Active processes influencing the morphology of submarine gullies – new insights from marine robotics

JENNY GALES[1], VEERLE A.I. HUVENNE[1], GARETH CARTER[2], CLAUDIO LO IACONO[1], LEIGH MARSH[1], KATLEEN ROBERT[1], PAUL SHAWYER[1], RUSSELL WYNN[1]

[1] NATIONAL OCEANOGRAPHY CENTRE, SOUTHAMPTON, UK; [2] BRITISH GEOLOGICAL SURVEY, EDINBURGH, UK

POSTER

Processes operating on the flanks of submarine canyons are often overlooked with attention focused on large-scale events in the axis of a canyon. This is because in-situ monitoring studies and evidence from sediment cores have shown that these can be hugely dynamic and active environments. Turbidity currents transport the highest volumes of sediment on earth, can reach speeds of 20 m/s and are able to travel on seafloor gradients as low as 0.3°. They can impact the location of hydrocarbon reservoirs, are responsible for cable breaks which disrupt internet traffic and can lead to slope failure and thus pose risk of tsunami. How the flows initiate, their behaviour and the influence they have on seafloor morphology still remain poorly understood. Using new evidence collected by a fleet of marine robotic systems in Whittard Canyon, Celtic margin, we highlight the importance of canyon-flank processes, specifically the role that gullies play in the formation and maintenance of canyon morphology. We show that these systems are highly active, may have significant influence on canyon-axis processes, and may be operating on significantly shorter time-scales compared to major down-canyon events. These processes are likely to be integral to canyon evolution and have greater influence on canyon biota compared to less frequent down-canyon events. We identify distinct canyon flank morphologies from quantitative analysis of geophysical data and attempt to link morphology with formation mechanisms. Processes controlling canyon morphology are poorly constrained with suggested mechanisms including turbidity currents, debris flows, slides, slumps and oceanographic processes such as dense water overflows, internal tides and contour currents. We use data collected by Remotely Operated Vehicles (ROVs), Autonomous Underwater Vehicles (AUVs) and shipboard systems, providing ultra-high (cm-scale) resolution geophysical data, targeted ROV-operated vibrocores, multicores and piston cores from gully flanks, axis and fans, and high-resolution video footage showing fine-scale canyon flank morphology. We show evidence for active processes influencing canyon flank morphology, including debris flows and debris fan formation, small-scale mass wasting, turbidity currents and potentially a new mechanism of gully formation through dissolution. We discuss how these processes are influenced by the underlying lithology, internal tide energy and canyon flank gradient, orientation, roughness and geometry, and examine the effect this has on flank morphology. We show that these processes may be fundamental in contributing to the evolution of continental margins, are active today and highlight their importance compared to well-documented canyon-axis processes. Understanding how these mechanisms differ is fundamental in understanding seafloor erosion patterns, basin-ward sediment transport, factors influencing turbidity current evolution and behaviour, continental margin and canyon evolution and factors influencing slope instability.