HYDROLOGIC HISTORY OF THE EASTERN HELLAS BASIN REGION, MARS. V.-P. Kostama[1], J. Raitala[1], M.A. Ivanov[1,2], M. Aittola[1], J. Korteniemi[1], H. Lahtela[1] and T. Törmänen[1]; 1 – Astronomy, P.O. Box 3000, 90014 University of Oulu, Finland, 2 - Vernadsky Inst., RAS, Moscow, Russia. <petri.kostama@oulu.fi>

Introduction: The eastern Hellas rim region displays evidence for continued fluvial/glacial activity throughout its evolution. First episodes of fluvial erosion date back to Noachian to early Hesperian age [1] and the last flow features found within the region are Amazonian [2]. Formation of the outflow channels and smaller channel systems occurred after the emplacement of the Hesperian lava flows although the deposition of the separate sources occurred during the different phases of lava emplacement. The interaction of regional volcanism and ice-deposits may have been the major triggering effect for the formation of the flow features [3-5]. Also, climate changes induced by variations in orbital parametres may have had large scale effects. Dispersed viscous flows such as the lobate debris aprons [6-8] and lineated flow-like deposits manifest the final episodes of the hydrologic history. The observations and analysis of the features suggest a complex and multitemporal regional fluvial activity.

Hesperia reservoir: First visible signs of hydrologic history appear around Hesperia Planum, where initial accumulation of volatiles (water) began from the highlands and concentrated within the broad depression of Hesperia. Although the source of the Noachian valleys is unknown, the hypothesis for their formation is base melting of thick ice sheets [9]. This led to the formation of a large volatile reservoir within the depression [1]. The highland channels extend under the lava flows now covering the Hesperia Planum. Area of the Planum was the principal sink for the channels that predate the emplacement of the lava plains.

The reservoir was depleted in an episode of massive areal erosion within the Hesperia Planum which also occurred before emplacement of the Hesperian lava plains [i.e. 3]. This episode led to the formation of the large topographic depression (Hesperia – Hellas connection; the SW trough [1]). Some of the ice may have remained, as there are evidence of later subsurface flows originating beneath the Hesperian lava stacks on the floors of the outflow channels [1].

Outflow channels and other systems: After the SW trough was covered by Hesperian lava flows, the larger channel systems cut through the surface and thus postdate the emplacement of materials that fill the SW trough. Dao, Niger, and Harmakhis Valles begin as full-size structures in broad, flat-floored, and closed depressions and run down the regional slope toward the Hellas Basin in the southwest. Dao and Harmakhis Valles are close to the NW and SE edges of the southwestern trough and are ~150-250 km apart. Niger Vallis runs parallel to Dao Vallis at about 60 km to the SE before it merges with Dao. A system of smaller channels begins from a chaos-like area at about 36°S, 94°E and runs in the southern direction. It joins Harmakhis Vallis at about 38.1°S, 92.8°E. Dao, Niger, and Harmakhis Valles are very prominent topographic features and represent deep linear depressions whereas the system of the smaller channels is a faint topographic structure (Figure 1).

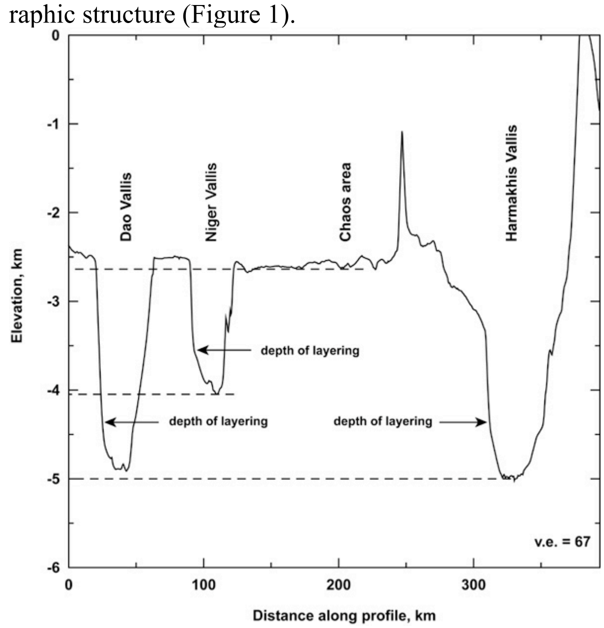

Figure 1. The depths of the source regions of the outflow channels.

Formation of these fluvial features requires the presence of water/ice in their source regions. Volcanic materials can superpose deposits of ice that survive under the cover of lava flows [e.g. 10], which will melt only a relative thin layer from the ice deposit [c.f. 4]. Also, a thin layer of dust or pyroclastic ash can act as an insulator and protect the underlying ice from melting (Vatnajökull observation, 2008). The advancing lava forms quenching surfaces both on the top and on the bottom that effectively insulate interiors of the flow from the surroundings [11]. In order to effectively melt the ice, intrusive volcanism is required (sills, dikes).

