GEOLOGIC MAPPING OF MTM -30247, -35247 AND -40247 QUADRANGLES, REULL VALLIS REGION, MARS.

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Introduction: Geologic mapping of MTM -30247, -35247, and -40247 quadrangles is being used to characterize Reull Vallis (RV) and to determine the history of the eastern Hellas region of Mars. Studies of RV examine the roles and timing of volatile-driven erosional and depositional processes and provide constraints on potential associated climatic changes. This study complements earlier investigations of the eastern Hellas region, including regional analyses [1-6], mapping studies of circum-Hellas canyons [7-10], and volcanic studies of Hadriaca and Tyrrhena Paterae [11-13]. Key scientific objectives include 1) characterizing RV in its "fluvial zone," 2) analysis of channels in the surrounding plains and potential connections to and interactions with RV, 3) examining young, presumably sedimentary plains along RV, and 4) determining the nature of the connection between the segments of RV.

Project Status: This analysis includes preparation of a geologic map of MTMs -30247, -35247, and -40247 (compiled on a single 1:1M-scale base). The current map area is included in previous Viking-based mapping efforts at regional [5,6] and local (1:500K; MTM -30247) scales. Crater size-frequency distributions compiled for the regional analysis [5,6] will be used in conjunction with newly generated statistics for units mapped in the current study using new datasets (e.g., MOC, THEMIS, CTX and HiRISE). This mapping effort will combine past results and new analyses to complete MTM-scale mapping of the entire RV system.

Mapping Results: This section describes observations made during geologic mapping and integrates new results with previous mapping of this area [e.g., 5,6].

<u>Tectonism</u>: Wrinkle ridges and ridge rings are the most prominent tectonic features in the map area and occur predominantly within ridged plains. Two dominant trends are observed—NE–SW (Hellas radial) and NW–SE (Hellas concentric)—indicating either multiple stress regimes were active concurrently or the stress regime shifted over time [14-16]. Crosscutting relationships suggest that ridge formation occurred after plains emplacement (Early Hesperian) and prior to collapse events and fluvial dissection associated with the formation of upper RV (mid-Hesperian?) [5,6].

<u>Fluvial Modification</u>: Fluvial processes have modified most highland and plains terrains. Most highland channels are incised within a sedimentary unit that fills intermontane areas [5-8]. These networks consist of narrow (<1 km) valleys up to several tens of kilometers in length and exhibit rectilinear patterns. Several narrow, steep-walled, flat-floored channels are also found within the plains adjacent to RV and some intersect RV. These channels are only a few kilometers in length, but some extend for several tens to hundreds of kilometers. The morphology and connections of these channels to RV suggests their formation may be related.

Several large craters in the map area exhibit degraded rims, parallel interior gullies, and eroded ejecta blankets. Most craters are partially filled by smooth or hummocky deposits, and several craters contain debris aprons that extend from their interior walls onto their floors. The range of crater preservation and the presence of gullies and debris aprons suggest that a combination of fluvial and mass wasting processes are responsible for erosion and degradation of highland craters [2,5-8,17-21].

<u>Reull Vallis System</u>: Segment 1 (S1) and part of Segment 2 (S2) of RV are found within the map area. S1 (~240 km long, 8–47 km wide, 110–600 m deep) displays erosional scarps, scarp-bounded troughs, small theater-headed channels that converge at a large (~50 km across) depression, streamlined inliers of ridged plains material, and scour marks on the canyon floor. To the south, RV opens into a series of irregular scarp-bounded basins that contain blocks of ridged plains on their floors. Floor materials are generally smooth to rough (at MOC scale) and likely include fluvial deposits, as well as debris contributed by collapse of vallis walls. The morphology of S1 suggests formation by combined surface and subsurface flow and collapse of ridged plains. S1 is believed to be the source area for at least some of the fluids that carved RV [5,6,22].

An obvious connection between S1 and S2 is not apparent. Recent work using HRSC data suggests that the "Morpheos basin" marks the site of the intersection of S1 and S2 [23,24]. It is believed that during the early stages of RV's formation water flowing south from S1 accumulated in this basin and was released to carve S2.

Segment 2 consists of morphologically distinct upper (S2-U) and lower (S2-L) parts. S2-U (6 to 13 km wide, 110 to 650 m deep) displays sinuous morphology and extends for ~240 km through degraded highlands. This segment preserves evidence that at least this part of RV was formed by surface flow including layering or terracing along canyon walls, and braided channels incised in floor material [5,6].

A portion of S2-L occurs in the southwest part of the map area, and begins where a narrow (1–2 km wide), shallow (~100 m deep) canyon downcuts into the main canyon floor [5,6]. Here, S2-L displays steep walls and a relatively flat floor, and is narrower (6 km) and shallower (140–350 m) than S2-L to the west [7,8]. Unlike S2-U, S2-L does not display features on its floor indicative of fluvial erosion, though the main canyon walls contain small-scale layering/terracing (tens to hundreds of meters thick) near the U-L transition. Floor material consists of debris infilling the canyon from fluvial deposition and wall collapse, and exhibits pits and lineations that parallel the vallis walls.

