THE GRANICUS AND TINJAR VALLES CHANNEL SYSTEM J. Nußbaumer[1] [1]Johannes Gutenberg University, Mainz

Introduction: Granicus Valles is a valley system that formed to the west of the Elysium Mons volcano (Fig. 1). It is interpreted to be the result of volcanic melting of the permafrost and associated mudflow activity, resulting in a meandering and anastomosing system [1]. The water in the flow either sublimated after a relatively short time or transferred into the ground, and thus may be partly responsible for the formation of the polygonal structures in Utopia Planitia.

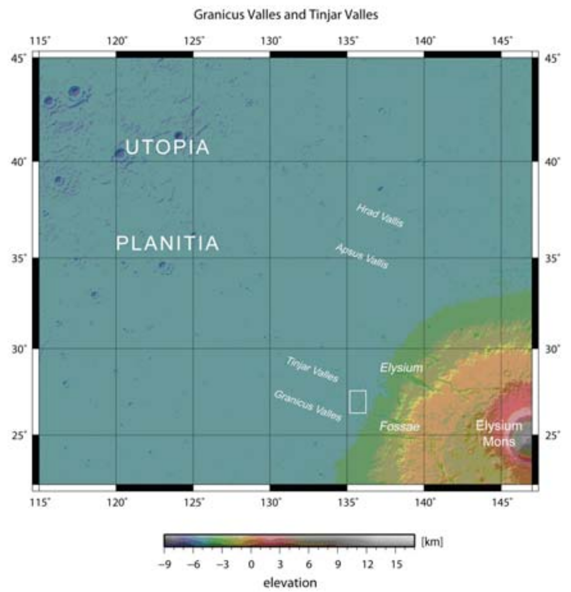

Fig. 1: Index map showing Elysium Mons shield volcano, Elysium Fossae, and Utopia Planitia, the basin of which served as the catchment for deposits related to the formation of Granicus, Tinjar, Hrad, and Apsus Valles.

The channel system can be divided geomorphologically into several sections. Beginning with the canyon structure and a fluvial drainage pattern [1], the channel system shows glacial morphologies as well (see Fig. 4). This is possibly due to a change in flow viscosity [2]. A hypothesized subglacial genesis is based on the shape and orientation of elongated ridges within the valleys [3]. However, terraces are observed along the channel margins, an observation that is more consistent with a fluvial genesis, but terraces can be caused by a number of things, including erosion or deposition by water or ice, or by pre-existing layers. Such volcano-induced melting events point to a volatile layer during the era of volcanism [1]. Explosively shaped landforms resulted from hot lava entering a volatile-rich zone in the subsurface, resulting in phreatomagmatic pseudocraters [1]. Granicus Valles is situated between two units, Aelc and to Ael2 (see [4]), based on Viking Orbiter era geologic mapping results. Unit Aelc is the coarse member showing fluidized ejecta structures. This unit is interpreted as a volcanoclastic lava flow [4]. Unit Ael2 is a young lava flow of Elysium Mons. Since the lavas of the Hecates Tholus shield volcano are older (located to the north of Elysium Mons) than the lavas of Elysium Mons, the center of volcanic activity appears to have temporally migrated to the south, potentially influencing the formation of the valley system.

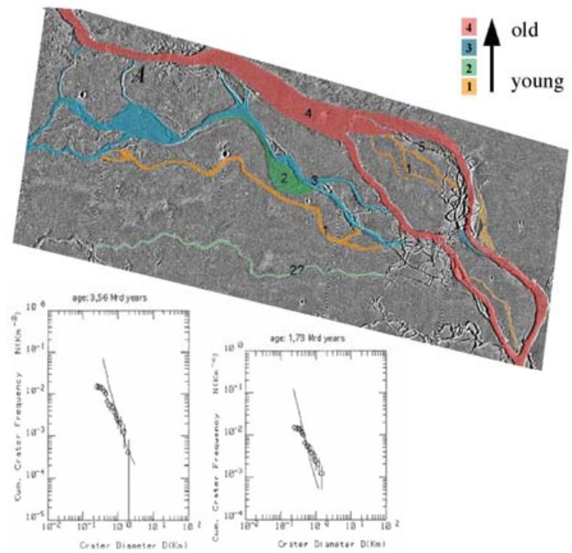

Fig. 2: Schematic map of the channel systems of Granicus valles above) and impact crater statistics (below); impact craters were counted in the red colored area. Also shown is location A used for Chezy-based calculations of the flow velocity, the amount of water per time, and the flow duration. Note that the crater statistics possibly indicate multiple resurfacing events.

