MESAS AND RELATED FEATURES ON THE EASTERN RIM OF THE HELLAS BASIN, MARS.

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Introduction: The studied region (Fig. 1a) is bordered by Teviot Vallis (in the east), the Hellas basin (west) and Reull Vallis (north). Southwards it gradually changes into the cratered Promethei Terra highlands [1-4]. This region has a very characteristic set of ~180 m high flat-topped mesas (~20 mesas, areas up to ~3500 km^2). In this work we describe and analyze these and related features and their morphology, and search for possible formation origins [see also 5].

Data and methods: We use the high-resolution data from MEX HRSC camera [6, 7] in conjunction with THEMIS [8] and MOC NA images [9]. Where applicable, HRSC and MOLA DTM's [10] were used to obtain information on the topography.

Regional setting: The study area (95-45°S, 90-110°E) is located on the ~0.0-0.8° eastern rim slope of the Hellas basin and it measures ~350x350 km across and has an area of ~122000 km^2. The terrain immediately around the mesas is smooth or slightly etched, and dissected by numerous fluvial channels as well as linear features, e.g. wrinkle ridges and crisscrossing lineaments, interpreted as dikes [see 5]. The area has previously been mapped as everything from late Noachian to early Amazonian [2-4]. The Hellas region has been frequently studied due to its large amount of volatile-driven features and phenomena [e.g. 11-15]; more detailed studies have shown that the east Hellas rim has been heavily modified by e.g. the evolution of the Morpheus-Reull-Teviot-Harmakhis Vallis complex and their tributaries [16-21] and in larger scale by Hesperia Planum volatile outbreaks [22].

Mesa description: The ~20 studied mesas are all elongated in the W/NW–E/SE direction along the local slope and rise ~180 m (max. 340 m) above the surrounding plains. The mesas have generally flat tops with no DTM resolvable features. However, morphology shows that the mesa tops exhibit either smooth, hummocky or slightly eroded textures (Fig. 1c). Several of the largest mesas (areas > 40 km^2) have steps on their summits (Fig. 1b), interpreted to be the remnants of the partly eroded layers within the mesa body. There is no indication of layering on most mesa walls. In the previous detailed geologic maps [2-4] the mesas have been interpreted as friable eolian, fluvial or possibly volcanic sediments, which may have been locally ice-cemented.

Channels: Most mesa margins are scalloped heavily with capes and concave bays. Narrow sinuous depressions originate from many bays, merging together into wider and more subdued channels downslope. They are interpreted to be caused by fluvial run-off leading from the mesas and extending towards Hellas.

Judging from the appearance of the mesas associated with the largest channels, the starting point of the channel migrates deeper into the mesa during the inferred channel/mesa evolution. At this stage, additional small tributaries merge with it from channel-parallel mesa lobes. Fig. 1b shows a mesa deeply cut by channels; see also the two-lobed large eastern mesa in Fig. 1a and the separated mesas at 41.5°S, 97°E.

Some mesa-related channels connecting with Reull Vallis have been embayed by the late stage Reull deposits; other examples show that mesa material liquidification has in places been younger than Reull materials. This indicates that the material flow from mesa formations has been activated during several phases of Mars' history. This may have been facilitated e.g. by changes in the climate [23-25] due to changes in the orbital parameters [25-30].

Mesa wall disintegration: The straighter mesa rim segments with no channels often exhibit one of the found distinct wall degradation styles, which generally occur on different mesa sides, with some overlap (Figs. 1b&c). 1) The south-facing slopes tend to have prominent debris aprons, extending up to 600 m away. The apron is smooth and featureless on a large scale, close-up it is either lineated or heavily etched. 2) The north-facing mesa flanks tend to have no aprons. Instead they exhibit large separate bodies at the foot of the slope. These usually lie at 200-400 m distances from the mesa tops laterally; vertical analysis is not possible due to DTM resolution limits. We interpret them as remnants of fallen material detached from the mesa. MOC NA images reveal the largest fallen blocks exhibiting lineations parallel to the mesa walls (Fig. 1c). This indicates that 1) prior, during or as a result of falling blocks have fractured along the lines due to zones of weakness in the mesa top edge, 2) blocks have been eroded post-emplacement along the lines, 3) lineations represent the layered structure of the mesa body itself (indicates large somewhat intact block sliding/toppling down the mesa flank, resulting in rotation; previously horizontal layers are now visible from above), 4) or a combination of the above.

