Quantifying the Relationship Between Structural Growth Rate and the Morphology of Submarine Channels and Reservoir Facies From Shelf-Edge to Deep Water: Case Studies From the Niger Delta System

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ABSTRACT

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 have influenced the morphology of submarine channels along their entire length from the shelf edge to their termination in deep water on the Niger Delta. From a 3D, time-migrated seismic 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) of the study area. We used elevations within the DEM raster to establish flow networks and flow accumulations, enabling the longitudinal depth profiles of the present-day channels 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 longitudinal profiles generally have a linear form with localised steepening associated with seabed structures. We demonstrate that channel hydraulic geometries are sensitive to active seafloor deformation, and we use our 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, allow us to quantify the extent to which they can keep pace with growing structures, and help us constrain the delivery and distribution of sediment to deep water settings.