THE TOPOGRAPHY OF VALLEY NETWORKS ON MARS: COMPARISON BETWEEN VALLEYS OF DIFFERENT AGES V. Ansan[1] , N. Mangold[1], Ph. Masson[1], G. Neukum[2] and the HRSC co-Investigator team. Lab. IDES-CNRS, bât. 509, CNRS and Université Paris-Sud, 91405 ORSAY, France, [2]DLR, Berlin, Germany, Contact: veronique.ansan@u-psud.fr

Introduction: Valley networks on Mars have been the subject of considerable debates about their formation processes since three decades [1-5]. MOLA altimetric data gives the possibility to study the geometry and topography of valley networks at spatial resolution of typically 500m - 1km [e.g. 6]. This resolution is sufficient to map large valleys but not small tributaries that we can map on high resolution imagery. The Mars Express High Resolution Stereo Camera (HRSC) allows us to exctract Digital Elevation Models from stereoscopic images with typical spatial resolution of 50 m or better, but vertical resolution not as good as that of MOLA, typically 20 to 100 m depending on terrains roughness and image quality. In this study we compare the organization of valley networks in four regions. South Aeolis and West Huygens regions are two locations typical of Noachian highlands with apparent deep valleys. West Echus Chasma plateau is a post-Noachian networks of very dendritic valleys. Alba Patera is a late network of Amazonian age observed with Viking images [3]. We use both DEMs (MOLA and HRSC) and manual mapping in order to quantify the difference of geometry between these two datasets.

Valley networks in Aeolis region and West Huygens region: These regions are characterized by densely cratered terrains dated of the Noachian period [7, 8]. The terrains between large craters are incised by valley networks. HRSC acquired some images with a spatial resolution ranging from 10 m to 40 m in 5 stereo bands and 4 color channels in Aeolis region. These images show that the densely cratered terrain has been modified by numerous valley networks. For example, the nadir images of 228 and 241 orbits, centered at 157.355°E and 30.576°S (**Fig. 1**) display a set of valley networks with a dense organisation (dendritic pattern with high bifurcation ratio). HRSC DEM gives a strong improvement in the drainage characterization compared to MOLA, reaching drainage densities three times higher than MOLA (0.45 compared to 0.15 km^{-1}). In the East Huygens crater, the improvement is not so large because the HRSC DEM does not reach the same resolution. In both regons however, valleys are deep, typically more than 100 m, reaching 400 m in the East Huygens area. Together with their high drainage density, these regions were submitted to a strong erosion.

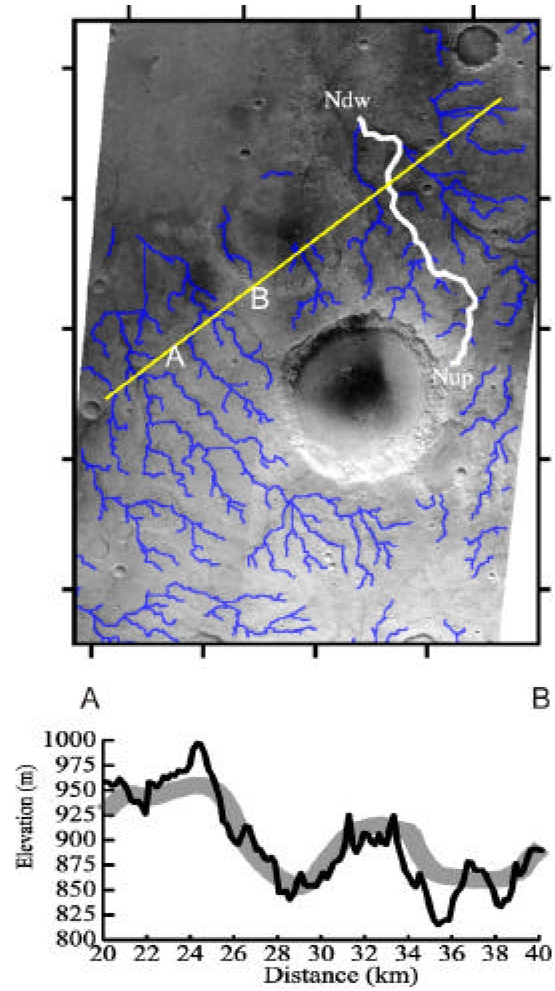
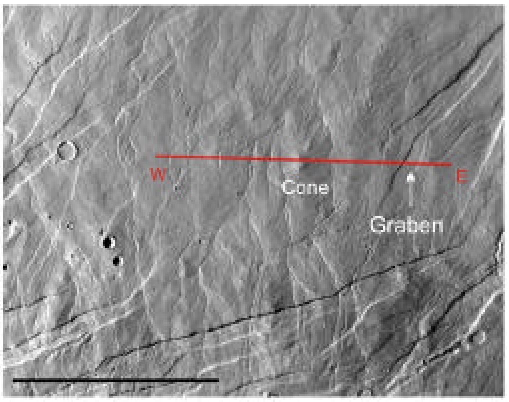


