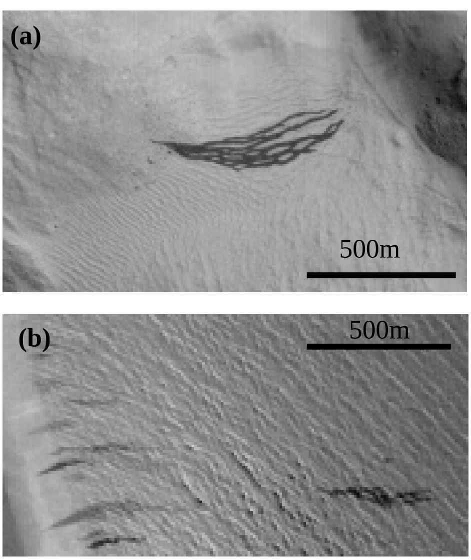
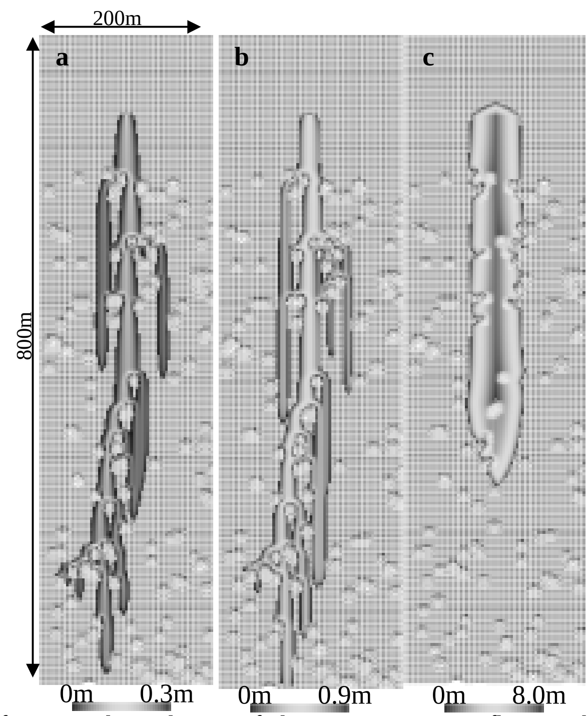
Rheological properties of slope streaks on Mars

H. Miyamoto[1,2], J. Dohm[3], R. Beyer[1], and V. Baker[3]
[1]Lunar Planetary Laboratory, University of Arizona; [2]Department of Geosystem Engineering, University of Tokyo, [3]Department of Hydrology and Water Resources, University of Arizona

Slope streaks have formed during the Mars Global Surveyor mission marking geologic activity at the Martian surface. As such, their origin is not without significance. Here, we present results from numerical modeling to help explain flow-like, morphologic characteristics, which include branching and anastomosing patterns influenced by local small topographic barriers. With a photoclinometric technique to estimate their sizes, numerical simulations of slow-moving plastic flows show that a fluid rheology and a short formation period are necessary to explain these features. We estimate that the typical values of a bulk viscosity and a bulk yield strength are less than 10 Pa s and less than 10 Pa, respectively (less than 1Pa s and 1Pa are more likely). The fluidity may be attributed to water-related flow with the solid content less than 20%, but a dry grain flow with extremely low cohesion and friction angle supported by dispersive pressure or lubricant such as atmosphere or subsurface discharge of gas is also possible. The continuous features of slope streaks from point sources are more easily explained by continuous discharges of material or lubricant. In this case, the estimated flow rate is less than several m3/s and the flow duration estimated to be less than 1day.



Slope streaks with distinct anastomosing patterns observed in MOC images: (a) M16-00596 and (b) M10-00967.



Results of numerical simulations of slow-moving viscous flows with different rheological properties: (a) yield strength is 1Pa and viscosity is 1Pa s; (b) yield strength is 10^2 Pa and viscosity is 10^2 Pa s; and (c) yield strength is 10^4 Pa and viscosity is 10^4 Pa s. Color represents depth. Flows are supplied on a 10 degree slope with 150 small mounds (3m height 20m diameter) that are randomly distributed. Flow rate is fixed for six case at 4 m^3/s. Bifurcation does not occur on c because the higher rheological property values make the flow thickness deep enough to cover small mounds. Note that color represents depth of the flow.