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Predicting Intra-Slope Submarine Fan Architectures Using High Resolution Forward Stratigraphic Models

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ABSTRACT

Sediment routing systems characterize the overall behavior of "source to sink" geomorphologic processes that drive sediments from catchment areas towards the shelf, slope and basin floor. Understanding the influencing mechanisms on such complex systems requires a multi-scale integration of traditional geomorphological, geological, geophysical and environmental data sets. Forward stratigraphic modeling workflows coupled with multi-realization have lately been used on large, basin-scale geomorphological systems (100s to 1000s of kms) to evaluate their overall behavior, architecture as well as associated vertical and lateral facies variations with regards to influencing tectonic, climatic, eustatic and environmental factors. Through this communication we explore for the first time the benefits of integrated high resolution deterministic Forward Stratigraphic Modeling workflows in assessing the architecture of intra-slope submarine fan systems and concomitant reservoir facies in deep water Trinidad. A reference case scenario calibrated to seismic data is built using a fine 200m x 200m grid-size model simulated at 20 kyrs, 10kyrs, 5kyrs and 1kyr time steps. A wide spectrum of lithologies is used (varying from fine-grained sand to mud), allowing prediction of reservoir and seal facies along sub-seismic scales of sedimentary architectures expected in such intra-slope fan systems. Sediment is directed downslope along the rugose mass transport deposit seafloor topography and diverted by mud volcanos. Modelled architectures reveal (1) proximal stacking patterns representing leveed channel deposits, (2) disconnected lateral compensation and avulsion geometries, (3) and fan fringe frontal splays. Furthermore, hundreds of automated simulations are conducted following various implemented experimental designs in order to assess the sensitivity of the reference case model with regards to lithological content, sediment capacity and sediment load and thus can be used to understand controls (e.g., climate conditions) on the deposition of intra-slope fans. Finally, these results highlight the opportunity for future work related to the impact of sedimentary architectures and associated facies on fluid flow behavior during hydrocarbon production.