Characteristics of the channels indicate that they were formed due to subsurface release of water. Observations show that have their sources at different topographic levels within the layered sequence of volcanic and sedimentary deposits within the SW trough

(Figure 1; see also [2]). Due to the subsurface nature of the sources, the hypsometric levels should correspond to the stratigraphic ages of the ice deposits (Figure 2). Dao and Harmakhis Valles had their sources in ice accumulations at the deepest horizons either in the ancient Noachian regolith or in the oldest volcanic deposits (early Hesperian). This ice corresponds to the first (oldest) recognizable episode of volatile deposits in the trough. The entire floor of Niger Vallis is significantly higher than both Dao and Harmakhis Valles, and ice in the Niger source area was deposited both hypsometrically and stratigraphically higher, actually at the middle stages of the volcanic fill in the SW (Hesperia-Hellas) trough. This indicates the second recognizable episode of ice accumulation in this region. The ice responsible for the formation of the smaller chaos-related channels was deposited at even higher levels and corresponds to the third episode of ice deposition.

The three different hypsometric levels of the sources suggest temporally alternating episodes of the enhanced ice deposition and lava emplacements during the early Hesperian to the lower Amazonian time. The diminishing size of the fluvial systems from the largest and oldest Dao and Harmakhis Valles through somewhat smaller Niger to the smallest chaos-related channels indicates time-wise decrease in the amount of deposited ice.

Besides the prominent outflow channels, there are smaller fluvial systems and possible crater lake chains within the rim region dating from early Hesperian to early Amazonian [12]. These channels are minor but quite extensive (several hundreds of km). They may have collected volatiles from various sources. Analysis of some of these show that they lack mature features, which would indicate relatively short activity [12]. All combined, these networks have also contributed to fluvial evolution of the eastern Hellas rim.

Viscous flows and features: After the channel formation, there have been more recent ice accumulations. That led to the formation of lobate debris aprons and lineated valley fill and the modification of the surface of Promethei Terra area [13,14]. Their time constraints are poorly limited and they could represent a time span from the late Hesperian through the entire Amazonian epoch (Figure 2). The suite of features like mesas, channels, and possible esker-like ridges suggests a late Hesperian to early Amazonian glacier or a set of ice rich dust deposits existed in the western Promethei Terra. The total volume of the deposit is estimated to be about 50-60 x 10^3 km^3 and potentially it could contain from 15-18 to 40-50 x 10^3 km^3 of pure ice [14]. This is comparable with the amount of ice involved in the formation of lobate aprons (5-13 x 10^3 km^3) emplaced at the later Amazonian.

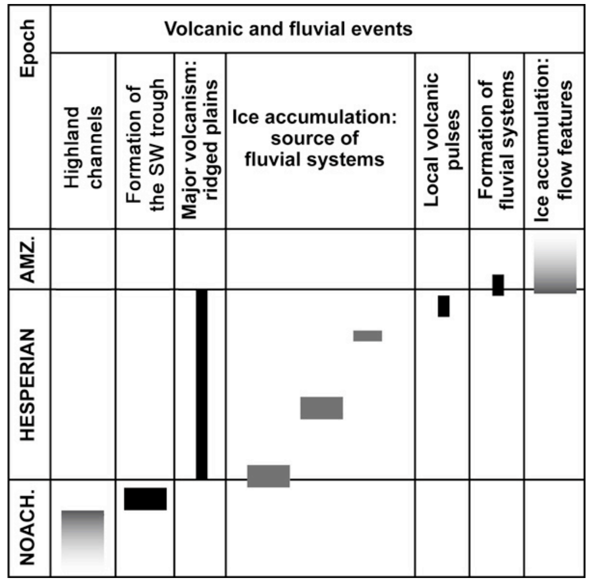

Figure 2. The age relation chart of the regional evolution events. The ice accumulation column in the middle corresponds to the deposition of Dao and Harmakhis, Niger and the system of small channels source ice, respectively.

Conclusions: The eastern rim region of Hellas basin is characterized by the continued interplay of ice deposition and volcanism induced fluvial activity (Figure 2): a) Water/ice has been available throughout the geological history of the region; b) Different levels of source ice indicate that the ice accumulation and volcanism took place alternately (Figure 1), and that the ice deposits were of different age; c) Diminishing size of fluvial features indicate diminishing amounts of deposited ice; d) Several sources contributed to the ice deposits around Hellas.

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References: [1] Ivanov et al. *JGR*, 2005, [2] Kostama et al. *LPSC39*, 2008; [3] Tanaka et al. *GRL*, 2002; [4] Squyres et al. *Icarus*, 1987; [5] Crown and Greeley *JGR*, 1993; [6] Squyres *JGR*, 1979; [7] Lucchitta *JGR*, 1984; [8] Crown et al. *Icarus*, 1992 [9] Carr and Head *GRL*, 2003; [10] Lescinsky and Fink *JGR*, 2000; [11] Gulick and Baker *JGR*, 1990 [12] Lahtela et al. *7. International Conference on Mars,* 2007, abstract #3243; [13] Raitala et al., *AGU Fall Meeting,,* 2007, abstract #P13D-1555; [14] Ivanov et al. *JGR, submitted* 2008.