Alluvial fan and source channel systems on Mars: fluvial timescales and ancient climate

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Alluvial fans on Mars, which are primarily sourced from erosional alcoves incised into crater rims, record a period of increased surface runoff which ended >1 Ga. However, we lack quantitative constraints on the frequency and duration of river-forming processes and the climatic conditions which accompanied these long-term habitable episodes. Here we use bedrock erosion and sediment transport models to show that cumulative time span of wet activity was between 100 yr – 1 Myr. We use Context Camera (CTX) digital elevation models to compile a dataset of > 200 channels upstream of depositional fans and determine key fluvial geometry metrics. Results from calculating Mars stream power parameters are compared to great escarpment channels on Earth and globally distributed terrestrial bedrock rivers. Although Martian channel profile morphologies fall within the range of those on Earth, they are slightly less concave-up and steeper for a given drainage area. Timescales depend strongly on poorly constrained variables such as erodability and grain size. Channel morphologies, intermittencies, spatial distributions, and orientations collectively suggest an arid climate and a source from snowmelt on steep crater rims, possibly from obliquity-paced insolation variations or orographic accumulation. Derived timescales are consistent with erosion rates and intermittencies observed on Earth and do not support short-lived or catastrophic sources, instead attesting to long-lived, recurring wet activity.