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Process-based modelling of turbidity-current hydrodynamics and sedimentation

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The production potential of deep-water reservoirs is primarily determined by rock bulk volume, porosity and permeability. As such, quantification of the geometry and spatial distribution of reservoir sands in deep-water deposits can provide crucial information to assess sand body volume, connectivity and the distribution of permeability baffles.

This study aims to investigate the influence of turbidity-current process, sediment composition and basin-floor relief, on the geometry and spatial distribution of reservoir sands in turbidite fans. For this purpose, a process-based model has been developed which simulates turbidity-current flow, erosion, and deposition based on principles of fluid dynamics that can deal with arbitrary basin-floor topography and accommodates various grain sizes. It unifies conservation of fluid mass, sediment mass and momentum in the form of the depth-averaged shallow-water approximation in combination with the Boussinesq approximation for density-driven flow in three dimensions. Sediment transport is modelled by an advection-diffusion type equation. Exchange of sediment with the bed is largely based on existing models for entrainment and deposition. Input for the model consists of parameters defining the initial basin-floor topography and parameters related to the composition of the flows, such as the grain-size distribution of the sediment, the flow density, and the magnitude and frequency of the flows.

Results will be presented of laboratory-scale model validation tests, in which modelling results from quasi-steady and waning turbidity currents are quantitatively compared to experimental data. Laboratory experiments involve small-scale flows interacting with complex topographic features as well as multiple successive flows over the same erodible bed. Results indicate that the model is capable of simulating turbidity-

current hydrodynamics and sedimentation with an acceptable degree of accuracy under a wide range of conditions.