Geochronology: Granicus valles formed during the Late Hesperian and/or Early Amazonian [4] with channel deposits emplaced by fluvial processes [1] during the Early Amazonian (~3 Ga old [4]). The last eruptive phase in Elysium is estimated to be 2.6 Ga ago [4]. Elysium-related volcanism was active during several Hesperian phases [4]. According to crater counts in the broadest primary channel, an age from approx. 1.7 or 3.5 Ga was calculated. Based on impact crater morphology and stratigraphy, which includes impact craters resurfaced by fluvial activity, several resurfacing events are hypothesized for the formation of the Granicus and Tinjar Valles channel systems (e.g. repeated emplacement of Elysium rise-sourcing lava flows and associated channel dissection). Resurfacing events become visible in the impact crater curve as bend or incision, which marks the relative-age of the resurfacing event (see Fig. 2)

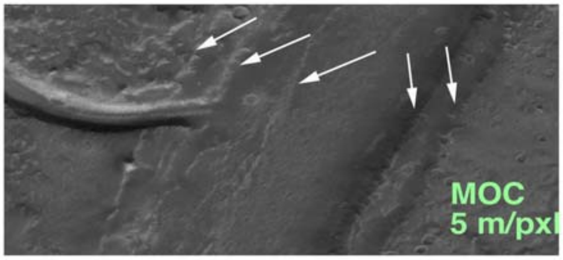

Fig. 3: MOC image showing fluvial terraces in Granicus valles. The depth and width of the valley is 200 m and 6 km, respectively.

Craters were covered by sediments of flood events, that are identified from fluvial terraces (Fig. 3). The flood events can be divided into 4 episodes [3] that occurred in the Early Amazonian, according to [4], synchronously with the different eruptive stages of the volcanoes. In these eruptive stages, different amounts of meltwater were produced. The first flood episode was at the southernmost point of the valley system (see Fig. 2), based on a younging of the channel surfaces toward the south. Relative age differences of Granicus Valles are identified by cross-cutting relationships between channel segments.

Geomorphology: The valley shows different valley cross sections and morphologies, in which ice and water-containing debris flows with different composition either simultaneous or at different times have flowed, dependently on the water content in the liquid medium and the temperature in the soil. Glacial-morphological structures favour a glacial genesis of the valley system, for example long ridges, that formed next to streamlined islands or next to channels, which ultimately flowed together (Fig. 4). The erosion at the obstacle and the resulting sedimentary accumulation may be the likely origin of these ridges. Downstream of an obstacle, smaller accumulation exists in fluvial systems vs glacial channels, because erosion is more intense in glacial channels and therefore, more material is available to form the glacial ridges. A terrestrial equivalent for a landform in the Granicus Valles valley system could be found near the Mt. St. Helens Volcano in Washington. An astonishing similarity of valley structures exist here (Fig. 5). In both cases these structures are oriented to the volcano, which have concentric graben systems.

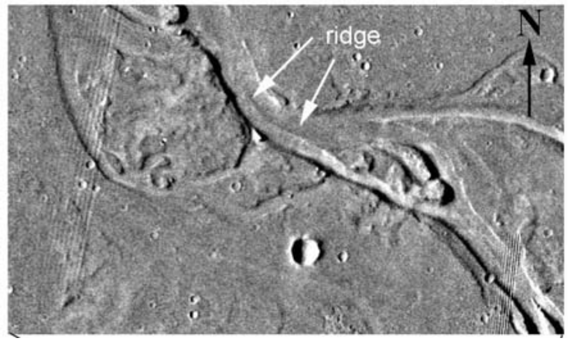

Fig. 4: Glacial ridges in Granicus Valles, Viking F649A, image resolution is 38m/pxl, image width is ~ 25 km.

Fig. 5: Landforms in Granicus Valles, HRSC image, orbit (1383), specific landform that resembles landforms at Mt. St. Helens marked with an arrow.

Paleohydrology: Through Chezy-based calculations, the flow velocity, the amount amount of water per time, and the flow duration has been calculated at point A in Fig. 2.

$$v = C\sqrt{Rs} \qquad C = \frac{1}{n}(R)^{\frac{1}{6}} \qquad T = \frac{V}{KQ}$$

$$V = \int_T Q(t)dt = KQ_{max}T \qquad Q=vA$$

C=64,46 (constant), R=70m (hydraulic radius), K=0,5 (constant), Results: water quantity Q=2295830 qm/s, flow velocity v=12,24 m/s, flow duration T= 8711s.

References: [1] Mouginis–Mark, P. J. et al. (1984) *Earth, Moon, and Planets, 30,* 149-173. [2] Christiansen, E. H. et al. (1981) *LPSC XII*, 138-140. [3] Chapman, M. G. (1994) *Icarus 10*, 393-406. [4] Tanaka, K. L. et al. (1992) *U.S.G.S. Map* I-2147. [5] Lewis, A. S. (1984) *Vistas in Astronomy, 27,* 25-53.