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Flow-deposit interaction in submarine lobes: Insights from outcrop observations and realizations of a process-based numerical model

Remco Groenenberg (1), David Hodgson (2), Amandine Prélat (2), Stefan Luthi (1), and Stephen Flint (2)

(1) Delft University of Technology, Civil Engineering and Geosciences, Geotechnology, Delft, Netherlands (r.m.groenenberg@tudelft.nl, +31 15 2781189), (2) Stratigraphy Group, Department of Earth and Ocean Sciences, University of Liverpool, UK

Submarine lobes make up the greater part of the bulk volume of submarine fans. Traditionally, lobes are viewed as consisting of sheets of sand deposited in an unconfined basin-floor setting from flows that decelerate at the terminus of channels due to loss of confinement. However, studies on modern systems (e.g. Golo Pleistocene lobe, east Corsica) and ancient analogues (e.g. the Permian Skoorsteenberg Formation, South Africa) have revealed that lobes consist of collections of depositional elements that exhibit considerable architectural variability, which is consider to be intimately related to the interplay between turbidity-current flow and sedimentation.

A novel approach is presented that assesses the interaction of turbidity currents with a subtle but evolving depositional topography. Conceptual models developed from outcrop observations are tested with a process-based numerical model. The outcrop dataset was collected from submarine lobe deposits extensively exposed in the Tanqua depocenter, SW Karoo Basin, South Africa. The process-based numerical model of turbidity-current flow and sedimentation (FanBuilder) is used to mimic the process sedimentology. Input parameters of flows are constrained by observations of the outcrop geology (sedimentology and depositional architecture). Modelling results are analyzed and compared with outcrop observations and, where necessary, lead to iterative refinement of the underlying conceptual process-sedimentological model.

The model successfully developed characteristic features of the depositional architecture, such as finger-like geometries and stacking patterns, which are comparable in scale and geometry to those observed in outcrop. The results highlight that lobe deposits have intricate geometries that, when stacked, form a complicated internal stratigraphy. In addition, new insights into the processes of lobe growth have come from the modelling that can be tested at outcrop in the future. Process modelling indicates that the stratigraphic complexity can be controlled by a subtle and dynamic depositional surface that drives instability in the position of distributive channels and the site of deposition. As such, this research emphasizes the importance of autogenic controls on the depositional architecture of submarine fan systems.