GLACIAL MODIFICATION OF EASTERN NEREIDUM MONTES, MARS: OBSERVATIONS FROM SOUTHERN HEMISPHERE MAPPING OF LOBATE DEBRIS APRONS AND ICE-RICH FLOW FEATURES. F. C. Chuang, D. A. Crown, and D. C. Berman, Planetary Science Institute, 1700 E. Ft. Lowell Road, Suite 106, Tucson, AZ 85719 (chuang@psi.edu).

Introduction: Lobate debris aprons (LDA), concentric crater fill (CCF), and lineated valley fill (LVF) are a suite of features present throughout the northern and southern mid-latitudes of Mars [1-10]. They are often associated with fretted terrain, regions in which the surface appears to have been "softened" due to the viscous flow of ice-rich materials [11-14]. LDAs in particular, exhibit similarities to several types of terrestrial cold-climate landforms [2,5,15] including rock glaciers [16-17], interconnected valley glaciers [18-23], debris-covered glaciers, as well as protalus lobes and ramparts [5,15]. Modeling results from the Shallow Radar instrument on Mars Reconnaissance Orbiter have supported a debris-covered glacier interpretation for LDAs in which hundreds of meters-thick ice is sequestered below a ≤ 50 m thick debris cover [24-26]. Global circulation models have also shown that regions of net ice accumulation are in agreement with some locations of LDAs [27,28].

Recent mapping of LDAs and other ice-rich flow features in the southern hemisphere of Mars, hereafter referred to collectively as ice-rich debris aprons (IDA), suggests that these are more widespread than previously noted and extend further east of Hellas [29]. With the availability of global 100 m/pixel THEMIS day IR data, this mapping has now expanded to the entire hemisphere between 30° and 50° S. IDA margins were mapped at ~1:180,000-1:250,000 scale and only features larger than 1 km^2 were considered. In our mapping, an IDA can be a single lobate feature, a collection of coalesced lobate features that form one larger feature, or many separate lobate features that share a common source. IDAs generally extend downslope from high relief source regions such as impact crater walls (interior and exterior), massifs (single and multiple), valley walls, and escarpments.

Mapping Results: A total of 3,365 IDA features were mapped using ArcGIS software, covering 379,569 km^2 of the study area (1.4%). Figure 1 shows the percent surface area covered by IDAs in 2° latitude and 2° longitude bins. Regions with the highest percentages (i.e. > 10%) occur in eastern Hellas and within Nereidum Montes in northeast Argyre basin (314°-334° E). The eastern Hellas region extends from the distal end of Dao Vallis across Promethei Terra and into the southern highlands (80°-150° E). Other regions with smaller concentrations at lower percentages include Terra Sirenum, northwest Argyre, western Hellas, and central Hellas.

While the large concentrations in eastern Hellas and northeast Argyre are generally in agreement with previous global surveys of ice-rich flow features [4,8,9,30], the features in Nereidum Montes have received less attention than those in eastern Hellas. In [9], this area is consistent with a low density background distribution of ice-rich flow features poleward of 40° S. The likely difference between our study and [9] is the inclusion of large sheet-like lobate features in the current study. With increasing surface coverage of Mars by Context Camera (CTX) images, we can now examine these features in detail.

Nereidum Montes CTX Observations: Nereidum Montes is mountainous terrain along the northern margin of the Argyre impact basin (300°-332° E, Fig. 2a). The region generally consists of dissected basin massifs and expansive nearly flat-lying plains. Massif blocks vary in size and relief with the largest up to 80 km across (long dimension) and 3.5 km high. The plains, generally between -1000 to -1500 m, have slopes of less than one degree in the middle to lower portions of the basin.

In eastern Nereidum Montes, CTX images of the sheet-like lobate features show evidence for past glaciation. Figure 2b shows an area where possible valley glaciers in the upper reaches of Nereidum Montes once flowed into open plains and may have later retreated. The glacially-modified surfaces and adjacent massifs have various textures ranging from smooth to pitted, similar to those on eastern Hellas IDAs. Downslope from the glacial flows, the terrain exhibits features analogous to those seen in terrestrial glacial outwash plains, including large boulders, meltwater channels, a streamlined island and an outlet valley (Fig. 2c). In addition, massif LDAs, arcuate ridges, viscous flow features, and spatulate protalus lobes common to eastern Hellas are also observed [31].

Implications and Future Work: Eastern Nereidum Montes is a region that appears to have experienced significant past glacial activity from our initial observations. Further analyses of ice-rich features using CTX will provide additional information on potential glacial activity and allow for detailed comparisons between ice-driven modification of the terrains adjacent to the Argyre and Hellas impact basins.

