



John Pitlick Fluvial Processes Research Group

Project:

Sediment Transport and Channel Form in Gravel-Bed River Meanders

Lead Investigator: Jordan Clayton

This project analyzed bed load transport and Shields stress distributions in a meandering, gravel-bed mountain stream, and their importance for the long-term morphological development of natural rivers.

In simple, experimental channels, feedbacks between the flow, bed texture and topography, and transported sediment determine the channel's equilibrium form. In most natural environments, however, these parameters are subject to large temporal and spatial variability in driving hydrologic processes, channel morphology, and land-use patterns, and are also affected by flow obstructions. These complications make quantitative predictions of flow strength, bed load distribution, and geomorphic adjustment difficult. My dissertation work examined these interactions for several bends of different curvature in the upper Colorado River. I obtained a high-resolution dataset of depth, bed load, and surface versus subsurface grain size information, and documented how variations in transport intensity allow stream reaches of differing morphology to transport equivalent amounts of sediment and thereby promote geomorphic stability. Bed load data taken throughout the reach indicate that the fine and coarse fractions of the load are differentially routed, such that fine grains are swept inward over the point bar, while coarse grains are routed outwards towards the pool.

At bankfull flow, all size fractions of the available sediment are transported throughout the bend, but the median grain size of the bed load increases with distance towards the outer bank. This differential routing decreases slightly with increasing discharge beyond bankfull, as indicated by a shift in the locus of coarse particle transport from the outside of the bend inward to the channel center (Fig. 1). Furthermore, while fine sediments are fully mobile throughout the bend, partial mobility of the coarse fractions of the load transitions to full mobility towards the bend's outer region. These variations in transport intensity lead to a volumetric balance of transported sediment between the inner and outer regions of the channel, which thereby promotes the geomorphic stability of the bend (Fig. 2).

Future work will explore these interactions for a larger variety of river terrain and channel morphologies. Additionally, the long-term implications of these results for meander development in natural systems have not been resolved. I plan to continue research on this topic with the aim of connecting the short-term sediment fluxes with the longer-timescale morphological evolution of meandering systems.

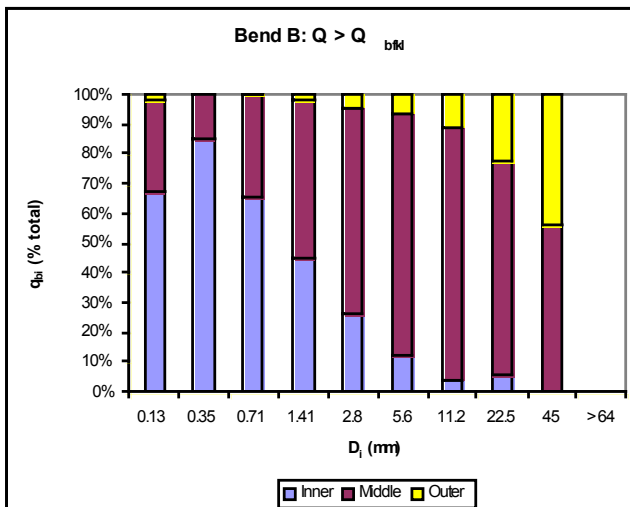
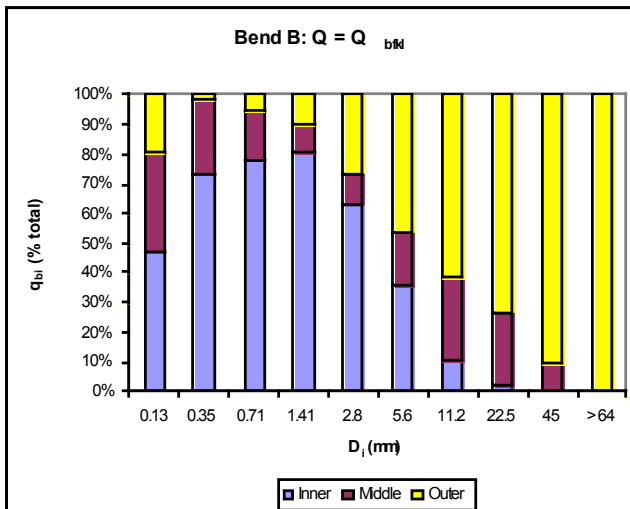
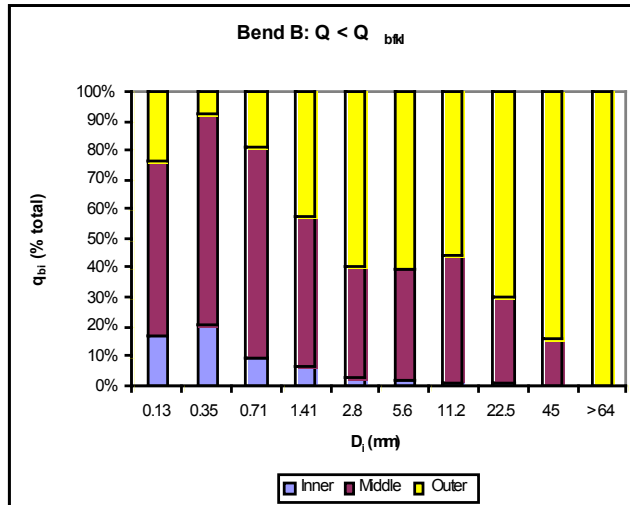