Conclusion and Discussion: When reconstructing the geologic evolution of the study area, we need to assess the importance of the smoothened Hellas rim mesas. The similarity between the mesas and their apparent lack elsewhere outside the study area shows that they are the result of one sequence of events occurring only in that area. Furthermore, the scalloped nature of the mesa flanks, the existence of channels running away from them, the erosion of the immediate surroundings of the mesas and the mesa locality shows that they are in fact erosional remnants of a larger construct. We suggest that this mesa system, now consisting of several separate units, is actually a remnant of a more wide-spread depositional unit: a possibly glacier-related massif, which at some point in Martian history covered much of the area studied.

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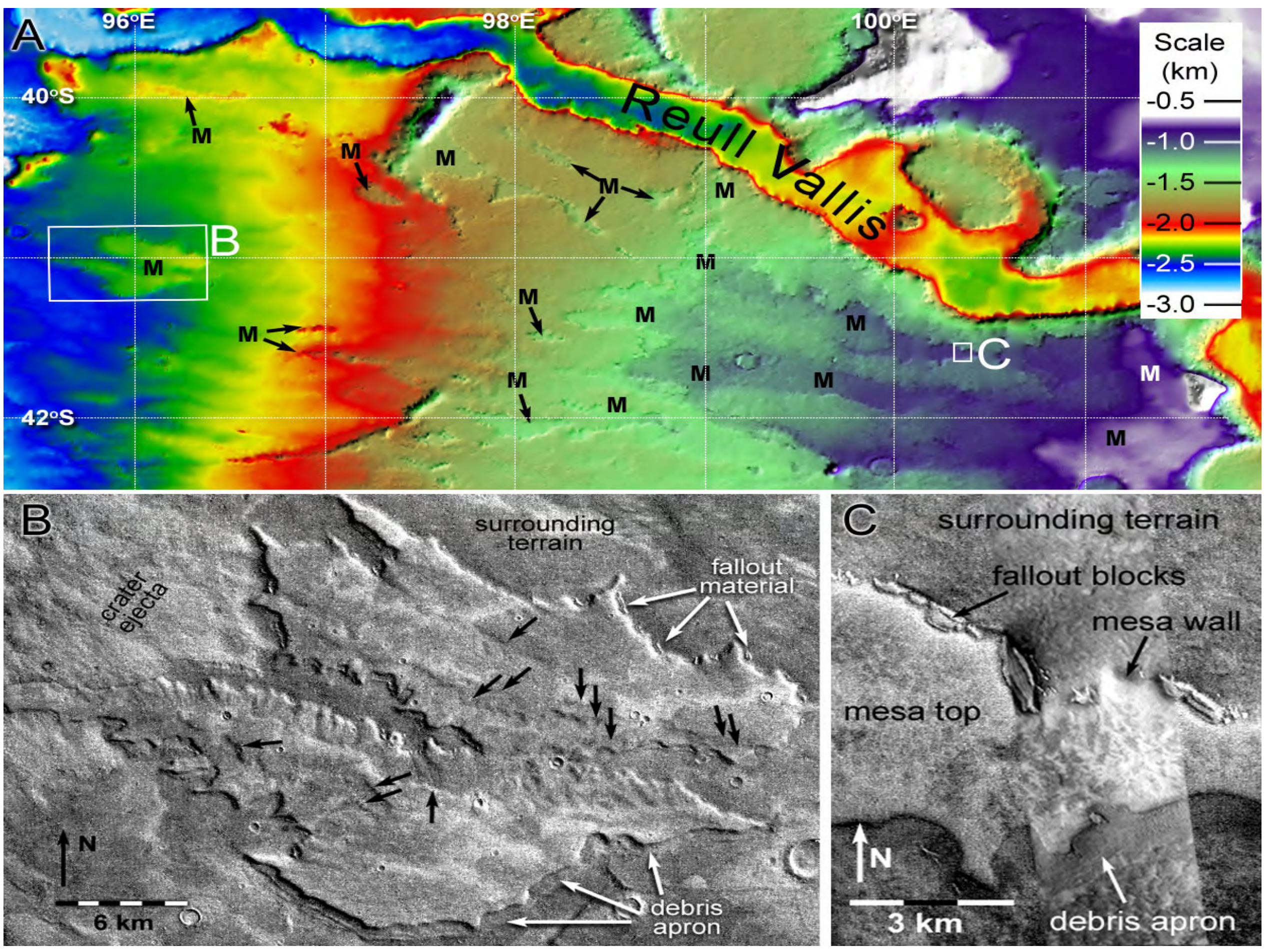

Figure 1. A) Mesa (M) locations on MOLA 128pix/deg DTM. White boxes show locations of figures b and c. B) Example of large mesa top with layered structure (black arrows point to steps). HRSC orbit 2510 nadir image. C) Mesa wall degradation types: lineated blocks (north) and eroded debris apron (south). Note the mesa top smooth texture. HRSC orbit 2466 nadir image and MOC NA S0702871.