Sediment Grain Size Trends throughout Delta Networks

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Commonly a network of channels forms once a feeding river channelbelt enters a low-gradient coastal plain, creating the classic delta planview morphology. This area is a zone of net deposition and consequently mass loss in the longitudinal direction. Tank experiments and subsurface data show that mass loss leads to down-channel sediment fining as deposition preferentially removes coarser particles (Paola and Martin, 2012). Understanding grainsize depositional trends is important for assessment of subsurface characteristics and importantly impact local subsidence rates and shallow groundwater flow.
We hypothesize that downstream fining trends are more pronounced 1) if rivers commonly experience overbanking and floodplain inundation, and 2) in deltas with a complex distributary networks.
We use a numerical model that describes fluvial transport with a simple geomorphic mass balance approach. It models a main channel belt as a 2D longitudinal profile that responds dynamically to changes in channel geometry, water discharge, sediment load, and grain-size distribution based on first-order, physics-based principles. Sediment flux is described with a modified Exner equation by separate erosion and sedimentation components. Erosion flux along the main flowpath depends on river discharge and channel slope, and is independent of grain-size. Depositional flux in both longitudinal direction and in lateral direction into the floodplain depends on stream velocity and on grain-dependent settling rates.
Model experiments show distinct thinning of deposits, and fining of grainsize downstream the fluvio-deltaic floodplain. An abrupt coarsening of the deposits and change in overall downstream fining trend occurs at the land-ocean boundary, associated with a decreased transport capacity and a rapid acceleration of sediment settling rates in the marine domain.
Preliminary scenarios with increased flood dynamics display a more rapid mass extraction and efficient sorting downstream, due to the upstream settling of sediment otherwise funneled downstream during bankful conditions.
A more complex delta distributary network dramatically affects mass extraction rates and associated overall fining trends. In addition, repeated occurrences of rapid grainsize coarsening are observed at distributary nodes.
Already these simple experiments provide new insights in grainsize distribution patterns in delta floodplains, but major advances can still be made by improving the simple modeling approach to a more sophisticated channel floodplain coupled model including tidal processes.

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