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Quantifying the relationship between structural deformation and the morphology of submarine channels from shelf-edge to deep water: Case studies from the Niger Delta system

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The processes and deposits of deep-water submarine channels are known to be influenced by a wide variety of controlling factors, both allocyclic and autocyclic. However, unlike their fluvial counterparts whose dynamics are well-studied, the factors which control the long-term behaviour of submarine channels, particularly on slopes undergoing active deformation, remain poorly understood. We combine seismic techniques with concepts from landscape dynamics to quantitatively investigate how the growth of gravitational-collapse structures at, or near the seabed in the Niger Delta have influenced the morphology of submarine channels along their entire length from the shelf edge to their termination in deep water.

From a 3D, time-migrated seismic reflection volume which extends over 120 km from the shelf edge to the base of slope, we mapped the present-day geomorphic expression of several submarine channels and active structures at the seabed, and created a Digital-Elevation Model (DEM). A second geomorphic surface and DEM raster—interpreted to closer approximate the most recent active channel geometries—were created by removing the thickness of hemipelagic drape across the study area. Elevations within the DEM rasters were then used to establish flow networks, enabling the longitudinal profiles of the channel systems to be extracted. We evaluate the evolution of channel widths, depths and slopes at fixed intervals downslope as the channel systems interact with growing structures. Initial results show the channel long profiles have a relatively linear form with only localised steepening associated with seabed structures. We demonstrate that channel morphologies and their constituent architectural elements are sensitive to active seafloor deformation, and we use the geomorphic data to infer a likely distribution of bed shear stresses and flow velocities from the shelf edge to deep water. Our results give new insights into the erosional dynamics of submarine channels and the effect of hemipelagic fill on present-day submarine channel geomorphology, and allow us to quantify the extent to which submarine channels can keep pace with growing structures.