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Complex rheological variation within flows emplacing hybrid event beds – insights from outcrop examples.

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Hybrid event beds (HEBs) are a common type of sediment gravity flow deposit in the distal and marginal parts of a number of deep-water depositional systems, which are poorly understood compared with turbidity current deposits. The basic expression of a HEB consists of a relatively clay and mud-clast-poor sandstone overlain by clay- and mud-clast-rich sandstone. HEBs are deposited by individual sediment gravity flows (hybrid flows), which are characterized by spatial and/or temporal variation from non-cohesive (clay-poor) to increasingly cohesive turbulence-suppressed rheology due to clay enrichment. Such increased significance of cohesive properties within the flow occurs during downstream run-out, either following bulk flow transformation, or the development of discrete rheological zones that become increasingly cohesive towards the rear of the flow.

Documented variations in the depositional character of HEBs within two deep-water systems (Upper Carboniferous, N. England; Maastrichtian, Norwegian Sea) highlight the complexity of rheological variability within hybrid flows, particularly those thought to be characterized by longitudinally distributed rheological zones. In some cases, the front of the hybrid flow remains non-cohesive whilst the rear of the flow becomes increasingly cohesive as turbulence is suppressed by increasing concentration. This is thought to result from continued differential grain settling, deposition and decrease of sediment concentration in the front of the flow, processes that may be subdued or prevented entirely when the rear of the flow became cohesive. In other cases, the front of the hybrid flow can become turbulence-suppressed and cohesive, but after such rheological variation has already occurred in the rear of the flow. Such behavior is thought to occur when the front of the flow is sufficiently clay rich and is also subjected to rapid deceleration. This research highlights the potential for discrete rheological variations (i.e. timing and style) at different positions within a hybrid flow, an awareness of which is important for better understanding the spatio-temporal evolution of hybrid flows and prediction of their deposits.