Using computer simulation to understand the Martian valley network formation and modification processes and resulting basin morphometric characteristics

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The origin of the Martian valley networks has been debated since their discovery. Two main alternative hypotheses exist: (1) they were eroded by emerging groundwater or groundwater sapping, which could form under cold climate; (2) they were formed by erosion from rainfall and runoff process, similar to what happens on Earth. Evidences for both hypotheses have been observed. These two views have very important climatic, geologic and exobiologic implications for early Mars. Our previous comparative morphometric analysis of Martian, terrestrial and lunar basins showed a spatial pattern of fluvial-like basins clustered around main stream in the lower elevation in Margaritifer Sinus region. This pattern is consistent with a dry climate punctuated with episodes of wet periods, possibly triggered by large impact cratering or optimum orbital condition. In this paper, we will use a computer model to simulate the roles of different processes (such as rainfall runoff, groundwater sapping, impact cratering and eolian fill) in forming and modifying the Martian valley networks. Our initial results show that the basin scale quantitative morphometric characteristics of the simulated landscape dominated by surface runoff can be statistically separated from those dominated by groundwater sapping. We will run different scenarios of simulations and compare the quantitative morphometric parameters of simulated landscape (which we know the processes) with those of the observed Martian landscape based on MOLA DEM data to infer and evaluate the relative importance of groundwater sapping vs. rainfall runoff and other modification processes in forming the observed Martian valley network landform.