Direct Measurements of the Evolution and Impact of Sediment Density Flows as they Pass Through Monterey Submarine Canyon, Offshore California

Paull[1], C.K., P.J. Talling[2&3], K.L. Maier[4], D. Parsons[5], J. Xu[6], D.W. Caress[1], R. Gwiazda[1], E. Lundsten[1], K. Anderson[1], J. Barry[1], M. Chaffey[1], T. O'Reilly[1], K. Rosenberger[4], J. Gales[3], B. Kieft[1], M. McGann[7], S. Simmons[5], M. McCann[1],E. Sumner[3], & Monterey Coordinated Canyon Experiment Team

[1]Monterey Bay Aquarium Research Institute, Moss Landing, California 95039, USA
[2]University of Durham, Durham UK
[3]National Oceanographic Center, Southampton, UK
[4]U.S. Geological Survey, Santa Cruz, California, USA
[5]Hull University, Hull, UK
[6]Ocean University of China, Qingdao, China
[7]U.S. Geological Survey, Menlo Park, California, USA

Sediment density flows flushing through submarine canyons carry globally significant amounts of material into the deep sea to form many of the largest sediment accumulations on Earth. Despite their global significance, these flows remain poorly understood because they have rarely been directly measured. Here we provide an initial overview of the recently completed Coordinated Canyon Experiment (CCE), which was undertaken specifically to provide detailed measurements of sediment density flows and their impact on seafloor morphology and sedimentology. No previous study has deployed as extensive an array of monitoring sensors along a turbidity current pathway. During the 18 months of the CCE, at least 15 sediment density flows were recorded within the axis of Monterey Canyon. Because no external triggers (i.e., earthquakes or floods) correlate with these flows, they must have originated as failures in the canyon floor or canyon flanks. Three flows ignited and ran out for > 50 km from water depths of <200 to >1,860 m, reaching velocities up to 8.1 m/s. The rest of the flows died out within the array. During these events, large objects on or in the canyon floor were displaced substantial distances downslope, including a 7.1 km downslope movement of an entire mooring; a 4.6 km displacement of an 860 kg instrument frame followed by repeated down canyon displacements of this same frame after it was entombed in sediment; and multiple depth changes of man-made boulders containing acceleration and pressure sensors. During this same time interval the canyon floor was mapped six times with autonomous underwater vehicles covering the canyon thalweg at the upper and lower end of the instrument array (200-540 and 1350-1880 m water depths). The repeated mapping surveys reveal that flows caused +3 to –3 m bathymetric changes within a continuous clearly defined ~200 m wide swath running along the canyon axis in <200 to >540 m water depth. This study shows that sediment density flows caused massive remolding of thick sections of the canyon floor in <540 m water depth as a consequence of displacement or fluidization of entire slabs of the seabed during these events.