

Did it Rain on Mars? Analysis of Valley Networks on Mars in an Intro Geo Course

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Background

- Evidence for dendritic valley networks has begged the question of whether it might have rained early in Mars history.
- One of the ways of deciding whether ancient Mars valley networks might have been produced by rainfall is to find out how similar they are to valley networks on Earth, which we know are produced by rainfall. The standard method for analyzing drainage basins is comparison of the number of drainage segments per square kilometer (drainage density) and how extensively branched the network is (stream order).
- Carr (1995) and Carr and Chuang (1997) published drainage basin analyses of valley networks on Mars in the mid 1990s using the best resolution Viking MDIMs available at the time, and they concluded that Mars valleys networks had lower stream orders and drainage densities than arid regions on Earth.
- In 2003, Hynek and Phillips published results of drainage basin analyses using higher resolution MOC images plus MOLA elevation data, and they concluded that drainage densities and stream orders, in fact, overlap values for drainage networks in the more arid rain-fed areas on Earth.

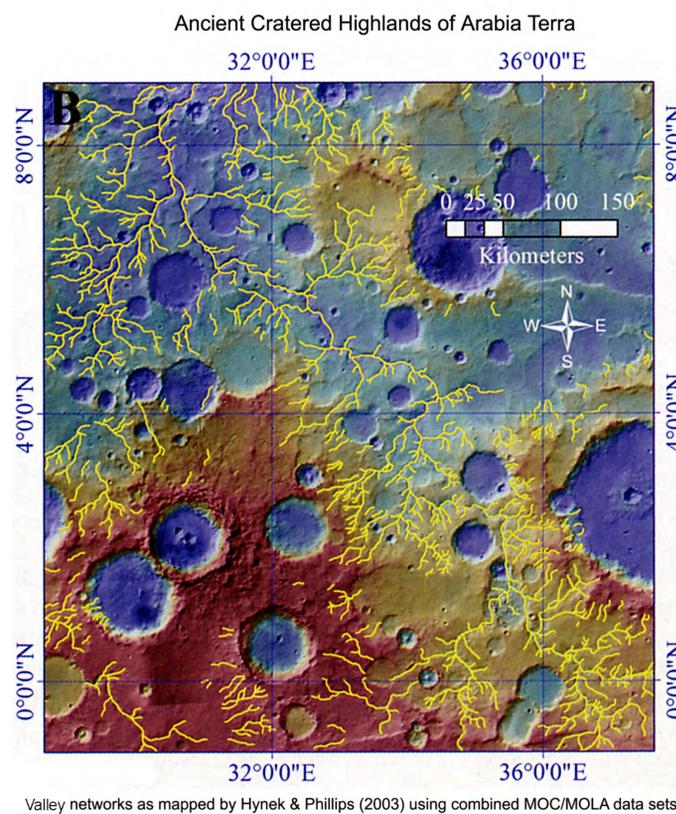
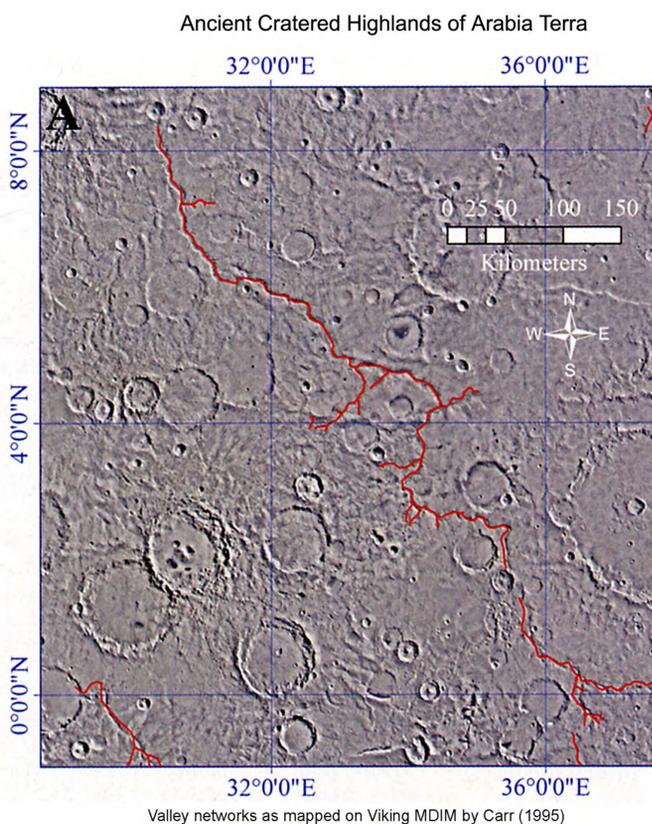
What Students Need to Know

This activity assumes virtually no prior knowledge on the part of students. The instructor can easily provide appropriate background in class on the Viking mission, on MOC images, and on MOLA data.

The Opportunity

- Adapting Hynek and Phillips' study makes a simple short exercise for students in an intro geo course or a geomorph course.
- Students have the opportunity to test a fascinating question with a simple technique used by geomorphologists.
- The activity also provides students with the opportunity to test an older published hypothesis with new data, which is a valuable and illuminating experience for students.
- This exercise can easily be completed in one 50-minute class period.
- To be honest, I never expected to use the technique of drainage basin analysis again after I took a geomorphology course in 1970!

The Activity



Comments & Suggestions

- After setting the stage with an introduction to the problem plus basic information on Viking, MOC, and MOLA data sets, students do the following:
 - Students put a piece of overhead transparency film over each image (if the images are 8.5x11) or a piece of shrink wrap plastic film (if the images are larger than 8.5x11 – this film is available in craft stores in rolls up to 60" wide and is *very* useful for mapping on large images and can be written on with overhead pens).
 - Students determine stream order for every valley segment in each image, writing the stream order for each directly on the transparencies.
 - Students then compare maximum stream order determined using the higher resolution MOC/MOLA data with that determined using the Viking data and with typical values for terrestrial streams.

- I then provide students with data (from Hynek and Phillips, 2003) on drainage basin area and on total valley segment length for both images.
 - Students calculate drainage densities for both images and compare the values with those for a variety of rainfall regions on Earth (from Carr and Chuang, 1997).
 - Students then combine what they have learned about stream order and drainage densities and re-evaluate the Viking-era view that Mars valley networks are low order, poorly integrated, and most consistent with groundwater sapping.
 - We then discuss various interpretations of the data.

Carr, M.H., 1995, The Martian drainage system and the origin of valley networks and fretted channels: *Journal of Geophysical Research*, v. 100, p. 7479-7507.
Carr, M.H. and Chuang, F.C., 1997, Martian drainage densities: *Journal of Geophysical Research*, v. 102, p. 9145-9152.
Hynek, Brian M. and Phillips, Roger J., 2003, New data reveal mature, integrated drainage systems on Mars indicative of past precipitation: *Geology*, v. 31, no. 9, p. 757-760.