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Formation of amphitheatre-headed canyons on Earth and Mars

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Amphitheatre-headed canyons are often thought to result from erosion by emerging spring water, or sapping. Observations of such valleys on Earth and Mars have led to the morphology-based interpretation that groundwater sapping is an important valley forming process. This interpretation has significant implications for Mars in particular because it has been used to constrain our understanding of Martian hydrology and the associated prospects for life. However, a mechanistic understanding of sapping erosion has only been demonstrated for granular media (i.e. sand). Many of the *sapping* valleys on Earth and (likely) Mars have been carved into bedrock, and the extension of previous work to bedrock erosion is unclear. To our knowledge, a process-based understanding of seepage erosion in bedrock does not exist, even though it is thought to be a first-order geomorphic process on Earth and Mars.

In order to address this knowledge gap, we are currently investigating Box Canyon, Idaho. Box Canyon, incised into the Snake River Plain, has many of the morphologic features often associated with sapping. In addition, it was carved into basaltic bedrock and has a large spring emanating from its amphitheatre-like head, making it an ideal candidate for a sapping origin and a Martian analog. We present first-order hydraulic measurements, sediment transport calculations, and field observations in an attempt to constrain the types of flows needed to carve Box Canyon. Sediment transport constraints indicate that spring discharges must have been significantly greater in the past if the canyon was carved by spring flow. Direct observation at the head of the canyon, however, has not yet indicated how sapping could be responsible for the erosion of the headwall. There is currently no overland flow contribution to the canyon, but, based on mapped bedrock scours, a paleo-flood from an unknown upslope source did enter

the canyon (and perhaps carved it). We are using various dating techniques to measure the rate of headwall migration in an attempt to decipher between a sapping and a flood origin.