What controls the nature and rate of submarine channel evolution? New insights from high-resolution repeat mapping of an active submarine channel

Maarten S. Heijnen[1], Michael A. Clare[1], Matthieu J.B. Cartigny[2], Peter J. Talling[2], Sophie Hage[1,2], Gwyn Lintern[3], Cooper Stacey[3], Daniel R. Parsons[4]

[1] *Marine Geosciences, National Oceanography Centre, Southampton, European Way SO14 3ZH, UK*
[2] *Departments of Geography and Earth Sciences, University of Durham, U. K.*
[3] *Natural Resources Canada, Geological Survey of Canada, BC, Canada*
[4]*School of Environmental Sciences, University of Hull, U.K.*

Subaqueous canyons and channel-levee systems are among the most important conduits for sediment transport on Earth; however, datasets that capture their ongoing evolution and directly measure the sediment transport processes within them are rare. In order to make inferences of the processes that excavate, modify and infill submarine channels we largely rely on the deposits that are left behind and results of scaled-down experimental studies. However, submarine channel morphology can be rapidly modified by successive turbidity currents, with channel bed and bank instabilities contributing to a complex morphodynamic evolution. It is therefore challenging to understand the controls on how channels evolve, which processes are most important, and what can be reliably interpreted from the resultant deposit morphology, architecture and facies.

Here, we can reconcile these issues using unusually detailed timelapse bathymetry surveys that capture morphologic evolution of an active submarine canyon and channel-levee system. Surveys capturing change over sub-annual to decennial timescales were performed in Bute Inlet, British Columbia over a ten-year period. We first present an overview of the morphological evolution of the system over a range of timescales. Second, we classify the nature and quantify the scale of erosional and depositional changes observed. Finally, we attempt to link these morphological changes to natural processes, such as turbidity current flow regime, to explain the evolution of the system. We illustrate this discussion with three main morphologic changes: 1) upstream-migrating crescentic bedforms that relate to frequent stratified turbidity currents; 2) upstream-migrating knickpoints that likely relate to non-stratified flow dynamics; and 3) meander-bend erosion and deposition that may relate to both turbidity currents and channel-margin instability. We discuss how the combination of these, and other processes, control the nature and rate of channel evolution, and we compare the findings to examine what can be reliably interpreted from deposits.