Figure 1. Transport of individual grain size fractions per region of the channel for flows less than bankfull, roughly equal to bankfull, and greater than bankfull (from Clayton and Pitlick, 2007).

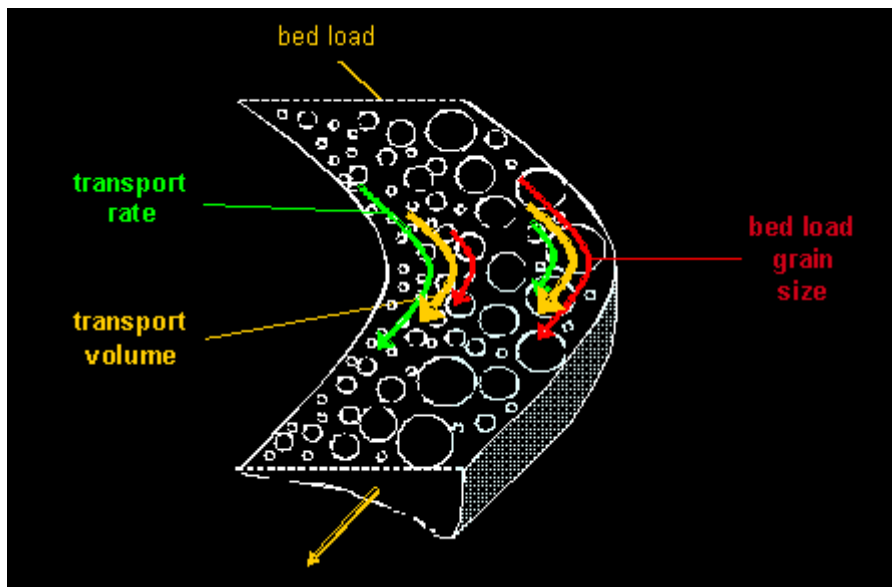


Figure 2. Increases in bed load grain size towards the outer region of bend are balanced by differences in transport rates and changes in transport patterns with discharge, resulting in a volumetric balance between the inner and outer regions of the bend.

Publications Related to this Work:

1. Clayton, J. A., and J. Pitlick (2007), Spatial and temporal variations in bed load transport intensity in a gravel bed river bend, *Water Resour. Res.*, 43, W02426, doi:10.1029/2006WR005253

Research Interests: fluvial geomorphology, sediment transport, gravel-bed rivers, spatial and temporal variability, meander bends.

Strategy: investigation of geomorphic systems through rigorous field experimentation and analysis, coupled with process-based modeling.

Other General Research Interests: effect of stochastic disturbances on the dynamics of geomorphic systems, flow and sediment routing in drainage networks, paleohydrology and geomorphic footprint of catastrophic flooding in the late Pleistocene, impact of land-use change on hydrologic systems and stream ecosystems.