ICE IN THE MID-LATITUDES OF MARS: AN INITIAL STUDY OF ICE DYNAMICS. J. K. Serla[1], P. R. Christensen[1] and A. Grau Galofre[1], 201 E. Orange Mall, Mars Space Flight Facility, School of Earth and Space Exploration, Arizona State University, Tempe, Arizona 85281, United States of America; primary contact email: jserla@mars.asu.edu.

Introduction: Landforms characterized by gentle slopes, convex upward profiles with relatively steep edges, and radial and concentric ridge-and-furrow lineation have been observed in the 30°–60° latitude bands in both hemispheres since the Viking orbiter days. The distinct morphology that is representative of viscous flow and the strong latitudinal dependence in their occurrence were hypothesized to be due to the presence of ice in these landforms. The landforms were proposed to be viscous flow features (VVF) and termed lobate debris aprons (LDA). Two other viscous flow features were also identified in the 30°–60° latitude bands – lineated valley fills (LVF) and concentric crater fills (CCF).

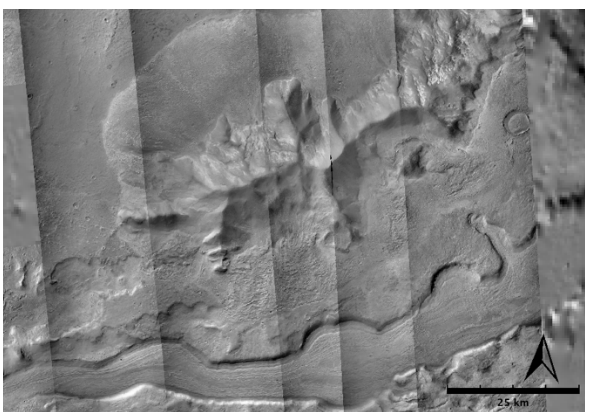

Figure 1: Lobate debris aprons and lineated valley fill. The image centered at 104.426° E and 41.75° S is a series of overlapping CTX images of the northeastern flank of the Hellas basin.

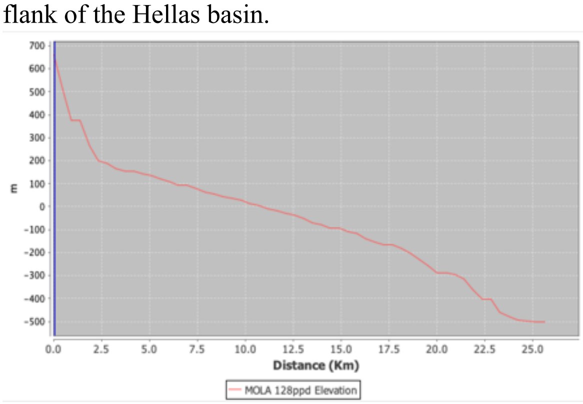

Figure 2: Mars Orbiter Laser Altimeter (MOLA) profile of the LDA in the above image showing gentle slopes, convex upward profiles with relatively steep edges.

Even though ice has been hypothesized to have played a major role in the formation of these landforms, the volume fraction of ice has been debated since they were first observed. Based on the morphology of the landforms, seminal work favored a rock glacier hypothesis with minor amounts of interstitial ice [1][2][3]. According to this hypothesis, when surface ice deposits are covered in debris, the ice enables cementation of the debris forming rock glaciers. These rock glaciers propagate by creep of interstitial ice.

Recent geophysical surveys using Shallow Radar (SHARAD) data favor a debris-covered glacier hypothesis [4][5]. According to this hypothesis, attenuation of radar signal and a lack of multiple reflections from the subsurface are indicative of massive (lacking interfaces) low-loss material deposits. The dielectric constant of the underlying material modeled based on radar data matches that of water ice and other low-loss materials like volcanic ash. Again, based on morphological evidence and latitudinal dependence of the landforms, the hypothesis favors water ice as the more likely material. The propagation of the landforms in this case is due to creep of ice.

Our long-term objective is to develop a physics-based model to understand and describe the ice dynamics of each of the VVF landforms on Mars. We intend to quantitatively characterize the similarities and differences between each of the landforms and present a holistic hypothesis taking into consideration the emplacement and evolution of ice in the mid-latitudes; including ice-atmosphere interactions, climatic forcing, and thermophysical properties of the debris mantle.

Objective: As a start, for this conference our primary focus is going to be on characterizing the ice dynamics of LDA landforms. We intend to develop a physics based zero-order ice dynamics model incorporating the theoretical framework of terrestrial glaciology. We will then apply this model to LDA landforms on Mars using comparative planetology assuming the LDA landforms to be debris-covered glaciers.

The goal of this work will be to model the ice flow of at least one LDA landform. We will describe the mass balance and assess the flow mechanisms to attempt to reproduce the observed morphology and flow profile. We will also attempt to discuss the effects of impurities (such as dust) in the ice on the ice dynamics.

Preliminary considerations: LDAs are likely cold-based ice bodies (i.e., the basal ice layers are frozen) that deform and flow visco-plastically under their own weight on very long timescales. The presence of dust in the icy matrix likely affects ice rheology [6], which will lead to a different equilibrium profile and form to that of a terrestrial cold-based glacial body. Modelling is required to assess the details of ice deformation and dynamics under the cold Martian temperatures, lower gravity values, and dusty ice

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References:

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