

Global Spatial Distribution of Hack's Law Exponent on Mars and its Early Climate

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Abstract

Widespread valley networks (VNs) on Mars and other evidence point to an early warm and wet climate. However, ongoing debates still exist about VN's formation processes and associated climatic conditions. The power law relationship between basin length and area (Hack's Law) can be diagnostic of different fluvial processes related to climatic conditions. Past studies of Hack's Law on Mars at local sites have produced inconclusive results. Here we used a parameter-free method to delineate watersheds globally on Mars based on mapped VNs and extracted their Hack's Law exponent (h). The majority of h values on Mars are similar to those in arid areas on Earth, implying similar runoff processes and arid conditions for VN formation on early Mars. Statistical analyses show that the spatial distribution of h on Mars is not random, but with a few clustered high and low values, likely controlled by local conditions (e.g., slope or structures).

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