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Late Noachian Fluvial Erosion on Mars: Cumulative Water Volumes Required to Carve the Valley Networks and Grain Size of Bed-Sediment

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Abstract

Our goal is to quantify the cumulative water volume that was required to carve the Late Noachian valley networks on Mars. We employ an improved methodology in which fluid/sediment flux ratios are based on empirical data, not assumed. We use a large quantity of data from terrestrial rivers to assess the variability of actual fluid/sediment flux sediment ratios. We find the flow depth by using an empirical relationship to estimate the fluid flux from the estimated channel width, and then using estimated grain sizes (theoretical sediment grain size predictions and comparison with observations by the *Curiosity* rover) to find the flow depth to which the resulting fluid flux corresponds. Assuming that the valley networks contained alluvial bed rivers, we find, from their current slopes and widths, that the onset of suspended transport occurs near the sand-gravel boundary. Thus, any bed sediment must have been fine gravel or coarser, whereas fine sediment would be carried downstream. Subsequent to the cessation of fluvial activity, aeolian processes have partially redistributed fine-grain particles in the valleys, often forming dunes. It seems likely that the dominant bed sediment size was near the threshold for suspension, and assuming that this was the case could make our final results underestimates, which is the same tendency that our other assumptions have. Making this assumption, we find a global equivalent layer (GEL) of 3 – 100 m of water to be the most probable cumulative volume that passed through the valley networks. This value is similar to the ~34 m water GEL currently on the surface and in the near-surface in the form of ice. Note that the amount of water required to carve the valley networks could represent the same water recycled through a surface valley network hydrological system many times in separate or continuous precipitation/runoff/collection/evaporation/precipitation cycles.

Keywords: Mars, climate, Late Noachian, valley networks, hydrology, water volume

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