ACHERON FOSSAE, MARS: EVIDENCE OF FLUVIAL ACTIVITY AND MASS FLOW. J. B. Plescia[1], [1]Applied Physics Laboratory, Johns Hopkins University, 11100 Johns Hopkins Road, Laurel, MD 20723, jeffrey.plescia@jhuapl.edu

Introduction: Acheron Fossae is an arcuate, topographically high piece of ancient terrain north of Olympus Mons along the boundary with the northern plains. The terrain consists of an older, Noachian-aged piece of crust that was uplifted and extensively faulted. Subsequently, a variety of modification processes have occurred including fluvial erosion, possible ponding of water, mass movement of material, and aeolian transport.

Regional Geology: The major geologic units include materials of various age and morphology.

Acheron Fossae Formation: An old, highly fractured and heavily cratered crustal block. The surface has numerous graben and has been modified by narrow incised valleys and broad, flat channels, mass wasting, and it is locally mantled. The primary bedrock surface is Middle Noachian in age (N(1) = 2404 – 2765) based on the stratigraphy of [1].

Mantled Plains: This unit occurs south of the topographically higher Acheron Fossae Formation and is a heavily mantled ridged plains unit. The thickness of the mantling increases southward obscuring the morphology of the underlying surface; dune fields cover the present surface. The original ridged plains surface, on which the mantle is deposited, is Late Noachian (N(1) = 2640 ± 327); there are few small superposed craters on the dunes indicating they are latest Amazonian in age (Figure 1).

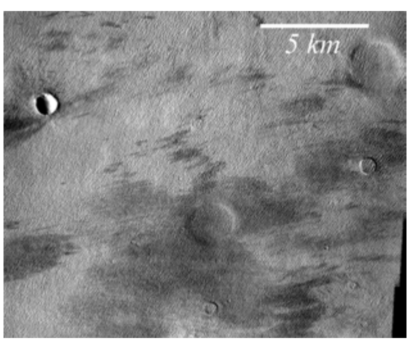


Figure 1. Mantled unit with widespread dunes. Dark albedo markings are sufficiently thin that they have no morphologic expression. Portion of THEMIS V01977007.

Plains: There are several plains units surrounding Acheron Fossae. Plains to the east are Late Hesperian in age (N(1)= 1552 ± 313) and have surfaces with lobate margins and flow morphology indicating they are volcanic. Plains to the north are smooth, mantled and locally textured and channeled and have a crater age of early Amazonian (N(1) = 762 ± 61). On the west side, the plains also display morphologies suggestive of volcanism. These are the youngest plains, being early Amazonian (N(1) = 378 ± 120). When observed in high resolution along the contact with Acheron Fossae, the western plains are composed of multiple units (Figure 2). The contacts are clearly depositional, although they have been interpreted as shorelines [2].

Figure 2. Western margin of Acheron Fossae showing contact with younger plains units. Portion of THEMIS V05897017.

Olympus Mon Aureole: The aureole deposits associated with Olympus Mons [3] lap up against the southern margin of Acheron Fossae. In the west they onlap the heavily cratered terrain; along the southern margin they overlap the mantled plains (but not the mantle itself).

Graben are the most common tectonic feature. In the eastern part of Acheron Fossae the faulting is intense and appears to radiate from a point near 36°N, 135°W. Graben are complex, cross cut each other, and often display a stair-step pattern of faults blocks. In western Acheron Fossae, the graben are simple and the faulting is less extensive.

Modification Processes: The original bedrock units of Acheron Fossae have been modified by a number of processes. Incised valleys (Figure 3) and wide, flat-floored channels are widespread and appear, based on morphology [4], to represent fluvial erosion features. The source of water – rainfall versus ground water sapping – is unclear. The presence of such features across Acheron Fossae indicates that rainfall or groundwater was widespread.

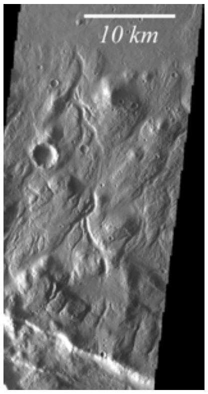
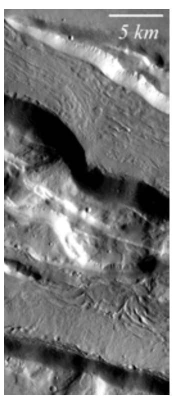


Figure 3. Incised valley features on the northern margin of Acheron Fossae. Portion of THEMIS 14184007.

Materials with lobate margins and surface morphology suggestive of flow (Figure 4) occur throughout Acheron Fossae. The material moves downslope, even down minimal slopes, and around obstacles indicating lateral transport. Such morphologies are found primarily in graben but also occur in craters and elsewhere.



Figurer 4. Mass wasting and flow of material found in graben in Acheron Fossae. Portion of THEMIS V01253007.

Discussion: Fluvial erosion occurs on many surfaces in Acheron Fossae. All of the units, with the exception of the dune fields, exhibit evidence of fluvial erosion. However, the valleys and channels do not cut the surrounding plains. The extended period of fluvial activity is best illustrated by the relation between incised valleys and faults within the large crater in north central Acheron Fossae (Figure 5). Here, fluvial erosion and faulting appear to have occurred contemporaneously. Some valleys are cut by west-trending faults and terminated; others cut across the fault scarp or run along the fault scarp indicting that flow continued after the faulting.

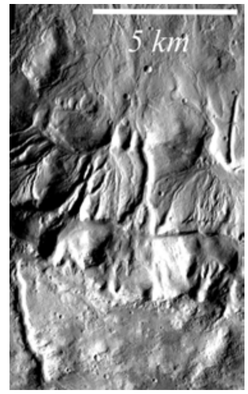


Figure 5. Southern flank of large crater in central Acheron Fossae illustrating contemporaneous faulting and fluvial erosion. Portion of THEMISV12362007.

Lobate materials within graben, large craters and observed on topographic slopes are clearly indicative of mass flow of surface materials. Geologic relations suggest that they are not volcanic flows or landslide deposits. The morphology is similar to that observed elsewhere on Mars; those other materials being suggested to be glaciers or rock glaciers [5]. A glacial / periglacial origin is consistent with the location of these materials within the large graben. Such materials only appear to originate along north-facing slopes; south-facing slopes lack such materials. This suggests that their formation is controlled by local insolation, consistent with a glacial or periglacial process.

Another morphologic feature suggestive of glacial or periglacial processes are small mounds with a central pit; some of these pits contain small topographic highs (Figure 6). Such features morphologically resemble pingos [6]. They also resemble features observed in Ulysses Patera [7] that were interpreted as cinder cones.

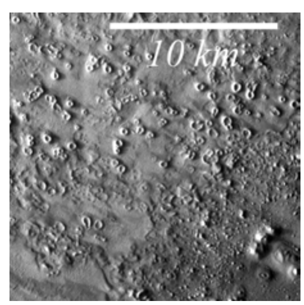


Figure 6. Small mounds (100-300 m in diameter) with a central pit. Some examples have a topographic high within the pit. Portion of THEMIS V14184008.