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## Heterolithic Hillslopes in Kansas Seem to Never Reach Equilibrium

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Many of the world's sedimentary basins feature layered sedimentary rocks with vertical differences in mineralogy, hardness and weathering rates. Landscapes formed in such heterolithic rocks often feature stepped hillslopes, where flatter and steeper sections alternate, resulting from different weathering rates of different lithologies. On occasion, the steeper sections have developed cliff faces where undermining from the underlying, faster weathering lithology causes the slower weathering lithology to collapse and break before developing its own regolith cover. As a result of undermining and collapsing, often unweathered (harder) blocks are found on top of weathered (softer) regolith, and these blocks can move downslope over time. The geomorphic dynamics and rates of change in these landscapes have been insufficiently explored and rarely dated. Specifically, the ability of multiple steps in hillslopes to delay a landscape's response to baselevel shifts and return to equilibrium remains unknown. Here, we present numerical modelling results as well as 20 cosmogenic exposure dates of cliff faces and blocks on hillslopes that detail key dynamics of a stepped landscape in the Flint Hills, part of the Great Plains sedimentary basin in Kansas in the United States. For modelling, we adapted a recently published 2-dimensional model that combines terms for hillslope diffusion and rock weathering with rules for hard rock break-up and movement through undermining. The model suggests that if hard-to-weather layers are sufficiently numerous, equilibrium at the top of the hillslope is elusive because of the long times needed to undermine hard layers until blocks break off. For exposure dating of our limestone cliffs and blocks, we used the cosmogenic nuclide Chlorine<sup>36</sup>. Dates suggest that almost all breaking of cliffs and movement of blocks happens during periglacial conditions in the LGM, despite anecdotal evidence of recent small movements of blocks.