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A Numerical Modeling Study on the Influence of Relay Ramps on the Pathways of Sediment Delivery into Rift Basins

R. Groenenberg (1), W. Athmer (1), M. Donselaar (1), S. Luthi (1), D. Sokoutis (2) and E. Willingshofer (2)

(1) Department of Geotechnology, Delft University of Technology, The Netherlands, (2) VU University Amsterdam, The Netherlands (r.m.groenenberg@tudelft.nl / Fax: +31 15-2781189 / Phone: +31 15-2783843)

Cretaceous and Tertiary deep-marine reservoirs in the Vøring Basin (Norwegian Sea) have been the focus of oil and gas exploration for the past decade. The basin margins are characterized by an intricate step-wise pattern of soft-linked extensional faults connected by relay ramps that form between two offset-overlapping normal faults. These may have considerably constrained pathways of turbidity currents and, consequently, the location, geometry and internal architecture of reservoir sands. In order to investigate this, a process-based numerical model is used to simulate turbidity current hydrodynamics and sedimentation over typical rift basin topographies in three dimensions. The model input consists of parameters defining the initial bathymetry and its evolution with time, as well as flow parameters such as the density, the total volume of fluids, the recurrence interval and the grain-size distribution of the transported sediment. Realistic relay-ramp bathymetries are obtained by means of physical scale modeling of a rift system development in sandbox experiments. Areas of the rift system where relay ramps evolve are digitally scanned, converted into a rectangular grid and upscaled for use as bathymetry in the model.

The resulting deposits depend strongly on the geometry of the relay ramp and the direction of the flow from the shelf. Flows perpendicular to the shelf edge will continue flowing across the relay ramps and deposit their sediment in a classical fan-shaped

region at the foot of the floor. Flows parallel or at an acute angle to the relay ramp strike will flow down the relay ramps and produce deposits that are elongated along the basin axis. This effect is enhanced if the relay ramp is antithetic.