GEOLOGIC MAPPING OF THE REULL VALLIS REGION, MARS

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Geologic mapping of the Reull Vallis region (27.5-42.5°S, 245-270°W) is being undertaken in order to determine the sequence of events that formed the Reull Vallis outflow channel system and to understand the geologic processes that modified the Martian southern highlands. The region is situated on the northeast rim of the Hellas Basin in the heavily cratered highlands and shows evidence of fluvial activity, volcanism, mass wasting, and tectonism [1-5]. The western portion of the Reull Vallis region was previously mapped in a study of Hadriaca Patera [4].

***Regional Stratigraphy*:** The types of geologic units mapped in the Reull Vallis region include highland terrains, volcanic plains and flows, a series of sedimentary plains, channel floor deposits, and surficial and mass wasting materials. Units and stratigraphic relationships were determined by analysis of Viking Orbiter images (resolutions from 46 to 200 meters/pixel) with compilation on a 1:2,000,000 base. Some units, particularly the older ones, were identified in previous mapping studies and have been assigned to Martian stratigraphic positions based upon crater-size-frequency distributions [3-5].

The Noachian basin rim unit (Nh_1) and mountainous material (Nm) are the oldest units in the Reull Vallis region [3]. The basin rim unit consists of rugged mountainous terrain that is heavily cratered and dissected by valley networks. Mountainous material tends to form large, rugged, isolated or clustered massifs that occur throughout the Reull Vallis region but tend to be concentrated near the channel. These massifs are believed to be ancient crustal materials uplifted during impact basin formation [3]. Degradation of Noachian highland units by valley networks, debris aprons/flows, and crater fill occurs throughout the region but tends to be concentrated within ~250 km of Reull Vallis. Many small valley networks are found within small drainage basins in the highlands and may have contributed to resurfacing of the region. The valley networks exhibit dendritic patterns that appear truncated by the smooth plains units that surround Reull Vallis. The smooth plateau unit (Hpl_3) forms flat, relatively featureless plains throughout the southern highlands and is interpreted to be interbedded lava flows and sedimentary deposits of eolian or fluvial origin [3]. Hpl_3 occurs adjacent to Hadriaca Patera in the Reull Vallis region [4]. Several exposures of plains in the region, originally mapped as Hpl_3 by Greeley and Guest [3], are now considered to be younger sedimentary units (described below).

The ridged plains of Hesperia Planum, located in the northeast corner of the region, are interpreted to be volcanic plains deformed by compressional tectonism [6-9]. The southern portion of the Tyrrhena Patera flank flow (AHff), which extends from the summit of Tyrrhena Patera ~1000 km to the north, occurs in the Reull Vallis region and is characterized by elongated, lobate lava flows and leveed channels [4, 10].

The channeled plains rim unit (AHh_5) forms a large portion of the southern part of the Reull Vallis region. The unit is characterized by narrow, sinuous channels, widespread knobs, and flat-topped, scarp-bounded mesas. AHh_5 is interpreted to consist of volcanic and/or sedimentary deposits eroded by surface runoff [3, 4, 11]. The pitted plains unit (AHpp) is found in a low-lying region between peaks of highland material near the intersection of Reull and Harmakhis Valles. The pitted plains are interpreted to be partially collapsed volatile-rich deposits, possibly containing coalesced debris aprons [4].

Five units were identified as a result of recent detailed mapping of the Reull Vallis region [12] that had previously gone unrecognized. These units include dissected plains (pd), smooth plains (upper, middle, and lower members - ps_3, ps_2, and ps_1, respectively), and mantled highlands (hm). The dissected plains unit (pd), located to the north and southeast of Reull Vallis, is typically found adjacent to the smooth plains units (see 34.5°S, 256°W). This unit fills low-lying areas between massifs and knobs in the highlands, and is highly dissected by numerous scarps and many small, sinuous channels. The dissected plains unit is more heavily cratered than the smooth plains unit, which contains fewer and more subdued wrinkle ridges. The dissected plains unit is interpreted to be deposits of sedimentary and/or volcanic origin [12] and was previously mapped as the southern part of Hesperia Planum [3].

