

Supplementary information
for
Scale dependant compensational stacking of channelized sedimentary deposits

Yinan Wang^a, Kyle M. Straub^a, and Elizabeth A. Hajek^b,

^aDepartment of Earth and Environmental Sciences, Tulane University, New Orleans, LA 70118, U.S.A.

^bDepartment of Geosciences, The Pennsylvania State University, University Park, PA 16801, U.S.A.

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DIGITAL VIDEO

Supplemental Video DR1. Video of laboratory experiments documenting evolution of channelized delta experiencing relative subsidence at a constant rate. Digital video was collected from camera at an approximately 45 degree from vertical which was then post-processed to remove camera distortion to yield a close to synoptic representation of the experimental basin. Video is presented at 360 times the actual experimental run-time. Video includes evolution of delta between run hours 70-79. Blue dye added to water aids identification of flow field.

EXPERIMENTAL METHODS

The TDB-10-1 experiment was modeled on the DB 03-1 experiment detailed in Sheets et al. (2007), but had the added aim of generating a stratigraphic package 2-3 times thicker than the DB 03-1 experiment, thus improving our ability to characterize compensation over a wider spectrum of time-scales. The TDB-10-1 experiment was performed in the Delta Basin at Tulane University's Sediment Dynamics Laboratory. This basin is 2.8 m wide by 4.2 m long and 0.65 m deep. Accommodation is created by slowly increasing base-level using a motorized weir that is

in hydraulic communication with the basin. This system allows base-level control through a computer interface with sub millimeter-scale resolution. Water and sediment supply to the Tulane Delta Basin are also controlled through the above mentioned computer interface. Water supply is controlled by a variable speed centrifugal pump, while sediment is delivered to the basin via an AccuFeed Vibra Screw Composite Feeder. The experiment included an initial buildout phase in which sediment and water were mixed in a funnel and fed from a single point source at the center of the upstream wall. The sediment feed rate was 0.011 L/sec, the water discharge was 0.451 L/sec, and their rates were kept constant throughout the experiment. As such the ratio of water discharge to sediment discharge in this experiment was 40:1. It is important to note that the ratio of water discharge to sediment discharge does not always stay constant for natural systems. In natural basins these parameters vary over many timescales which could confound the interpretation for both allogenic and autogenic signals. For example, larger Q_w explicitly changes the allogenic forcing, but also makes larger channels and therefore alters the timescales of autogenic dynamics. The delta was allowed to prograde into the basin producing a symmetrical fluvial system that covered the width of the basin. After the system prograded 3.1 m from source to shoreline, base-level rise was initiated at a rate equal to the total sediment discharge divided by the desired delta area top (base-level rise rate = 5 mm/hr). This combination of sediment feed rate and base-level rise allowed the shoreline to be maintained at an approximately constant location through the course of the experiment. The sediment mixture was composed of 70% by volume quartz sand ($D_{50} = 110 \mu\text{m}$) and 30% coal sand ($D_{50} = 440 \mu\text{m}$). The coal has a specific gravity of 1.3, whereas quartz has a specific gravity of 2.65, so the coal grains are substantially more mobile than the quartz grains and serve as a proxy for fine-grained clastics. The mixture of quartz and coal is similar to that used in previous experiments (Heller et al., 2001; Martin et al., 2009; Sheets et al., 2002). Finally, the edges of the basin were artificially roughened, in order to direct the channels away from the walls.

Three types of data were collected from the experiment: system morphology, surface topography, and deposit stratigraphy. The morphology of the fluvial system was recorded with two G10 Cannon cameras connected to a computer interface. One of the cameras (Camera 1) was positioned to collect images of the entire basin that could be used to characterize surface dynamics while the second camera (Camera 2) was positioned to collect both surface morphology and topography data. Cameras 1 and 2 recorded images of the active delta top at 1 minute intervals. Topographic measurements were taken in a manner modeled on the XES subaerial laser topography scanner. In contrast to XES, however, where the topography of the entire fluvial surface is recorded periodically, we chose to monitor the topography at 2 minute intervals along three flow-perpendicular transects, located 1.6 m, 2.1 m, and 2.6 m from the infeed point. This system uses oblique digital images of lines cast by vertical laser sheets from which true topography can be calculated. To measure a full cross-section of topography, including areas inundated by water, the experiment was stopped every two minutes and water was allowed to drain off the fluvial surface prior to collecting measurements. This arrangement allowed instantaneous (the exposure time of the camera) measurements, rather than the 30 to 45 minutes required for a full-surface scan. With this system, we obtained measurements with a horizontal spacing of ~ 1 mm and a vertical resolution of 0.5 mm. The TDB-10-1 experiment was run for 82 hours, and produced an average of 410 mm of stratigraphy. We sectioned, peeled, and imaged the deposit at each of the topographic strike-transects. Image data for all three data types were obtained using Cameras 1 and 2 that were mounted continuously in the same positions, meaning that a given pixel location in any one image corresponds to the same physical location

in all three. We could locate an event on a morphology image, match it with the elevation data from the same point on the corresponding topo image, and match both with the same point on the deposit image.

No attempt was made to formally up-scale the results from this experiment to field scale. In addition, parameters associated with this experiment were not set to produce an analogue to any particular field fan-delta system. As such, specific geometric data associated with this experiment cannot strictly be utilized to estimate the field scale deposit geometries or dynamics of a specific system. Rather, the goal of the experiment was to create a self-organized, distributary depositional system in which many of the processes characteristic of larger fan-delta systems could be monitored in detail over spatial and temporal scales which are impossible to obtain in the field. This experimental technique is similar to the ‘similarity of process’ philosophy outlined in Hooke (1968). As such the focus in this paper is on identifying the general scales of compensation which characterize the evolution of topography in the TDB-10-1.

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