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Large-volume (150 km3) and highly energetic submarine flows that did not erode their soft substrate

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Submarine flows are frequent processes occurring across the seafloor, ranging from dilute turbidity currents, debris flows, and slides. However, our understanding of these flows and their erosive behaviour is limited by a paucity of high-resolution field data. Here we present two exceptionally detailed field datasets. The first uses a suite of shallow sediment cores to map out large-volume (>100 km3) individual turbidite beds for hundreds of kilometres across a basin-plain. The second uses high-resolution geophysical imagining coupled with a suite of shallow sediment cores to document a small-scale slide complex, off the coast of Norway. These two datasets document very different types of submarine flow, are situated in different geological settings and occur at different water depths. In both cases, the high-resolution field data enables individual event beds to be documented and the erosion beneath their deposits mapped out. We demonstrate that beneath the turbidite beds, found offshore NW Africa, there is no erosion, and beneath the slide complex in Norway there is only limited erosion at the toe of the event. The lack of erosion is surprising considering the substrate is unconsolidated fine-grained silt/mud and the event beds are large-volume and coarse-grained in nature. Conceptual models are proposed to explain this lack of erosion. First, flows can stratify in terms of sediment concentration, which could suppress near-bed turbulence and shear stresses. Second, small proportions of mud within flows could increase fluid viscosity and impart yield strength, which would also damp near-bed turbulence and shear stresses. Third, fluidization and/or dewatering from the underlying substrate could reduce the friction coefficient in the boundary layer to almost 0, making erosion by the overriding flow more difficult. These observations from different geological settings and different types of event (turbidity currents and a slide) suggest the lack of erosion may be common behaviour in submarine flows. Currently this behaviour is poorly understood, providing a challenge for future numerical and experimental simulations.