



## Retreat of a giant cataract in a martian outflow channel

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The circum-Chryse catastrophic outflow channels are the largest valley systems on Mars. Large-magnitude floods are widely considered to have eroded them primarily during the Hesperian epoch. Here we test the hypothesis that outflow channel erosion has been accomplished largely by upstream migration of large cataracts or knickpoints as a consequence of abrupt base-level changes. We describe the evolution of a ~600-m-deep tributary outflow channel to Ares Vallis, Mars. High-resolution topography, image analysis, and crater statistics indicate that this tributary canyon developed by the upstream migration of a large, ~300-m-tall cataract during multiple flood events that span ~1 Ga of Mars history (3.7 to 2.6 Ga). Issuing from Hydapsis Chaos, these floods were initiated at a similar time and occurred over a similar time range to flooding in Ares Vallis, suggesting a potential regional control on flood initiation and chaos formation. Additionally, we provide evidence that cataract retreat and significant incision within the tributary canyon occurred only after a series of down-cutting events within Ares Vallis. Topography data and crater statistics taken from the floor of Ares Vallis indicate a ~300 m base level drop that coincides temporally with an Early Amazonian (~2.6 Ga) flood event and cataract formation within the tributary canyon. The results both confirm the hypothesis of long-term, multiple flood events within martian outflow channels and demonstrate the influence of base-level change on their incision.