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The Effects of Varying Tectonic Subsidence in a Fluvio-Deltaic System

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Deltaic systems have long been recognized for their socioeconomic impacts as well as their high potential to trap and store hydrocarbons. However, there are many different variables that strongly influence the formation of these systems whose constraints are not always well understood. The Sediment Transport and Earth-surface Process (STEP) basin at the University of Texas at Austin has the ability to create large 3D physical experiments, designed for nurturing new understanding of these systems and the parameters that influence their evolution. We explored how a laterally tilting basin influenced a prograding fluvio-deltaic system by creating tilting that occurs along a rotational axis, bisecting the model's basement and allowing the delta to experience uplift in one half of basin and subsidence in the opposite half. After six experiments, we observed that varying rates of tilting dramatically changed progradation patterns as well as the resultant stratigraphy. The tectonic tilting forced a continuous change in topset slope, which accounts for the evolving behavior of the fluvial system with regards to channel occupation and thus shoreline asymmetry. When slow tilting was applied, the delta advanced faster in the direction of uplift due to the relative decline in water depth. This created truncated stratigraphic intervals dominated by active channel cut and fill with thin but laterally linked channel bodies depositing finer material. Behavior was significantly different on the subsidence side of the delta; shoreline migration was stunted while the delta became primarily aggradational, depositing thicker, alternating packages of sands. During higher rates of tilting, deposition at the uplift end was quickly abandoned and instead focused on stacking conformable sequences of delta lobes in the area of increased subsidence, resulting in a complete lack of progradation in any direction. Progressively greater rates of tilting yielded more dramatic steering of channelized flow toward the area of greatest subsidence resulting in an increase of sediment volume routed here as well as asymmetry in delta planform geometries. The self-organized channel dynamics influence by tectonics is manifested in the resultant stratigraphy, providing unprecedented insight into the integration of small- and large-scale fluvio-deltaic processes.