lobe coincide with upstream migration of the knickpoint immediately upslope of the lobe. We suggest that submarine lobes partly preserve a record of autogenic perturbations, rather than the upstream flow events and their external triggers. This has important implications for how to interpret lobe deposits and their use in reconstructing Earth's history and geohazard assessments.