The morphology of S2 suggests formation by fluvial processes and subsequent modification by collapse and mass wasting. Several narrow, steep walled and flat-floored canyons enter S2-U suggesting fluvial contributions to RV. These tributaries begin within and cut through various plains units adjacent to RV.

<u>Regional Stratigraphy</u>: Materials forming highland terrains - *highland material* and *highland plateau material* - are found in the southern part of the map area and previously mapped as the basin rim unit and mountainous material [5,6,29]. *Highland material* is the

most rugged, exhibits the most topographic relief, and tends to form isolated knobs and massifs. *Highland plateau material* is less rugged and forms more continuous expanses. Highland channels are generally found within highland plateau material. In THEMIS day IR and Viking Orbiter images, these highland units appear mountainous and very rugged. However, in high-res images, the highland surfaces are rounded and mantled by a fairly continuous deposit [25,26]. At the peaks of some of the steepest highland massifs, as well as along some crater rim crests, this mantling unit is being removed downslope via mass wasting

The northern part of the map area consists primarily of *ridged plains material*. This unit has been interpreted as flood lavas [27-29], although no obvious flow fronts are visible. In THEMIS day IR images, inter-ridge areas display relatively smooth and featureless surfaces except for the presence of low-relief scarps and small sinuous channels, interpreted to be fluvial in origin. However, high-res images show that inter-ridge areas contain dune features, accumulations of smooth materials in low areas, and small knobs adjacent to some ridges. Subsequent fluvial activity, including collapse and erosion to form S1 and smaller channels, and deposition of sediments has significantly modified portions of the ridged plains in this area; these deposits are identified as *modified ridged plains*. The ridged plains sequence is interpreted to be sedimentary and/or volcanic material that was modified by fluvial and eolian processes, including erosion, mobilization and deposition of surficial materials. *Dark plains material* is found along the western edge of S1, and one exposure occurs in the ridged plains east of S1. These plains display lower albedo relative to adjacent materials. The western exposure displays a distinct scarp edge and appears stratigraphically higher than the ridged plains, and is indistinct from adjacent exposures of the modified ridged plains. The eastern exposure occurs in an irregular depression; this exposure appears to embay the surrounding ridged plains.

Several plains units are found in the southern part of the map area; most plains occupy local low-lying regions and are observed to embay highland massifs. *Smooth plains material* displays smooth surfaces, but in high-res images smooth plains display low-relief scarps, small channels, pits and scattered knobs suggesting sublimation and collapse of volatile-rich material, as well as modification by fluvial and eolian processes. The largest exposure of these plains occurs adjacent to S2-U, but smaller exposures are found among the highlands. The *modified smooth plains material* is stratigraphically lower than the smooth plains material and forms the lower wall material along S2-U. These materials were likely exposed during the formation of RV. An additional smooth plains unit - *smooth plains material 1* - forms a few small exposures in the vicinity of S2-U, and in most places is adjacent to smooth plains material. Although these two units are currently mapped separately, they may be similar materials. The smooth plains sequence is interpreted to be a mixture of sediments deposited prior to and during the formation of RV by overflow of the canyon and from erosion via valley networks, and may also include materials deposited via mass wasting [5-8].

Three distinct plains units occupy the southeast portion of the map area. *Etched plains material* is found at the origin of S2-U in the location corresponding to the "Morpheos basin" [23,24]. In THEMIS day IR images, etched plains display a mottled appearance, which in high-res images is due to low albedo materials being eroded to form yardangs and exposure of underlying higher albedo plains. A small exposure of *knobby plains material* is found along the eastern edge of the map area. This unit consists of small (10s of meters in diameter) knobs surrounded by relatively smooth plains. Inspection of this unit in high-res images reveals that the knobs may be remnants of the mottled plains to the south and west. M*ottled plains material* occupies much of MTM -40247; these plains appear smooth at most scales and fill low-lying areas around highland massifs and degraded craters. The mottling and lack of detail expressed throughout much of these plains suggests these materials may be eolian in nature, similar to the mantled highlands unit mapped by [6], and may be related to a regional mantling unit [25,26].

Mass wasting formed some of the youngest deposits in the map area. Debris aprons [1,5-8,19-21] and viscous flow features [25,26] are found along massifs and crater walls. Massif-associated features typically have uniform or mottled albedo, lobate frontal morphologies, and appear to be composed of multiple coalescing flows. Crater-associated features are relatively small and display mottled albedo, relatively featureless surfaces, and arcuate to lobate fronts. Some crater floor deposits contain rings concentric to the crater walls, similar to concentric crater fill [30,31].

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