Fig. 1. Close-up of HRSC image (orbit 228-241) located in Aeolis region. Numerous dendritic valley networks incised Noachian densely cratered terrains. Blue lines correspond to valleys automatically extracted from the HRSC DEM; these valleys correspond to those mapped visually. The profile between A and B shows MOLA in gray and HRSC DEM in black. HRSC DEM displays a better resolution enabling us to identify two valleys in location only one is visible in MOLA. Typical depths reach 100 to 200 m in locations.

Valley networks in Echus region: This region is located at the North of Valles Marineris. On the plateau at the west of Echus Chasma canyon (278-281°E, 0-5°N), valley networks show similar fluvial dendritic pattern. These valleys were identified from their difference of thermal properties on THEMIS images [11]. HRSC provides the possibility to look in details to their morphology and geometry with the spatial resolution at ~20 m/pixel. Valleys in Echus area are not restricted to the locations where they have been observed through THEMIS images [11]. They extend over more than 200 km along Echus Chasma western plateau. MOLA topography enable us to detect only a few valleys in this region with depth of about 100 m. This is mainly due to the widths of valleys: valleys less than 500 m wide can not be detected on MOLA DEM despite the excellent vertical resolution. The HRSC DEM at spatial resolution of 50m gives slightly better results by detecting most valleys deeper than 30 m. In general, the main valleys reach depth of 70-80 m, but most tributaries are 20-50 m deep. This suggests lower incision than in the Noachian terrain despite the drainqge density is higher, likely as a result of good preservation conditions.

Valley networks in Alba Patera: Alba Patera flanks display erosional valleys that were discovered using Viking images [e.g. 3]. They display locally very high drainage densities (up to 2 km^{-1}). However, HRSC images shows that they are very small patterns, ressembling more rills or gullies (intermittent runoff erosion) than valleys formed from sustained erosion. Depth of valleys were not measurable with MOLA due to their small size. The HRSC DEM provides depth of valleys showing they are typically lower than 30 m **(Fig. 2)**. This confirms valleys formed on Alba Patera volcano are likely the result of transient erosional processes, possibly related to snow melting due to volcanic activity [3].

Conclusion: Compared to MOLA, HRSC DRMs improve the quantification of valley networks properties such as drainage densities. The four studied regions enable us to compare Noachian regions to post-Noachian regions. The comparison shows that the West Echus plateau younger drainages are much more shallow with less incision than in the South Aeolis and East Huygens regions, despite that the drainage densities is higher and their maturity is large. This difference is probably the effect of three parameters: (1) Noachian terrains are not as well preserved as late episodes of activity on freshly formed Hesperian rocks, possibly explaining small tributaries are missing over Noachian terrains, (2) the duration of Noachian networks might be longer to explain the larger incision of valleys, (3) the bedrock composition is uncertain and might be different. Alba Patera displays valleys even shallower than Echus plateau, with maximum of 20-30 m. Morphologically, they are also different and less mature. Assuming similar lithology (ash deposits) the time required to form Alba valleys is even much more restricted than the time required to form Echus Chasma plateau valleys.



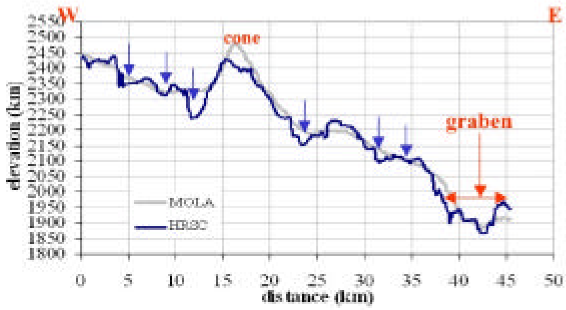


Fig. 2: Close-up on the Alba Patera northen flank. Many valleys are visible, but they are very small and poorly branched. Automatic extraction is not possible due to tectonic patterns. HRSC DEM in black enable the identification of shallow valleys (typically <30 m depth) whereas MOLA (in gray) give a similar envelope without visible valleys in the topography.

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