
Introduction: Linear valley fill (LVF) and lobate debris aprons (LDA) are widespread in fretted terrain in the northern part of Arabia Terra [1-3], but occur elsewhere in this latitude band in the northern hemisphere, such as at Acheron Fossae, a series of arcuate parallel graben on a rise north of Olympus Mons (217°-237° E; 34-40° N) where the graben floors are characterized by viscous flow-like features [4] resembling LDAs and LVF. Questions associated with the analysis of LDAs and LVF are: 1) the range of environments in which LDAs form; 2) the relation of LDA to underlying topography; 3) the nature and direction of flow in LDAs; 4) relationships between the LDA and the LVF; and 5) the mode of origin of the LDA and LVF (e.g., groundwater-fed, ice-assisted rock creep, ice-rich landslides, rock glaciers, debris-covered glaciers) [2-9]. Recent analyses of LVF in the Deuteronomius Mensae region [10-11] have shown evidence for local sources of LVF also in valley walls, down to 50 km wide, merging flowlines into broad trunk valleys, extensive along-valley flow, and termination in lobate deposits, all features that are similar to valley glacial landforms on Earth.

In this study we analyzed the floors and walls of the graben composing Acheron Fossae [4], examining the viscous flow-like features there and assessing their morphology, topography, relation to underlying topography, slope and orientation. We also compared the graben floor structures to lobate deposits found on the pole-facing slopes of impact craters superposed on the Acheron Fossae region (Fig. 1). We previously [12] subdivided LDAs into linear (occurring along valley walls and crater interiors) and circumferential (aprons generally surrounding isolated massifs), a distinction we found useful here.

Description of Viscous Flow Features in Acheron Fossae: The Acheron region lies on the NW flank of the Tharsis rise and forms a broad north-facing topographic arch at least 700 km long, and rising 2-3 km above the surrounding plains; its eastern edge forms a broad dome-like high about 150 km in diameter. Acheron Fossae dissect this basic background topography, forming at least two sets of graben [4] in which viscous flow features of various types and stages of development occur. The Acheron terrain is mapped as Noachian in age, and the graben are emplaced by plains materials of this age, to the Amazonian age [7]. Thus, the graben themselves, although showing characteristics suggesting at least two generations of formation [4], have apparently not been active in the Amazonian. Thus, these features could serve as a template of known geometry to assess the role of modification by LDA and LVF. Three types of viscous flow features are seen in the Acheron region and differ somewhat from the classic LDA and LVF in Deuteronomius [3]; we focus on these first.

Mode of origin of the LDA and LVF: The topographic characteristics of the linear LDAs, the LVF and the piedmont-like lobes, their slopes and relation to underlying topography, suggest that ice-assisted viscous flow (with ice content in excess of 40-50% [e.g., 9]) was the major process operating to form these features; we interpret the majority of the features to be related to the formation and evolution of debris-covered glaciers.


Fig. 1. MOLA gradient map of eastern Acheron Fossae.

Fig. 2. Graben, linear and LDAs. HRSC 0037.

Fig. 3. MOLA altimetric profile (orbit 13424) across Fig. 2.

Fig. 4. Perspective view of crater in Fig. 2; arrow in Fig. 2 shows viewing perspective. HRSC 0037 draped on MOLA. VE=2x.

Fig. 5. Perspective view of piedmont-like LDA emerging from graben. THEMIS V09791029 and V01852010 draped on MOLA. VE=2x.

Fig. 6. Impact crater with wall and floor LDA; HRSC 0037.

Fig. 7. Impact crater with wall and floor LDA; HRSC 0037.