POSSIBLE RECESSIONAL MORAINES IN THE NILOSYRTIS MENSAE REGION, MARS. A. Johnsson[1], J. Raack[2], E. Hauber[3]. [1]Department of Earth Sciences, University of Gothenburg, Gothenburg, Sweden (andreasj@gvc.gu.se), [2]Institut für Planetologie, Westfälische Wilhelms-Universität, Münster, Germany. [3]Institut für Planetenforschung, Deutsches Zentrum für Luft- und Raumfahrt (DLR), Berlin, Germany.

Introduction: Previously, numerous studies reported on glacier landforms on Mars such as viscous flow features (VVF) [1], glacier-like flows (GLF) [2] and lobate debris aprons (LDA) [3] where water-ice is believed to be present under insulating debris cover [1]. This notion was confirmed by SHARAD measurements [4]. In terms of possible glacial erosional and depositional landforms most studies have focused on small-scale moraine-like ridges that are associated to gully systems in interior crater environments [e.g., 5], large-scale glacier landforms at the equatorial volcanic province [e.g., 6], landforms suggesting basal glacial meltwater processes [7,8] and possible drop-moraines from past CO_2 glaciers [9].

In this study we surveyed an area that border areas of known VVF's and GLF's along the dichotomy. The motivation was to search for landforms that may provide new insight into glacial and climatic conditions in Mars recent history.

Here we report on preliminary results of possible glacial erosional and depositional landforms associated with several valley systems in the Nilosyrtis Mensae region (Fig. 2). Observed landforms include possible truncated spurs and lobate small-scale ridges associated with valley entries. The latter is interpreted as possible well-preserved recessional moraines which may provide insight into past climate and glacial dynamics such as volume loss, maximum extents and cycles of glacial retreat. The lobate small-scale ridges show similarities to drop moraines in the Dry Valleys, Antarctica (Fig. 1).

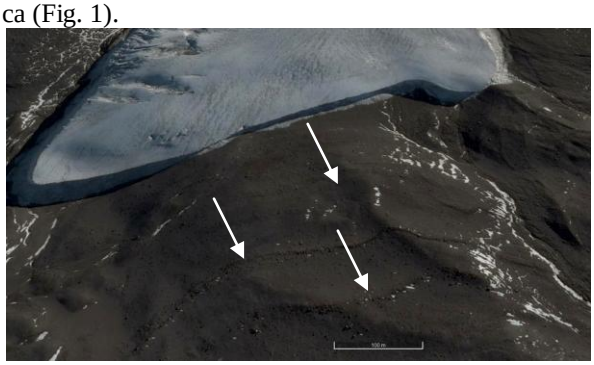

Figure 1. Stocking glacier, Antarctica. White arrows point to a sequence of drop moraines separated by ~100 m [10]. Credit: CNES/Airbus.

Data and methods: For our study we used Context Camera Images CTX (6 m/pxl) and MOLA topography. The study will greatly benefit from future HiRISE images (0.25m/pxl) but to date no such coverage is available of the studied landforms. For Earth comparison we used publicly available Google Earth images.

Observations and results: The area is dominated by fretted terrain, mesas, cliffs and flat floored valleys. The studied north-facing cliff range is ~250 km long and are a few hundred to a more than a thousand meters in height. The cliff is characterized by deeply incised valley systems. Here we report observations from two valleys.

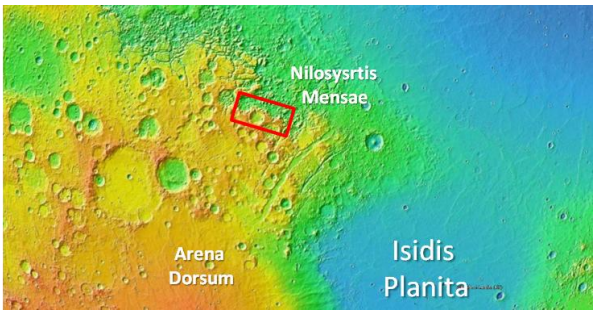

Figure 2. Location of study region in Nilosyrtis Mensae (red box). MOLA elevation from Google Earth.

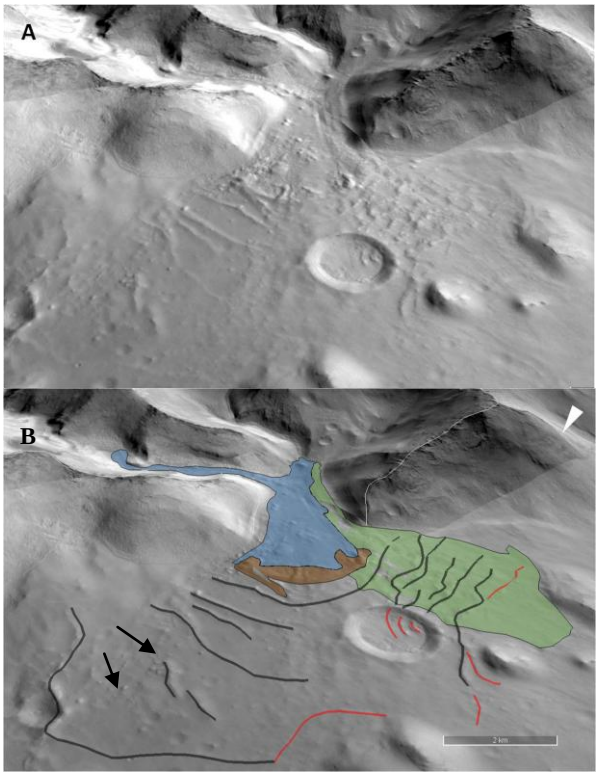

Figure 3. A) Perspective view of VS1 from Google Earth CTX mosaic. B) Same area overlaid by preliminary mapping.

