EPSC Abstracts
Vol. 7 EPSC2012-878 2012
European Planetary Science Congress 2012

Hellas outflow channel study: the formation and timing of Waikato and Reull Valles, Mars

V.-P. Kostama and S. Kukkonen

Astronomy, Department of Physics, University of Oulu, P.O. Box 3000, 90014 Oulu, Finland (petri.kostama@oulu.fi)

1. Introduction

There are several large scale outflow channels to the east-northeast of the Hellas basin in the southern hemisphere of Mars. Majority of these channels are located in the large scale topographic trough connecting Hesperia Planum and Hellas basin. One of these valley systems is located outside the Hellas-Hesperia Trough (HHT, [4,6]). This ~1500 km Reull Vallis and its parts have been studied in greater detail in the past [i.e., 5,8]. Previous studies noted the upper parts of the Reull system separated by a topographic depression (previously identified and provisionally named as Morpheos basin), and identified it as a possible paleo-reservoir, filled by the release of fluents from the upper part of the Reull system, now known as Waikato Vallis [5-7].

In earlier study [5], we presented a hypothesis for the formation of the Reull Vallis system and its segments, including Waikato, Reull and Teviot Valles which addressed the geomorphic observations of Reull Vallis system. The new data from HRSC, CTX and HiRISE enable to add more detail to the evolution of the whole fluvial system. The crater size-frequency counting using the hi-res data and geological analysis of the upper WMR (Waikato–Morpheos–Reull) system region and southern Hesperia Planum enable us to 1) estimate the formation age of the upper Reull Vallis and Waikato Vallis outflow channels, 2) more explicitly define the size of the Morpheos basin, and 3) present a detailed analysis of the upper parts of this system. Using the observations and calculations, an updated view and time of the evolution of the system and associated region is presented.

2. WMR-system

It has been observed that Reull Vallis has some important characteristics, most importantly the Segments 1 and 2, [8] of the main Vallis are not connected to each other [i.e. 5,8]. Between the previously identified segments is a flat-floored topographic depression, the Morpheos basin [5-7]. The deepest measured parts of this depression are at ~450 m level [5]. The morphologically smooth floor of the basin is surrounded by the rugged surface of the cratered terrains. A hypothesis of a transient reservoir of water, formed by the flows from the Waikato Vallis (Segment 1), that existed in the western portion of the Morpheos basin was suggested and studied [5-7]. This reservoir acted then as the source for the flows that carved Segment 2, the upper Reull. In the earlier study, it was noted, that this reservoir may have formed quite rapidly and it may not have been a long-lived feature [5]. The existence of the depression, and both inlet (Waikato Vallis) and outlet (Reull Vallis) channel suggest that Morpheos basin may have been an open-basin lake [1,3] for a period of time. Volumetric re-analysis proposed that a likely level of filling would be around the levels of 450-500 m [2]. However, Capitoli and Mest [2] also noted that if multiple pulses of water from Segment 1 were released, a level up to 550 m at the basin could be reached. Our recent measurements and mapping [7] support this proposition of basin fill to the ~500-550 m contour level.

3. Evolution and age of the WMR

Crater counts were used in to determine the surface age of key regions (c.f. Fig.1). Two principal stratigraphic levels were identified: 1) Hesperia Planum regional lava flows with age of ~3.67 Ga, and 2) the widely spread ejecta blanket (age ~3.52 Ga) of the eastern crater (35.5°S, 115.5°E) which effectively covers the channel structures of the Waikato Vallis. This period of ~150 Ma is therefore the time-limit of the major outflow formation.

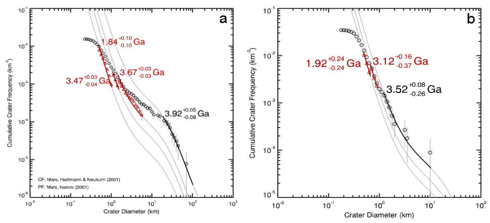

Figure 1: Results of the crater counts: A) Hesperia Planum surfaces. Formation of the plains ~3.67 Ga. B) Ejecta of the eastern crater (35.5°S, 115.5°E). Impact event occurs ~3.52 Ga.

Geological mapping, photogeological observations and crater counts were used to analyze in detail the regional evolution. The formation scheme of the WMR system is presented in four phases (Fig. 2):

A) Placement of the regional Hesperia Planum lava flows, and formation of the larger impact structures (such as Fitzroy and the crater cluster in the middle). Morpheos basin is a local topographic low.

B) Activity from Waikato Vallis initiates channel formation, erodes the crater rims of the two eastern craters in the crater cluster (35.5°S, 114°E) and cuts through the southern Hesperia Planum. The flows connect and empty to the existing Morpheos basin depression filling it partly with transported material.

C) Continued activity from the source regions of Waikato Vallis breach the rim of the largest crater in the cluster, and fill the crater (at least partly). The already formed channels to the east are favored and the smaller craters and rims are even more eroded. Previously partly filled Morpheos basin depression to the south is filled in the deepest parts to the west until the flows breach the neck in the west thus forming the Reull Vallis.

D) Large impact event (35.5°S, 115.5°E) occurs and the extensive ejecta blanket covers majority of the previous signs of activity. Some remains of the first activity phases can still be seen (eroded rims, tear drop shaped islands and flow fans). Later activity from Waikato fills the large crater and adjoining smaller crater in the crater cluster and in places overflows the SW-S-SE rims. The deposits left from these flows are later eroded, as is the floor of the now empty Morpheos basin reservoir. Latest activities in the region are the viscous flows on the rims of the craters and channel walls and floors.

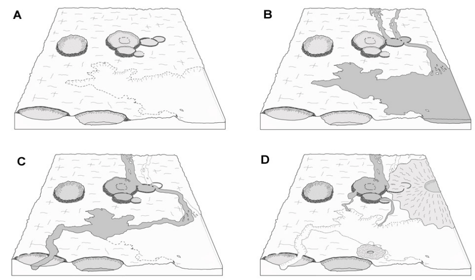

Figure 2. Evolution of the Waikato Vallis – Morpheos basin – Reull Vallis (WMR) system (see text for details).

Conclusions

A refined evolution scheme for the WMR system was found. The study shows that the system was formed and was subject to several pulses rather than just one phase of activity during a limited period of time between 3.52-3.67 Ga. The analysis of the study region also confirms the existence and revealed a more exact size for Morpheos basin. Geological mapping supported by the crater counts imply that the basin was filled up to the ~500 m contour line.

References

[1] Cabrol, N.A and Grin, E.A., Icarus, Vol. 142, Icarus, pp. 160-172, 1999.

[2] Capitoli, E.J. and Mest, S.C., First International Conference on Mars Sedimentology and Stratigraphy, 19-21 April 2010, El Paso, Texas, 1547, p.12, 2010.

[3] Fassett, C. and Head, J.W., Icarus, Vol. 198, Issue 1, p.37-56, 2008.

[4] Ivanov, M.A. et al., Journal of Geophysical Research, Vol. 110, Issue E12, CiteID E12S21, 2005.

[5] Kostama, V.-P. et al., Journal of Geophysical Research, Vol. 112, Issue E11, CiteID E11001, 2007.

[6] Kostama, V.-P. et al., Earth and Planetary Science Letters, Vol. 294, Issue 3-4, p. 321-331, 2010.

[7] Kostama, V.-P. et al., EPSC-DPS Joint Meeting 2011, 2-7 October 2011, Nantes, France, p.1555, 2011.

[8] Mest, S.C. and Crown, D.A., Icarus, Vol. 153, Issue 1, pp.89-110, 2001.