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Debris Flow and Turbidity Current Interactions in a Large Submarine Axial Channel Belt, Upper Austrian Molasse Basin

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Deposits of subaqueous debris flows can build up substantial topography on the seafloor and the resulting seafloor morphology controls the pathway of turbidity currents. The detailed interaction of submarine debris flows and turbidity currents is still poorly understood. To investigate the interplay between these two end members of sediment gravity flows, the distribution of their deposits needs to be documented. Map views of seafloor morphology are available for parts of the modern seafloor and in high-resolution seismic-reflection data. However, these data sets usually lack lithologic information. In contrast, outcrops provide cross-sectional and lateral stratigraphic details of deep-water strata with superb lithologic control but provide little information on seafloor morphology. Here, we present a methodology that leverages fundamental lithologic information from sediment core and well logs with a novel calibration between core, well logs, and seismic attributes. Using this calibration, we created 3D lithofacies proportion volumes. These volumes enable the interpretation of the 3D distribution of the important lithofacies and thus the investigation of seafloor morphology produced by mass transport events and its impact on succeeding turbidite deposition.

The study area is located around the Puchkirchen sandstone, a depleted gas field in the Upper Austrian Molasse Basin. Sedimentation in the Molasse Basin during the late Oligocene to early Miocene was dominated by a large deep-marine axial channel belt, 3-5 km wide and over 100 km long, that served as a conduit for debris flows and turbidity currents. The data set includes a 3D seismic reflectivity volume, a pre-stack seismic inversion of this volume resulting in P-impedance, S-impedance and density volumes, and 40 wells with the basic suite of wireline log measurements, of which 13 are cored.

Core analysis reveals that the Puchkirchen sandstone consists of massive sandstone beds deposited directly from suspension through the collapse of high-density turbidity currents. The Puchkirchen sandstone is underlain by and laterally equivalent to thick debris flow deposits. Lithofacies proportion maps show that debris flows deposited a relatively regular distribution pattern of levees and lobes. When subsequent high-density turbidity currents encountered this mounded debris flow topography, they slowed and deposited a portion of their sandy high-density loads just upstream of the morphologic high. Understanding the depositional patterns of debris flows is key to understanding and predicting the location and character of associated sandstone accumulations. This detailed model of the filling style and the resulting stratigraphic architecture of a debris flow dominated deep-marine depositional system can be used as an analogue for similar modern and ancient systems.