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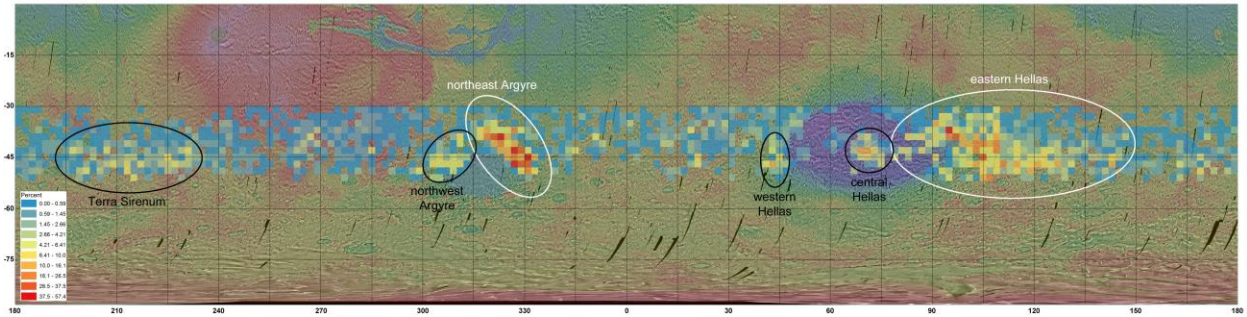

Figure 1. Map of percent surface area coverage by IDAs in 2° longitude by 2° latitude bins across the southern hemisphere. Regions with the highest percentages (> 10%) are where the greatest concentrations exist (eastern Hellas and northeast Argyre; white ovals). Other minor concentrations at lower percentages include Terra Sirenum, northwest Argyre, western Hellas, and central Hellas (black ovals).

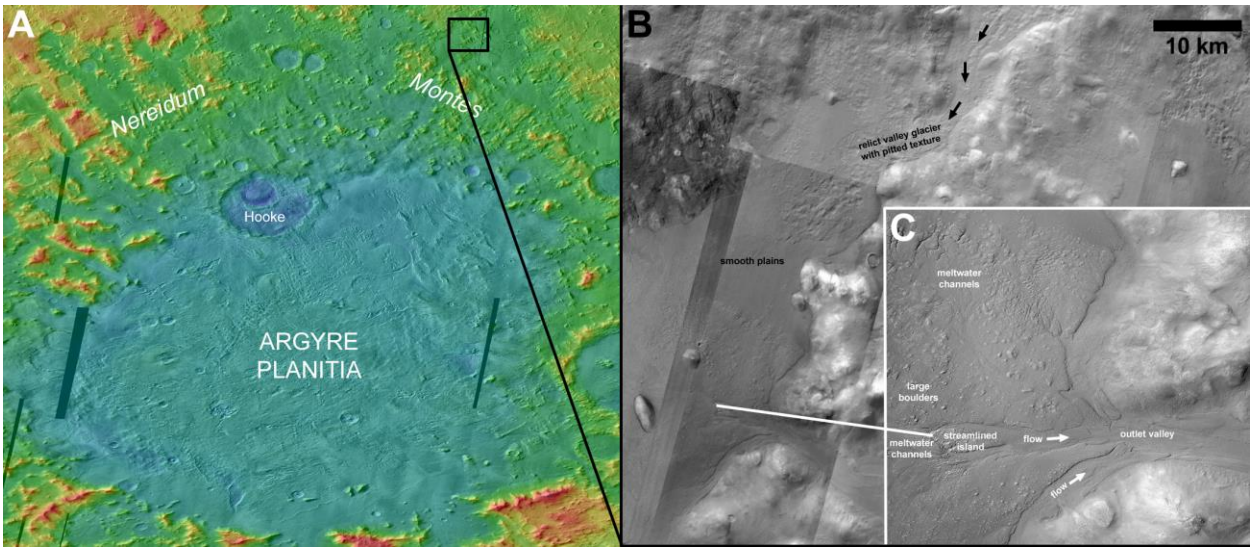

Figure 2. (A) View of Argyre impact basin and Nereidum Montes. Background THEMIS day IR base mosaic and MOLA topography (hot colors=higher elevations). (B) Portion of Nereidum Montes in CTX where possible valley glaciers once flowed into open plains. Subsequent glacial retreat and deposition of ice-rich mantle materials (smooth to pitted textures) may have occurred. (C) Terrain below the smooth plains with analogous features seen in terrestrial glacial outwash plains such as large boulders and meltwater channels (portion of CTX P14_006466_1930).