Process Based Modeling: Recent Studies and Their Implications for Deep-Water Reservoir Modeling

Ernst W. Hansen[1], Riccardo Basani[1], Age Vellinga[2], Trond Høye[1]

[1]GEO Gravity Flows, Trondheim, Norway.
[2]University of Southampton, Southampton, United Kingdom.

ABSTRACT

Sandstone successions of turbiditic origin have long been recognised as important hydrocarbon reservoirs. With exploration moving further offshore, there is a growing need for deeper understanding of turbidite successions and their depositional processes. The conceptual knowledge developed from the analysis of seismic and outcrop data has seen remarkable progress in recent years. An understanding of the fundamental depositional processes, however, has been hampered by scaling issues in controlled experiments, and practical problems in measuring vital parameters in field observations of turbidity currents. In the recent years process based software has been used successfully to construct 3D numerical models for the simulation of turbidity currents, both at laboratory and basin scale. All principal hydraulic properties of the flow, and its responses to topography, can be monitored continuously in 3D over the whole duration of the current. The physical equations underpinning sediment transport, erosion and deposition, are used in order to achieve a better understanding of the intrinsic structure of the turbidity currents, erosion of the substrate and the turbidite facies and related depositional patterns. Three-dimensional models are now able to reproduce the stratigraphy on a basin-scale. Erosion, deposition and sediment compaction can be continuously monitored. Single and multiple flows, described according to their grain distribution, density, size and velocity, can be simulated. Here we show example studies of the Ormen Lange (Norway) and Peregrino Field (Brazil). Single bed layers can be identified and characterized, giving both a broad and detailed picture of the overall structure of a reservoir, as shown in the simulation of Peira Cava basin (France). The model results can help to identify areas of high and low permeability, predict connectivity, locate pinch out zones and characterize the reservoirs in 3D. This tool can be beneficial in an early stage of field development; in the exploration phase, to understand the geometry and architecture of the basin and reservoirs, and in an appraisal phase, describing the properties of the reservoirs as training image for further development of detailed reservoir models.