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1. Introduction: Mars is a cold hyper-arid planet where liquid water is extremely rare [1]. Most water is instead locked in a number of frozen reservoirs such as the polar caps, latitude-dependent near surface ground ice and as glacier ice. Previously, numerous studies reported on glacier landforms such as viscous flow features and lobate debris aprons where water-ice is believed to be present under insulating debris cover [2]. This notion was confirmed by SHARAD measurements [3]. However, very little is known about glacial landforms in which water is an important factor. Most studies have focused on moraine-like ridges that are associated to gully systems in crater environments [4], glacier landforms at the equatorial volcanic province [5] and drop-moraines from CO$_2$ glaciers [6]. Here we report on unusual irregular ring-shaped landforms within a mountain complex in Nereidum Montes, Mars. These landforms are well-preserved and may suggest recent ablation of a debris-covered, cold-based glacier. These martian ring-shaped moraine-like landforms show a striking resemblance to the Veiki moraine in northern Sweden. The Veiki moraines are believed to have formed at the lobate margins of a stagnant ice-sheet during the first Weichselian glaciation [7].

2. Data and Methods: For our study we use HiRISE (25 cm/pixel), CTX (6 m/pixel), MOLA topography and point data. CTX images have been processed using ISIS 3.0. The terrestrial analogues are covered by LiDAR. The LiDAR data have a point density between 0.5 to 1.0 points/m$^2$, with a footprint of 0.5 m and a scan angle of 20°. Accuracy of the z-axis is typically better than 0.1 m on flat surfaces. Field work is planned for 2017 and a forthcoming HiRISE DTM will allow for more detailed analysis of the martian landforms.

3. Observations: The martian moraine-like landforms (MLL’s) are located at the end of a valley that are open in the eastward direction. In plan form the overall morphology has a distinct lobe shape (Fig. 1 A) and covers an area of approximately 80 km$^2$. Individual MLL’s form irregular opened and enclosed ridges (Fig. 1B). By shadow measurements ridges are calculated to be 10-15 m in height. Ridges show a high concentration of boulders and clasts (Fig. 1 C). The outer lobe perimeter is mainly made up of fractured mounds. The Veiki moraines in northern Sweden show a similar irregularity of landforms forming ridged plateaus and enclosed depressions (Fig. 1D).

4. Discussion: The MLL’s are located in close spatial proximity to other landforms similar in morphology to pronival rampart glaciers and cirque glaciers. The topography around the MLL’s shows features that show similarities to roche moutonnées, bergschrunds (crevasses at the head of a glacier), arêtes, cols (saddle-like narrow depression formed by two head ward eroding cirques that reduce an arête) and cirques. If these interpretations are correct it shows an area with clear evidence of possibly current and former presence of glacier ice.
of glaciation, including possibly preserved glacier ice and glacial landforms. This include landforms strikingly similar to the Veiki moraines of northern Sweden. A better understanding of these features may provide important insight into martian geologic and climatic history. This project is on-going and more work is needed to gain a better understanding of the sequential evolution of glacial landforms in this area.

5. Summary: We have identified an area in the Nereidum Montes region that shows clear evidence of glaciation, including possibly preserved glacier ice and glacial landforms. This include landforms strikingly similar to the Veiki moraines of northern Sweden. A better understanding of these features may provide important insight into martian geologic and climatic history. This project is on-going and more work is needed to gain a better understanding of the sequential evolution of glacial landforms in this area.

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