# UPSTREAM-MIGRATING KNICKPOINTS: THE DOMINANT CONTROL ON SUBMARINE CHANNEL EVOLUTION?

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Submarine channel systems are the primary conduits for sediment transport to the deep sea. The turbidity currents that pass through them are the volumetrically most significant sediment transport mechanisms on Earth. Submarine channel deposits preserve valuable archives of Earth history, while the associated mass movements pose a hazard to critical seafloor infrastructure. Therefore, understanding how submarine channels form and develop is important. It has been hypothesized that the development of meandering, due to outer bank erosion, is a key control on submarine channel evolution. This hypothesis is based on river studies. Several recent studies show that flow in submarine channels is very different to that in fluvial settings, however. Other inferences have been made from the deposits left behind by past flows, scaled-down laboratory studies, and uncalibrated numerical models, but the key controls on the morphologic evolution of submarine channels remain elusive.

Here, we can reconcile these issues using unusually detailed time-lapse bathymetry surveys that record the morphologic evolution of a highly active submarine channel. Multiple seafloor surveys were performed in Bute Inlet, British Columbia over a ten-year period. We track the evolution of a 60 km-long submarine channel that is surveyed from its source to lobe at an unprecedented high spatial and temporal resolution. We first summarize the morphologic changes observed from these repeated surveys. Second, we classify the nature and quantify the scale of erosional and depositional patterns associated with this morphological evolution. Finally, we relate the observed morphologic changes to the processes that control channel evolution and discuss the implications of our findings for other submarine channel systems worldwide.

We find that upstream-migration of knickpoints (sharp and steep steps in the channel topography), is by far the most important process responsible for the observed erosional and depositional patterns and is the driving forces behind the channel evolution. Individual knickpoints can migrate several hundreds of meters upstream per year and can cause up to 30 meters depth of erosion over this entire migration distance. The influence of outer bend erosion is found to be negligible in comparison to knickpoint migration, with the latter capable of completely modifying both plan-view and cross-sectional morphology of the channel. High resolution bathymetry data reveals that similar knickpoints are also common in many other submarine channel systems worldwide, yet their potentially critical role in channel evolution has largely been ignored until now.