Introduction

Eskers are sinuous sedimentary ridges that are widespread across formerly glaciated landscapes on Earth [Figure 1], [e.g., 1]. They form when sediment in subglacial tunnels is deposited by meltwater, and are exposed when ice retreats.

Some sinuous ridges on Mars have been identified as eskers; some are thought to have formed early in Mars’ history beneath more extensive ice sheets [e.g., 2], but smaller, younger systems (Figure 2) associated with extant glaciers in Mars’ mid latitudes have also been identified [3, 4].

Elevated geothermal heating and formation during periods with more extensive glaciation have been suggested as possible prerequisites for esker deposition [3, 4]. Numerical modeling [5, 6] also supports geothermal heating as a possible cause of the area of assumed liquid water beneath Mars’ south polar ice cap [7].

Methods

Here, we adapt [9] with [10] to simulate possible Martian subglacial lake drainage experiments. This allows sediment deposition over longer lengths of tunnel, and to greater mean depths, than for terrestrial systems.

Future work will use measured bed topography of a mid-latitude esker to assess the impact of topography on deposition patterns and esker morphology. We will also expand the range of discharge regimes investigated by adapting a model of Antarctic subglacial lake drainage [10] to simulate possible Martian subglacial lake drainage events driven by subglacial geothermal events of the type postulated as a possible cause of the inferred liquid beneath Mars’ South Polar Ice Cap [7].

Results (continued)

This effect is borne out by the variable discharge experiments. Figure 4 A,B (Earth g) show relatively rapid tunnel closure after peak discharge, with conduit enlargement confined to the distal ~ 8–10 km of the tunnel (as in Figure 3). Sedimentation is confined to the last ~ 2 km of the tunnel as water flow power stays high due to conduit closure even as discharge falls.

By contrast, Figure 4 C,D (Mars g) shows much slower conduit closure after peak discharge, the conduit is enlarged over most of the model domain (and especially in the last ~ 10 km, as in Figure 3). Sedimentation occurs ~ 10 km upstream of the tunnel mouth as flow power is lower, and begins earlier due to the larger tunnel size.

Conclusions and Future Work

Our results suggest that esker formation within a subglacial meltwater tunnel would be more likely on Mars than Earth, primarily because subglacial tunnels tend to be larger for equivalent water discharges, with consequent lower water flow velocities. This allows sediment deposition over longer lengths of tunnel, and to greater mean depths, than for terrestrial systems.

Future work will use measured bed topography of a mid-latitude esker to assess the impact of topography on deposition patterns and esker morphology. We will also expand the range of discharge regimes investigated by adapting a model of Antarctic subglacial lake drainage [10] to simulate possible Martian subglacial lake drainage events driven by subglacial geothermal events of the type postulated as a possible cause of the inferred liquid beneath Mars’ South Polar Ice Cap [7].

References: