AMAZONIAN LOBATE DEBRIS APRONS (LDA) IN THE MID-LATITUDES OF MARS: ASSESSING THE ROLE OF WATER ICE IN THEIR FORMATION AND EVOLUTION, Lillian R. Ostrach and James W. Head, 1Dept. Geological Sci., Brown University, Providence, RI, 02912 USA (Lillian_Ostrach@brown.edu).

Introduction: Lobate debris aprons (LDA) are geomorphological features believed to have formed due to ice-assisted debris flow; they are thought to contain varying concentrations of ice-rich material and are prevalent in the northern and southern hemisphere of Mars at the mid-latitude regions [1-12]. The large number of these features suggests significant modification of martian land surfaces and may indicate a global response to varying climatic conditions occurring as recently as the late Amazonian. LDAs occur at the base of escarpments and isolated massifs and exhibit distinctive longitudinal profiles with convex upward shapes. On the basis of morphology and associated features, all agree that water ice was involved in mobilizing talus aprons, but opinions differ on the amount of ice involved, ranging from ice-filled pores to debriscovred glaciers. Thus, a key question is the amount of ice entrained in the deposit. Previous research [e.g., 1] has focused on analysis of these longitudinal profiles to determine ice concentrations within the features as well as to provide insight into LDA formation and evolution. In this study, we assessed the techniques used to measure ice content within designated LDAs to duplicate the results of previous studies [1] and to assess further the areal distribution and association of different characteristic profiles. Based on these findings, we analyzed three LDAs in the Deuterolimus Mensae region of Mars according to the procedures outlined in [1] in an effort to expand our knowledge of these ice-rich flows.

Previous Work: Li et al. [1] examined 36 LDAs in the northern hemisphere using MOLA topographic profiles. The normalized apron profiles showed a strong resemblance to a simple plastic flow model idealized by the equation \((bH)^2 + (x/L) = l\) where \(b\) and \(x\) are the thickness and radial length of the ice sheet and \(H\) and \(L\) are the maximum thickness and radial length [1]. Li et al. [1] interpret the deviation of the apron profile from the idealized model profile to represent the amount of ice contained within the apron, categorized as Types I-III, with Type I having the highest ice content and Type III the lowest [1].

Technique Assessment: We examined 11 of the 36 LDAs previously surveyed in the Deuterolimus Mensae region (Fig. 1), numbered 17 through 27 in the previous research [1], and created normalized longitudinal profiles of the aprons based on MOLA tracks. Best-fit approximations to the data points of the apron profile were calculated and plotted on the same axes as the simple flow model in order to assess the divergence of the apron profile from the model. The differential area between the two curves was calculated and compared with \(A\), the differential area between the normalized simple model and a linear fit [1]. Classification of apron profiles was determined based on agreement with the following: Type I \(\leq A/3\), \(A/3 \leq Type II \leq 2A/3\), Type III \(> 2A/3\) [1].

Apron Classifications: We verified 7 of the 11 apron classifications through duplicate results. The remaining 4 aprons were unverifiable based on the distribution of the MOLA data (aprons 22, 23) and track data that was too transverse to the escarpment/deposit (aprons 20, 21).

Type I Classification LDAs: Type I LDAs best match the model parabolic profile and exhibit a distinctly convex shape that deviates from the simple model around the lower reaches [1]. Aprons 17 and 18 are classified as Type I, with the highest ice content, according to the analytical process presented previously [1].

Type II Classification LDAs: Type II LDAs show greater deviation from the simple model than those designated Type I but maintain a convex shape closely similar to the model [1]. Aprons 24 and 25 are classified as Type II aprons and closely resemble the shape of the simple model but plot below the model curve.

Type III Classification LDAs: Type III LDAs largely deviate from the simple model, plotting well below the parabolic curve [1]. Aprons 19, 26, and 27 are classified as Type III aprons and exhibit profiles diverging significantly from the simple model plot.

Discussion: Based on the results of the duplication and verification of the techniques used by Li et al. [1] in assessing the ice content of LDAs, we identified three additional LDAs for application of this method (the Deuterolimus Mensae region at approximately 41°N, 24°E) and topographic profiles were obtained by identifying the appropriate MOLA track data. Analysis of the data established that the three aprons, A-C, are Type III debris aprons. This initial analysis of additional aprons further illustrates that the distribution of the three types is not regional but that specific types can occur closely together in a similar geological environment. This heterogeneous LDA population in contiguous areas suggests that 1) different sources and ice associations may be responsible for the observed LDAs, or 2) current profiles may represent a modified configuration of the formational topography of the LDA and may thus represent various stages in the loss of ice, evolution or modification of the LDAs. Ongoing research is examining the apparent random configuration of different apron types through the assessment of several morphological and morphometric parameters to test whether causes are due to formation or modification.

Fig. 1. The Deuteronomilus Mensae region showing the placement of the 11 debris aprons used to verify previous research techniques [1]. Note the line drawn between aprons 26 and 27; this indicates the three aprons chosen for independent evaluation. Image derived from Fig. 1b in [1], latitude 37°-41°N; longitude 18°-24°E; part of quadrangle MC-5.

Fig. 2. Longitudinal profile of apron 18, MOLA N-S track data. Note the convex shape of the debris apron to the left of the escarpment, which closely resembles a parabola. From data contained in this graph, the distal and proximal margins of the apron were determined and the apron profile data were isolated for detailed analysis of shape and application to the classification.

Fig 3. Composite graph of apron data and simple model data that shows the deviation of the apron profile from the idealized simple plastic flow model. Note the apron profile strongly resembles the model; analysis of the differential area between the curves classifies this as a Type I debris apron, with the highest ice content [1].

Fig 4. Composite graph of apron data and simple model data for apron 25, determined to be a Type II apron. This apron profile deviates slightly from the model, especially in the lower reaches and exhibits less of a lobate distal margin than the model.

Fig 5. Composite graph of apron data and simple model data for apron 26, determined to be a Type III apron. This apron profile shows the greatest deviation from the model which is interpreted to mean that this apron type contains the least amount of ice-rich material [1].

Fig 6. Longitudinal profiles of Aprons A-C provided by MOLA track data. Individual profile analyses were undertaken to determine the class of these three aprons; based on the examination of these apron profiles, aprons A-C were designated Type III debris aprons, containing the least amount of ice. Note the varying profiles on the longitudinal profile: aprons A and C have noticeably convex, parabolic shapes with a lobate distal margin and slight slope at the base of the escarpment, and the profile of apron B is concave in appearance and is not easily distinguished from the downward slope of the escarpment from which it originates.