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Evolution of an experimental channel belt

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Many river channels migrate across the surrounding landscape. In the process, they imprint a broader corridor, or channel belt, with features including scroll bars and abandoned channels. The extent of the channel belt represents a key feature for reconstructing river history from landscapes and sedimentary deposits, and for predicting landscape evolution and the dimensions of coarse sediment bodies preserved in stratigraphy. Empirical data-sets capture the dimensions of channel bodies in stratigraphy, but for braided rivers, predictive models for the width of channel belts are limited. This study uses a new set of physical experiments to quantify the evolution of a braided channel belt in time and space, and under constant forcing. We conducted the experiments at St. Anthony Falls Laboratory in a flume 37 m long and 2.7 m wide, with a unimodal grain size distribution of medium sand, and over a manually built slope of 0.01. The flume operated with a fixed base level and constant input discharges of water and sediment. We restricted the input discharge so that the initial channel width was fifteen times smaller than the flume width, allowing unconstrained channel motion. The channel evolved from an imposed, straight geometry and a rectangular cross section. Consistent with previous studies, the channel developed alternating bars and a meandering thalweg, then widened and shallowed, formed mid-channel bars, and abandoned water-worked surfaces. We define a dimensionless time $t* = tq_s/D^2$, where q_s is sediment flux per unit channel width and D is median sediment grain size. The widening rate of the channel belt declined with time, and became negligible after $t* = 2.8 \times 10^9$. Topography continued evolving locally at scour zones. We estimate the equivalent, dimensioned evolution timescale for the Sunwapta River, Canada, as 6000 years. These results suggests that natural, unconstrained, braided rivers may show a difference of three orders of magnitude between the quasi-annual timescale for in-channel morphodynamic adjustment and a millennial timescale for channel-belt maturity.