Global mapping and morphometric analysis of valley networks on Mars using THEMIS, MOLA, and MDIM data

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Formation of a valley network on the surface of Mars is still a matter of debate, although the first description was made in back to 1972 based on Mariner images. Striking similarities exist in morphological characteristics between river channels on Earth and valley networks on Mars, however, formational processes proposed include such as groundwater sapping and mass-wasting. High-resolution datasets recently obtained, such as Mars Orbiter Laser Altimeter (MOLA), Mars Digital Image Model (MDIM), and the Thermal Emission Imaging System (THEMIS), are now available to study the global distributions of valley networks, which would give new insight into their formation processes. In this study, I integrated these three datasets on GIS software and geologically mapped valley networks globally at the maximum image resolution of ˜200 m/pixel, which resulted in identifying 8,331 units of valleys on the entire surface of Mars. Because of the higher resolution and wider areal coverage of the datasets that I use, the number of valley networks identified is far more than those previously studied. Both the drainage densities and the fractal dimensions are calculated at selected 13 and 33 areas, respectively, based on the mapping results. Importantly, I found that the valley network could be categorized into two subtypes, such as (1) a valley network with low fractal dimension, which typically has a long main-stream with few tributaries, and (2) a valley network with high fractal dimension, which is usually a network confined within a narrower area and often associated with complex, multiply-branched patterns of tributaries. The global distribution of valley networks is not homogeneous: Most valley networks are identified in a narrow band, which overpasses Hellas Planitia and Argyre Planitia and south of the Tharsis rise. I compared the global distributions, as well as those of the two subsets determined by fractal dimensions, with several types of global maps including optical image, water abundances, free-air gravity, magnetic field, and RMS slope. No obvious correlations have been found except for a slight correlation with the magnetic field, which may be reasonable because no formational processes would have been active after the valley formations in Noachian.