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Base-Level Buffers and Buttresses as a Proposed Control on Fluvial Valley-Fill Geometry and Facies

All alluvial river systems are constrained by buttresses (e.g., cataracts, lakes, tributary junctures, sea level, etc.) that locally dictate a base level elevation to which the river may not substantially cut below or aggrade above. Such rivers are also constrained by a range of discharge, substrate, and sediment-load factors that dictate a maximum and minimum stable gradient profile up dip of buttresses. These maximum and minimum profiles serve as buffers that constrain the range of likely incision and aggradation and, thus, potential unit thickness. The river(s) proper, however, may operate with variable degrees of autonomy from the buttress within these limits. If the buttress is mobile (e.g., a strandline/ bayline, etc.), the difference between minimum initial and maximum final gradient will limit preserved thickness.

Buffers and buttresses are applied here to explain geometry of fluvial valley-fill deposits of the Dakota Sandstone. Near the terminal regressive shoreline, abundant fluvial sand easily filled limited vertical space between the buffers, forcing the sediment to be stored laterally into a single-story sheet. Farther up dip limited buffer-zone thickness similarly forced lateral dispersal. Here, however, the thicker buffer zone resulted in a thicker sheet. Likewise, the thinner ambient channels underwent multiple and rapid incision/aggradation cycles that were likely climate, rather than sea level, driven. Sea level, thus, had little effect on individual channel incision events here, but may have controlled sheet geometry and incisional limits. Still farther up dip, limited sediment supply was insufficient to fill the buffer zone, and individual narrow and heterolithic valleys prevailed.