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Controls on channel steering by tectonics in sedimentary basins

C. Paola (1), K. M. Straub (2), and W. Kim (3)

(1) St Anthony Falls Laboratory, University of Minnesota, Minneapolis, USA (cpaola@umn.edu), (2) St Anthony Falls Laboratory, University of Minnesota, Minneapolis, USA (kmstraub@tulane.edu), (3) Jackson School of Earth Sciences, University of Texas, Austin, USA (geowskim@uiuc.edu)

Channel steering refers to the ability of spatial variations in uplift or subsidence to influence the migration, spatial distribution, and/or path direction of channels. We report the results of three experiments on channel steering under conditions of average net deposition. The experiments were done in the University of Minnesota Experimental EarthScape basin, which via its programmable subsiding floor can be used to create a wide variety of patterns of space-time subsidence. Underpinning the experimental program is the idea that the first-order control on tectonic channel steering is a ratio of two fundamental time scales: the time needed for lateral tectonic tilting to produce a slope comparable to the mean streamwise slope of the channel system; and the time needed for the channel system to occupy a fixed, large fraction of the basin surface. The experiments cover a wide range of values of this time-scale ratio, and also include cases with pure deposition (subsidence only) as well as mixed erosion and deposition (relative uplift and subsidence). Lateral tectonic patterns included a simple trough and a more complex geometry patterned after a relay ramp system. Overall, we find that the time scale ratio exerts the expected control: steering is weakest, for either tectonic geometry, when the channels are ‘fast’ relative to the tectonics. But steering effects are manifested in different ways, depending on the geometry and possibly the history of the system.