REULL VALLIS – EVOLUTION OF A FLUVIAL SYSTEM IN EASTERN HELLAS REGION, MARS.
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Introduction: The eastern Hellas region has been characterized and modified by apparent volatile rich activity. Still, the scales of these processes, their exact places in local geologic history, and even their forms are still very debatable [c.f., 1 and references therein]. In eastern Hellas, as also elsewhere on Mars, the large channels and runs have been subject to extensive studies [e.g., 2-8]. One of the channels, Reull Vallis, begins in Hesperia Planum and runs from east to west across the Promethei Terra. We present a hypothesis for the evolution of Reull and its complimentary fluvial system. We suggest that this system consists of several parts that were formed during several distinct phases.

Data and methods: We defined and analyzed the different parts of the fluvial system and correlated temporally the processes that led to their formation using available images and topographic data (VO MDIMs, MGS MOC, MO THEMIS (IR and VIS), MEX HRSC, and MGS MOLA-gridded topography (128 px/deg)). Crater counting served to derive relative and to model the absolute ages of different portions of the Reull Vallis system; measurements from MDIM and MOLA were used to estimate volumes and their balances for different parts of the system.

The segments of the fluvial system: We identify at least five parts within the Reull Vallis fluvial system (Fig. 1) separable either by 1) morphology, or type of flow (sub/on-surface) or 2) by its place in the evolution of the fluvial system. The first, northernmost part (depression with provisional name "Morpheos Trough"), begins within the southeastern portion of Hesperia Planum at ~31°S, 246.5°W. At ~32.5°S, 246°W, it is transformed into a morphologically distinct channel, "Morpheos Vallis" (segment 1 of Reull in [8]), which represents the second part of the system and also a change in the system; from subsurface to on-surface. This channel runs southward, and disappears at the northern edge of "Morpheos Basin" [9,10] at about 35°S, 246°W. This basin is the third part of the system; it represents a closed topographic depression elongated in W-E direction in the SE portion of Hesperia Planum, which received and stored water from Morpheos Vallis. The morphology of Morpheos Vallis suggests a catastrophic outflow through it. If we assume velocity of the flow to be 60-70 km/h, it would take ~5-8.5 days to fill the basin up to the 650 m contour level (~200 m deep); the volume of stored water is ~11-17 x 10^4 km^3. Morpheos Basin appears to be the source area of Reull Vallis. The fourth part of the fluvial system is the upper Reull Vallis (Fig. 1) (segment 2 of Reull in [8]). It begins as a full-sized topographic and morphologic feature at the western edge of the Morpheos Basin (~37.5°S, 247°W). For the largest portion of the channel of Reull Vallis is on a very shallow slope (Fig. 2). At ~42°S, 254°W, slope of the channel increases, whereas the regional slopes on both sides of it stay the same (Fig. 2). Volume of the upper Reull is ~1700 km^3. The fifth part of the system is the lower Reull Vallis (Fig. 1). It starts at ~42.5°S, 257°W as a broad and deep canyon and runs to the west along a shallow slope, which is similar to the regional slope outside of the channel and to the slope of the upper Reull (Fig. 2). Volume of the upper Reull is ~8300 km^3. The longitudinal profile (Fig. 2) shows that Teviot Vallis, an apparent tributary to Reull Vallis (its volume is ~3100 km^3), continues the topographic trend of the lower Reull.

Figure 1. Viking MDIM showing the five parts of the Reull Vallis fluvial system.

Figure 2. The longitudinal topographic profile of Reull Vallis consists of two distinct parts, the upper and lower Reull separated by a major break in slope. A “tributary” to Reull (Teviot Vallis) continues the topographic trend of the lower Reull.

Harmakhis Vallis: The consecutive phase(s) of Reull Vallis cannot be determined – the more recent formation and activity of Harmakhis Vallis took place near the apparent terminus of the Reull Vallis. Also, a debris apron covers the connection between these two. Still, it is obvious that this abrupt “dead end” cannot be the real terminus. We see some possibilities for the final phases of Reull: 1) The Vallis continued as a channel where Harmakhis is now located and later formation of Harmakhis effectively erased the evidence for the ear-
lier, “lowest” Reull. Some evidence for older channel parts can be seen in some parts of the lower Harmakhis. 2) Alternatively, Reull Vallis flow changed style for some reason (change of slope gradient, strength of flow, or target material) from a channel scouring flow. It is possible that it continued as a laminar flow, or the fluvials and transported material were ponded in the area from where Harmakhis now begins. The flow marks on the surrounding plains seem to suggest that at least in the final phases of Reull activity this in fact happened (Fig. 3).

Crater counting: In order to estimate ages in different portions of the Reull Vallis fluvial system relative to Hesperia Planum and to each other, we have counted craters in three large regions: 1) Hesperia Planum (1.50 x 10^6 km^2, 3266 craters, 1.2-49.9 km in diameter), 2) Morpheos Basin (0.24 x 10^6 km^2, 357 craters, 1.2-31.4 km in diameter), and 3) Reull Vallis region (both upper and lower Reull, 0.27 x 10^6 km^2, 261 craters, 1.2-39.7 km in diameter). The crater size-frequency distributions show that the Morpheos and Hesperia curves are practically coincided, while the Reull Vallis curve is distinctly lower (Fig. 4). Thus, the crater retention age of the Morpheos basin is indistinguishable from that of Hesperia Planum and the area around Reull Vallis is younger, which is consistent with apparent sequence of events during formation of the Reull Vallis fluvial system.

Conclusions: Our analysis suggests that the Reull Vallis fluvial system consists of several distinct parts that have different origin and age. The whole evolution of the system appears to be consisted of three major episodes: (1) formation of the lower Reull (apparent beginning of it is the Teviot Vallis in ~44°S, 258°W), (2) formation of the Morpheos fluvial sub-system (these two episodes may or may not be contemporaneous), and 3) formation of the upper Reull that connected the Morpheos sub-system with the lower Reull Vallis.

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