Ice-driven degradation styles on Mars: a numerical approach

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Both liquid water and water ice likely have played significant roles in shaping Martian landscapes: specifically landforms and deposits including those interpreted to result from fluvial, lacustrine, periglacial, glacial processes. Recent spacecraft observations reveal that the Martian mid-latitudes are most likely zones where the effects of ice on the surface geology are prominent and representative of geologically young periods of volatile-driven activity. As such, geomorphic features indicative of ice-flow on this zone are currently an area of intense study in the planetary community. Among the most prominent of these features are lobate debris aprons, lineated valley fill, and concentric crater fill, which are found in the fretted terrain of the northern hemisphere and in areas surrounding the Argyre and Hellas impact basins in the southern hemisphere.

In order to examine the generation, flow behavior, and physical properties of postulated Martian ice-driven flow features, we are developing and testing a new numerical simulation codes developed for a suite of viscous flow types, including putative ice flows on Europa (Miyamoto, et al., in revision). The approach is to employ a depth-averaged two-dimensional model to explore how simulated Martian flows respond to a 3-dimensional Martian surface. Our model is based on the growing body of experimental and theoretical results (e.g., Durham et al., 1992, 1997; Goldsby and Kohlstedt, 2001), and thus we are evaluating how flow rheology relates to such factors as ice content, ice and dust particle sizes, and internal structure. An advantage of this approach is that a prescribed surface is naturally combined into the model as a boundary condition to give slope information for the kinematic model of the flow. This is particularly important when the flow material is not well understood, since the response of the flow to topography (i.e., confinement, obstacles, change in slope) will provide additional information on the flow rheology (Miyamoto and Papp, 2004). By closely reproducing observed planform shapes and responses to underlying slope and topographic obstacles from a series of Martian case studies, we will discuss about the flow initiation (via failure or accumulation of ice), flow rheologies, and emplacement rates of possible ice flows which contributed to form these features.