Characterizing the relationship between river branch number and water discharge using distributions of channel belt properties

Tian Dong[1] and Timothy Goudge[1]

[1]University of Texas at Austin

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Abstract

Distinguishing single-thread and braided channel patterns and reconstructing paleo-water discharge from the sedimentary rock record has proven to be difficult. This is because only remnants of the river channels are preserved, often accounting for a small fraction of the overall stratigraphy. Instead, channel belt deposits—the amalgamation of deposits from many individual channels—are observed more often. Identifying channel patterns from geologic records is important for testing a range of hypotheses, including whether single-thread rivers were rare prior to the arrival of land plants in the Silurian. Here, we develop new quantitative metrics using distributions of channel geometry and channel belt properties with the ultimate goal of distinguishing channel types in the rock record. Metrics measured include width, sinuosity, radius of curvature, wavelength, and amplitude, and are measured from modern fluvial systems in the US via remote sensing techniques. An entropy-based braided index is used to quantify river branch number, which is directly related to a conventional braided index. Preliminary finding suggest that channel belt width and wavelength are well correlated with river branch number and water discharge via power-law relations, respectively. Specifically, mean river branch number is inversely related to channel belt wavelength, normalized by mean total channel width. In addition, mean channel belt width is directly related to water discharge at 2% exceedance flow event. This could imply that extreme flow events may contribute significantly to channel belt formation, more so than typical bankfull flow events (5–25% exceedance flows) based on threshold channel theory. Analyses presented here will aid improved interpretation of sedimentary deposits on Earth and other planets to infer past surface conditions.

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Tian Yang Dong, University of Texas at Austin, Geological Sciences, Austin, TX, United States and Timothy A Goudge, University of Texas at Austin, Department of Geological Sciences, Jackson School of Geosciences, Austin, TX, United States

Abstract Text:

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First Presenting Author
Presenting Author

Tian Yang Dong
Primary Email: tian.tyler.dong@gmail.com

Affiliation(s):

University of Texas at Austin
Geological Sciences
Austin TX 78713 (United States)

Second Author

Timothy A Goudge
Primary Email: tgoudge@jsg.utexas.edu

Affiliation(s):

University of Texas at Austin
Department of Geological Sciences, Jackson School of Geosciences
Austin TX 78713 (United States)

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