



Estimating formative conditions of Holden Northeast fan, Mars

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The recently discovered deposits of a channelized fan located northeast of Holden Crater preserve a history of vertical and lateral accretion and avulsion of many channels, indicating water flowed freely across the surface of the fan during its construction. These sedimentary deposits, however, do not unambiguously discriminate between a deltaic or purely riverine origin for the feature. We quantitatively assess the evidence for water recorded by the sedimentary deposits at Holden NE Crater, using data from Mars Orbiter Laser Altimeter (MOLA), Thermal Emission Imaging System (Themis) and Mars Orbiter Camera (MOC). In particular, we use a numerical model of riverine (i.e. alluvial) fan construction [Parker et al., *J. Hydraul. Eng.*, 124, 985-995, 1998] to invert topographic and volumetric data from MOLA, producing an estimate of the time required to build the fan out of channel and overbank deposits. This analysis provides a minimum estimate of formation time, as there is no way to assess how frequently the fan was active. We estimate a minimum formation time of 50 terrestrial years, corresponding to a fluid discharge of 410 m³ and a total fluid volume equal to 900 km³. These modest values imply that fan formation did not require precipitation if a local source of water was present. If the martian soil contained significant water ice, groundwater could have been delivered to the surface by heat generated from the impact formation of nearby Holden Crater to the south.