The upper, middle, and lower members of the smooth plains unit (ps_3, ps_2, and ps_1, respectively) can be found adjacent to and surrounding Reull Vallis and have relatively featureless surfaces. They are lightly cratered with mostly small (<1km diameter) craters. The smooth plains appear to embay Noachian highland units Nh_1 and Nm and exhibit lobate terminations. The smooth plains units in the Reull Vallis region are interpreted to be deposits of sedimentary origin [12]. The upper member of the smooth plains unit (ps_3) occurs immediately adjacent to the main channel of Reull Vallis (see 41°S, 256°W). This member exhibits a few wrinkle ridges adjacent to the channel that have subdued morphologies and may be partially buried by ps_3. The middle member of the smooth plains unit (ps_2) occurs adjacent to ps_1 around 40°S, 253°W. The lower member of the smooth plains unit (ps_1) occurs adjacent to ps_2 and, in some places, adjacent to ps_3 and Reull Vallis (40°S, 252°W).

The mantled highlands unit (hm) consists of smooth, featureless deposits covering highlands in the southeastern corner of the region. Highland mesas and knobs have subdued morphologies within this unit, whereas in adjacent units they are more rugged and pronounced. Few pristine superposed craters are present in this unit. The mantling material is interpreted to be a widespread, continuous deposit of wind-blown material.

Vallis floor material (AHv) consists primarily of smooth deposits that form the floor of Reull Vallis. Also, where the channel narrows, floor material contains lineations parallel to channel walls, and where the channel widens into a large irregular basin, the floor is pitted and etched. AHv is interpreted to result from collapse of volatile-rich volcanic and/or sedimentary material [5]. Numerous occurrences of debris aprons and debris flows (da - mapped as Ada by Crown et al. [4] and Crown and Stewart [13]) and crater fill material (cfl) are found in the Reull Vallis region. Large debris aprons and debris flows are found around highland massifs adjacent to Reull Vallis. Most debris aprons in the region have smooth, featureless surfaces but some contain linear flow features or pits [14]. The majority of debris aprons and flows in the region tend to overlie ps_3; several debris aprons are found on pd around highland massifs, but these aprons are not as extensive as those on the smooth plains. Many craters in the highland units of the region have smooth floors that appear to be resurfaced by crater fill material (cfl). The crater fill probably consists of material from outside the crater rim and/or debris flows from crater rim materials.

***Reull Vallis*:** The main channel of Reull Vallis (~1500 km long, 6-10 km wide, and 100-600 m deep) cuts through Noachian highland materials and younger plains units which have resurfaced low-lying areas in the highlands. The source area for the fluids that carved Reull Vallis is located within the ridged plains of Hesperia Planum. The source area consists of several small channels that converge in a large irregular depression from which the main channel extends. Sections of Reull Vallis exhibit pits and linear grooves within floor materials and layering in channel wall and floor materials. A large theatre-headed basin is located south of the main channel and also shows evidence of layering within its walls. This basin may be another source of fluids that carved Reull Vallis. Reull Vallis resembles Dao and Harmakhis Valles, west of Reull Vallis, which are believed to have formed by collapse of volcanic and sedimentary plains and subsequent erosion by surface and subsurface flow [4, 11, 15]. Reull, Dao, and Harmakhis Valles all flow toward the Hellas Basin.

Geologic History of the Reull Vallis Region: Emplacement of the Hellas Basin during the Early Noachian Epoch was followed by a period of intense bombardment that formed the ancient cratered highland units [3-5, 7, 16, 17]. The region then underwent extensive volcanism during the Late Noachian/Early Hesperian Epochs, exemplified by two large volcanic systems, Tyrrhena Patera and Hadriaca Patera (believed to be composed of layered pyroclastic materials), and the ridged plains of Hesperia Planum [10, 16]. Compressional stresses in the region primarily affected the Tyrrhena Patera flank flow and Hesperia Planum by forming cross-cutting sets of wrinkle ridges radial to and circumferential to the Hellas Basin [3, 9, 10, 16, 18]. Degradation of the cratered highland units and paterae by fluvial activity occurred throughout the region with numerous fluvial valleys developing in the highlands and on paterae flanks [4, 5, 10, 12, 16, 19]. A series of laterally extensive volcanic and/or sedimentary plains (including AHh_5, pd, ps_3, ps_2, and ps_1) were emplaced in the region, filling in low-lying regions of the highlands. Formation of Reull Vallis resulted in erosion of Noachian-, Hesperian-, and Amazonian-aged units. Overflow of fluids from Reull Vallis may have caused widespread dissection of sedimentary plains in the region [15]. Emplacement of the mantled highlands unit, debris aprons/flows, and crater fill appears to be among the youngest geological events in the region.

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