MAPPING VALLEY NETWORKS IN THE NOACHIAN TERRAIN AROUND NAKTONG VALLIS, MARS: TOPOGRAPHIC CONTROL ON DRAINAGE DENSITY.

Yumu Yamaguchi[1]; Hideaki Miyamoto[2]

[1] Space and Planetary, Tokyo Univ.; [2] The University Museum, Univ. Tokyo

Most of the cratered uplands of Mars are dissected by networks of valleys, whose evolutionary histories are still controversial. The valleys show branching patterns closely analogous to terrestrial fluvial valleys, which may indicate that the valleys were cut primarily by surface runoff after precipitation. However, short, stubby tributaries and amphitheater heads of valleys may favor another hypothesis, where the valleys were cut by groundwater emerging from below a thick cryosphere. In addition, other researchers suggested mass wasting aided by the presence of groundwater at shallow depths mainly formed valley networks.

In order to precisely understand the shapes of the valley networks, we geologically map the valley networks in the Noachian cratered upland, using THEMIS-IR daytime images (100 m/pix), the Viking MDIM 2.1 (231 m/pix) and the MOLA topography (about 300 m/pix). The criteria we used for our mapping are: (1) A valley is a generally linear-shaped depression, which is traceable with its shadow; (2) a valley has an observable U- or V-shaped cross section, which is necessary to eliminate cliffs; (3) the length of a valley is at least twice its width, which is used to avoid mapping horizontally-short depressions; and (4) the valley length is longer than 5 km, which is required to exclude bumpy areas.

The study area of this work is the northeast part of the boundary area between Arabia Terra and Terra Sabaea. The area includes 10 major valley networks, including Cusus Valles, Locras Valles, Naktong Vallis, and Verde Vallis. We identify more than 5000 individual valley segments, whose total length is about 36,000 km. We identify a significantly larger number of valleys in the same region than previous studies due to the better resolution of data. The drainage areas range from 10,000 to 120,000 km2, which are relatively larger compared with those obtained by a previous study.

The drainage densities estimated in this study are almost comparable to terrestrial drainage networks. We also find that a positive correlation exists between the drainage densities and the mean slopes of drainage areas. The systematic increase in the drainage density with respect to the increase in mean slope suggests that the maturity of valley networks depends largely on the local slope. This indicates that local water sources for the formation of valley networks are unlikely. On the contrary, if the water is supplied by precipitation at much the same rate, the mean slope of the precipitated area generally controlled the velocity of the resultant surface runoff, which largely influences the efficiency of erosion and eventually determines the maturity of the drainage density. Therefore, we suggest that the most likely source of water for the formation of valley networks in the study area is precipitation. Also, hypotheses which suggest that the valley networks were formed by groundwater have difficulty in explaining the strong correlation between mean slopes and drainage densities, because the hydraulic head does not necessarily depend on the mean slope.

We cannot exclude the possibility that the correlation between drainage densities and mean slopes indicates that valleys were degraded after fluvial activity corresponding to topographic relief, and we cannot discuss the origin of the valley networks based purely on this correlation. Nevertheless, the morphological drainage patterns apparently differ depending on the slopes. The valley network, which has the lowest drainage density and the shallowest slope consists of several main trunk valleys and many short tributaries, whereas the other network, which has the highest drainage density and the steepest slope, shows less clear distinction of main trunk valleys from tributaries. This morphological tendency is consistent with the hypothesis that the slope controls the evolutions of valley networks, which supports that precipitation-fed surface runoff eroded the valley networks.