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Testing the multiple-flood hypothesis for Martian outflow channel erosion using high-resolution crater count statistics

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The circum-Chryse outflow channel systems of Mars are the largest known fluvial-eroded planetary landscapes in the Solar System, and are widely considered to have formed by catastrophic floods released from groundwater aquifers. Understanding their history of water discharge is important in reconstructing the global hydrological cycle on Mars, and in establishing the occurrence of putative oceans. Analysis of the geomorphology of outflow channels indicates evidence that channel erosion was achieved by multiple episodes of catastrophic flooding suggesting that abrupt release of water from subsurface aquifers occurred at repeated intervals but with lower discharges. Here we test this hypothesis by using crater count statistics to address the timing of erosion/resurfacing events in proximal Ares Vallis and the Iani Chaos region. In this study, Mars Reconnaissance Orbiter Context Camera (CTX) images at 6 m/pixel were obtained from specific outflow surfaces associated with the Ares Vallis system. These surfaces were identified from morphologic and topographic relationships determined from High Resolution Stereo Camera (HRSC) images and derived HRSC DTMs. For the first time, impact craters > 100 m in diameter were identified and counted over the entire coverage area of CTX on specific terraced flood surfaces in proximal Ares Vallis. Size-frequency relationships of small and large impact craters on these surfaces were used to identify periods of erosive scour and crater destruction associated with outflow events. We assume that all outflows at Ares Vallis were capable of destroying pre-flood impact craters below a critical diameter. Preliminary data presented on cumulative frequency plots suggests an initial episode of crater destruction at 3.0 – 3.4 Gy for craters < 1 km in diameter for all surfaces. This is indicated by a sudden decrease in slope of the cumulative frequency curve from established crater production curves (Hartmann and Neukum, 2001). At crater diameters < 600 m the production function is re-established along the 1.0 – 1.4 Gy isochron for the topographically lowest terraced surfaces in Ares Vallis. This indicates an extensive period (Late Hesperian to Middle Amazonian) of crater destruction in the main channel of proximal Ares Vallis and is consistent with morphologic and topographic evidence for multiple flooding events.