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External vs. Intrinsic Controls on Bimodal Fluvial Architecture in the Morrison and Wasatch Formations, eastern Utah and western Colorado

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ABSTRACT: Stratigraphy of alluvial basins is characterized by often rapid, if not abrupt, changes in density of channel-stacking patterns. Fluvial sequences tend to be very sandy, with densely stacked channel-belt deposits (>70% net:gross), or very muddy, dominated by floodplain deposits with a low density of channel-belt deposits (<40% net:gross), with relatively few sequences of intermediate density. Rapid vertical changes in stacking pattern are often interpreted to record similar rapid changes in boundary conditions acting on the basins, whether of tectonic, climatic or eustatic origin. Alternatively such rapid changes in stratigraphy may reflect critical thresholds crossed during monotonic changes in controlling parameters or other nonlinear responses of basin-filling processes.

In order to evaluate whether abrupt changes in stratigraphy correspond to coincident changes in boundary conditions, we examined two fluvial sequences in the southern Rocky Mountains that contain independent proxies of changing external controls. Characteristics of fluvial strata that are assumed to relate to extrinsic controls include: grain-size distributions, reconstructed paleohydraulics, sand-body size and geometry, as well as proxies for paleoclimate and source area. Units studied are the Morrison Formation (Upper Jurassic) in east-central Utah and the Wasatch Formation (Paleogene) west-central Colorado.

Results for the Morrison Formation show that, in the study area, the abrupt change in channel-stacking pattern was not coincident with any change in the channel deposits. Instead, the stratigraphic change took place regionally as the influx of volcanic ash into the study area gradually increased over time, suggesting a critical threshold response. In contrast, in the Wasatch Formation the onset of climate change during the Paleocene-Eocene Thermal Maximum (PETM) created a sudden and widespread change in both the channel-stacking pattern (from low-density to high-density) as well as several characteristics of the formative river channels. At the end of the PETM, however, the rivers channels immediately returned to their pre-PETM conditions, but the dense channel-stacking patterns persisted for a few tens of meters before abruptly changing back to the earlier, low-density, channel stacking pattern. This asymmetry of stratigraphic response indicates hysteresis likely controlled by feedbacks within the depositional system.

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