The lobate moraine-like landform (brown). Remnant knobby terrain (blue). Lateral knobby terrain (green). Small-scale ridges (black lines). Possible ridges (red). Aligned hills/boulders (black arrow).Scale bar is 2 km.

Valley system 1 (VS1): consists of three connecting tributary valleys with a total catchment of ~220 km^2. The largest valley are associated with two small cirques that contains VFF remnants. In the upper section of the valley a small tongue of VVF residue is still present. The other two connecting valleys are alcove shaped depressions similar to terrestrial niche glaciers. The outlet valley contains deposits that terminate in a lobate feature similar to a terrestrial terminal moraine. The moraine-like feature are followed by a sequence of radial small-scale ridges separated by a few hundred meters (Fig. 3). These ridges show a striking resemblance to moraines associated with glaciers in the dry valleys. Located in between the ridges are aligned small-scale hills or large boulders.

Valley system 2 (VS2): consists of a main valley and three alcove-shaped tributary valleys with a total catchment of ~250 km^2. Like VS1 this system has remnant VVF on the valley floors and VS2 display similar lobate features and ridges that radially extend outwards from the outlet valley (Fig. 4). The main valley also display features that closely resemble terrestrial truncated spurs.

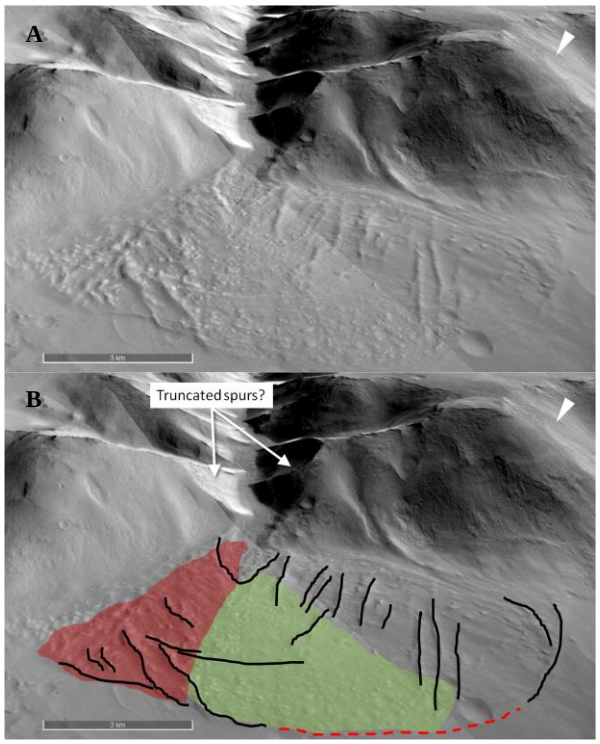

Figure 4. A) Entrance to VS2. Perspective view from Google Earth CTX mosaic. B)Preliminary mapping showing knobby/hummocky terrain (green). Wrinkled terrain (red). Small-scale ridges (black lines). Possible ridge (dashed red line). Scale bar is 3km.

Discussion and preliminary conclusions: Here we report on a number of landforms that may provide insight into Late Amazonian deglaciation in the Nilosyrtis region. Although the true nature of the small-scale ridges are difficult to decipher from CTX imagery alone, the physical context in which they occur may suggest a glacial erosional/depositional system. The truncated spur-like features may suggest significant erosion of previous valley topography. The main glaciers would have been fed by a number of tributary valleys and niche glaciers. The larger lobate moraine-like remnants at valley entrances may represent the last stage before glacier-like flow ceased. The succession of small-scale ridges radiating out from the valley system entrances are interpreted as possible recessional moraines. The spacing between ridges of the three valley systems are within the range of 400-800 m and may show a cycle of retreat and standstills of these past glaciers.

The two valley systems reported here display topography and geomorphology that are in plan-view consistent with past glacial erosion and deposition. Interestingly they all contain landforms rarely observed on Mars in the form of a succession of ridges. If the interpretation of these ridges are correct then they may be used as proxies for past glacial extents and ice-volumes. The succession of ridges may potentially contain a climate signal of relatively rapid glacial retreat and periods of glacial standstills. Based on the available data it is impossible to determine whether these past glaciers were warm or cold based. The observed aligned small-scale hills/boulders may suggest at least localized basal sliding. However more work is needed for a more complete reconstruction and understanding of climate and possible glacial history in this area. The study area currently lack coverage by HiRISE (25 cm/pxl) that may give better clues about the geomorphology than at present. Future work will include HiWish for selected sites and DTM's

References: [1] Milliken et al., 2003. JGR-Planets (E6) 108. [2] Hubbard et al., 2014. Cryosphere 8. [3] Hauber et al. 2008. JGR-Planets. [4] Holt et al.,2008. Science (21) 322. [5] Arfstrom et al., 2005. Icarus (2) 174. [4] Gallagher and Balme, EPSL (1) 431. [6] Scanlon et al., 2015. PSS. [7] Butcher et al., 2017. JGR-Planets. [8] Gallagher et al., 2015. EPSL 431. [9] Head et al. 2006. Met & Plan Science (10) 41. [10] Swanger et al. 2017. Scientific Reports 7.