GEOMORPHIC MAPPING OF LANDSLIDES IN ARAM VALLEY, MARS
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Introduction: A geomorphic surface map was created for Aram Valley that connects Aram Chaos to Ares Vallis, in western Arabia Terra of Mars. The channel is located at 341°E and 3°N and trends east-west for ~80 km. Roda et al. [1] hypothesized the channel formed from a single catastrophic flood event during the Hesperian (3.7-3.3 Ga). Water flowed out of Aram Chaos, east into Ares Vallis, likely over a very short period of time, calculated to be approximately 10 days [1]. The central section of the channel subsequently experienced mass wasting, as the walls collapsed in landslides or possibly debris flows (Fig. 1). This study examines the deposits associated with these mass wasting events by creating a geomorphic surface map focusing on the deposits and the channel floor to understand the timing and mechanisms of the modification of the channel post formation.

Aram Valley: Aram Valley originated from Aram Chaos, a chaotic terrain likely formed from a large impactor. There are several theories of how the chaotic terrain formed ranging from a volcanic intrusion melting the permafrost layer to subsurface rock dissolution [2]. In each case, the original terrain experienced high pressure release of water. Then a catastrophic flow from the eastern rim, carved an outflow channel, Aram Vallis, connecting Aram Chaos to Ares Vallis. The valley has steep sides and a flat floor. The floor is smooth and covered with aeolian features and deflated craters. The walls appear to have widened through the landslide slope failures, much like the landslides that eroded the walls of the Vallis Marineris canyon system [3]. The landslides in Aram Valley are unlike those in the Coprates Chasm in Vallis Marineris, where landslides overlay one another with clear flow termini forming moderately oblate fan-shaped aprons, with distinct individual flows overlapping each other [4]. On the other hand, Aram Valley landslides are much smaller and have debris mounds at their toes and do not spread out flat onto the valley floor.

Methods: A base map was created of the Aram Valley using Jmars to create the digital terrain model taken from HRSC and overlying images from CTX and Hi-Rise imagery. The base map was then imported into Arcmap. Using GIS’s Arcmap software, linear features were drawn for each unit (Fig. 2). Point features were used to label each landslide. Units are displayed as L1-L9 for landslides (red lines), scarp (pink lines), the bottom of the channel (blue lines), and the wall of the channel (yellow lines). Point of contact is presented as a dotted line between L6 and L7, while overlapping is presented as a solid black line as L5 overlays L6.

Landslide Deposits: Landslides (L1 – L9) are identified by number moving west to east. The edges of the landslide apron were determined by identifying the margin of sediment accumulation on the terminus in a lobate structure blanketing the channel floor. The landslides vary in size (1 km² to 45 km²). The larger landslides (L3-L8) are in the central part of the valley while the smaller landslides are on the margins. It is not clear if the absence of smaller landslides in the center is a function of formation or preservation. The landslides originate from both the north and south facing channel walls. However, the south facing wall has more individual landslides and a larger total landslide area. The preservation of the landslide aprons and scarps also varies. Some are well preserved, like L7 with a discrete scarp, clear terminal edges, and longitudinal grooves. While others are eroded and winnowed (see Fig 1).

Several of the landslides interact with each other. For example, L6 lies under L5, therefore L5 formed first. However, for others, there are more complex interactions. For example, the contact between L6 and L7 is not clear. The landslides aprons may have formed concurrently or one may have formed first and shaped the other. Image resolution and erosional processes make the contact unclear.

Fig 1: Complex interplay between units L3 and L4 in the western part of the channel (towards Aram Chaos). CTX image F05_037571_1828_XN_02N018W. Image outline in Fig. 2.

Landslides L5-L8 have pronounced scarps (Fig. 2). The landslides have similar toe features but can be split between two morphological differences: L1, L2, L5, and L6 have gentle slopes while L7 and L8 are steeper with multiple scarps in the headwall. These differences
could be related to fluid flow, volatile content, erosion, or wall properties.

It is hard to discern detailed relationships between L3 and L4 (Fig 1). L3 originates from the south-facing wall, flowing south onto the channel floor. L4 originates from the north-facing slope and flows north. A topographic valley separates the two deposits. It could be an erosional valley, that formed after L4 was deposited, bisecting the deposit. The shape of the deposit terminus seems to support northward flow. On the other hand, it could be a separation between landslide deposits that formed from different sides of the valley. This possibility is supported by some sedimentary layers in the deposit connecting with deposits clearly linked to L3. This uncertainty enhanced because there are at least three lobes in a complex interplay and there has been surface deflation, making it challenging to distinguish the boundaries of the mass wasting processes in this part of the channel, the direction of flow, and the relative ages.

**Future Work:** Additional mapping will focus on identifying specific units in the deposits, determining crater retention ages where possible, and flow analysis to help determine the relative timing of the individual landslide deposits and how their formation compare with the formation of the valley itself. This research can lend insight into whether a tectonic event or impact-initiated slope failures, wall characteristics, and possibly role of volatiles in the formation of the landslide deposits.


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Fig. 2 A map of Aram Valley between Aram Chaos and Aram Vallis. Base map is a DTM taken from HRSC. Overlaying images are a combination of high resolution CTX and Hi-Rise imagery derived from JMARS. Geomorphic surface map of the channel displaying landslides L1-L9 in red lines; scarp in pink lines; contact points in dotted lines, overlapping points in solid lines; bottom of the channel in blue lines; walls of the channel in yellow lines; region of intricate structures (Fig. 1) is boxed.