HYPSOMETRIC ANALYSIS OF GLACIAL FEATURES IN THE EAST HELLAS BASIN REGION, MARS: IMPLICATIONS FOR PAST CLIMATE SHIFTS. A. M. Rutledge[1] and P. R. Christensen[1], [1]School of Earth and Space Exploration, Arizona State University, Tempe, AZ; allie.rutledge@asu.edu

Introduction: Geologic features on Mars show evidence of modification by water and water ice [1-5]. Past obliquity variations have been theorized to have promoted the formation and stability of ground ice near the equator, allowing the accumulation of glaciers and the subsequent formation of periglacial terrain [6-8].

Likely glacial features, such as lobate debris aprons (LDAs), intra-valley fill, hourglass craters containing flow features, and ice-cemented mantling deposits at the heads of gullies have been observed on the eastern rim of Hellas Basin, ranging from latitudes of 30°S to 60°S (Figure 1) [8-9,10-12]. LDAs originate at the base of steep massifs and are characterized by lobes of gently sloping, convex-upward surfaces with relatively steep outer margins. The flow-like morphology of these features, including radial and concentric lineations, suggest these features were formed by glacier-like viscous flow processes [13-14]. The shallow radar (SHARAD) instrument aboard the Mars Reconnaissance Orbiter (MRO) returned results for these features consistent with massive ice deposits, supporting the hypothesis that these are debris-covered glaciers [15]. These features are thought to have formed from atmospheric precipitation of water ice during the late Amazonian [8, 16].

These fairly young probable glaciers are important because they represent significant amounts of present-day, near-surface ice, with implications for martian climate and geologic history, studies of the regional and global water distribution, and astrobiology studies.

Hypsometric Analysis: Terrestrial glaciology uses the hypsometric curve, or the empirical cumulative distribution function of elevations, as one method to evaluate parameters such as equilibrium line altitude (ELA) and mass balance of a glacier. ELA is the position, or elevation, at which accumulation is balanced by ablation. Mass balance, the difference between accumulation and ablation, is crucial to the survival of a glacier over time. Both these parameters are closely related to temperature and precipitation and can thus can serve as key indicators of climate change.

We apply terrestrial glaciology inventory methods to the lobate debris aprons on the eastern rim of Hellas Basin, Mars to complete a detailed areal inventory of the buried ice deposits and to evaluate the hypsometric curve of each feature. We then examine the relationship between LDA hypsometry and latitude in order to understand the effect of past climatic variations on present-day ice distribution. The Thermal Emission Imaging System (THEMIS) Day IR 100m Global Mosaic was used as a base map to determine areal extent, and Mars Orbiter Laser Altimeter (MOLA) data were used to ascertain elevations [17]. The JMARS software was used to processs and assess these datasets [18].

Initial Results. Initial results show that at latitudes at or greater than 45°S, LDAs exhibit hypsometric curves similar to classic terrestrial alpine glaciers – that is, the curve is steep at the upper and lower boundaries, and flattens in the midsection (Figures 2 and 3). This type of curve is indicative of a typical glacier with both accumulation and ablation zones, and could potentially be used to determine the (probably defunct) equilibrium line altitude of a lobate debris apron. LDAs at latitudes closer to the equator exhibit atypical hypsometric curves. This change in hypsometry with latitude potentially signals a past shift in temperature and precipitation dependent on latitude.

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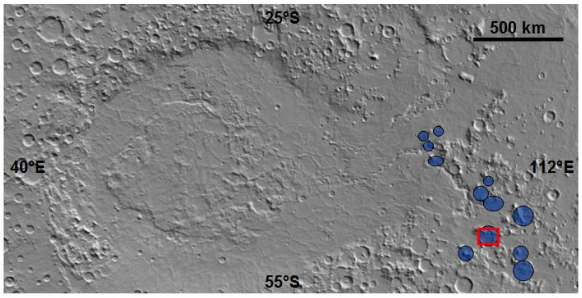

Figure 1: Location of major lobate debris apron (LDA) complexes on the eastern rim of Hellas Basin, indicated by blue shading. The LDA highlighted in this study is located within the red box. Background is from the Mars Orbiter Laser Altimeter global map in JMARS [18]. (Figure from Rutledge and Christensen 2010 [19].)

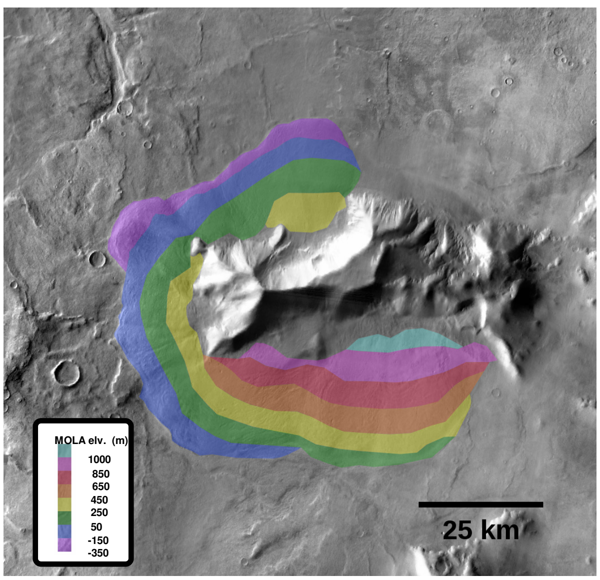

Figure 2: Hypsometric analysis of the high-elevation, higher-latitude lobate debris apron (LDA) surrounding a massif on the eastern rim of Hellas Basin, identified in Figure 1. Base imagery is THEMIS daytime infrared imagery in JMARS [18]. The base of the apron is at MOLA elevation -350m and it is centered at 45°S, 102°E. Average elevation bins are identified by color. This LDA exhibits a hypsometric curve similar to classic terrestrial alpine glaciers – that is, the curve is steep at the upper and lower boundaries, and flattens in the midsection. This type of curve is indicative of a typical glacier with both accumulation and ablation zones, and could potentially be used to determine the - probably defunct - equilibrium line altitude of a lobate debris apron. (Figure from Rutledge and Christensen 2010 [20].)

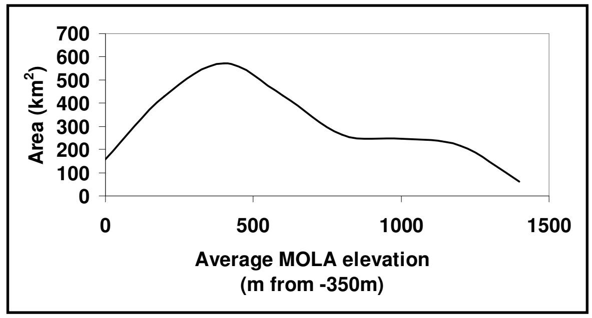

Figure 3: Hypsometry of the lobate debris apron identified in Figure 2, exhibiting a hypsometric curve typical of terrestrial glaciers, where the curve steepens at the outer edges. This possibly indicates paleo-accumulation and ablation zones during a period of active glaciation. (Figure from Rutledge and Christensen 2010 [20].)