EXTENSIVE SHEET DEPOSITS IN EASTERN HELLAS PLANITIA: VOLCANIC FLOWS OR CRYO-FLUVIAL DEPOSITS? – A COMPARISON. M. Voelker, E. Hauber, and R. Jaumann, German Aerospace Center, Institute of Planetary Research, Rutherfordstr. 2, 12489 Berlin, Germany (martin.voelker@dlr.de).

Introduction: Sheet deposits on Mars are extensive blankets of either sedimentary and/or volcanic material, which are often characterized by relatively high thermal inertia values. The aim of this study is to provide a detailed discussion about the origin of these sheet deposits. As they are found in many different locations, their understanding can shed light on the sedimentary and volcanic evolution of the planet. Sheet deposits have previously been interpreted as the products of either volcanic [1,2,3] or fluvial [3,4,5,6,7] processes. Many sheet deposits are observed close to volcanic regions (e. g., Tharsis and Elysium), suggesting a pyroclastic or volcanic origin [8]. However, it appears likely that some of the sheet deposits are of cryofluvial origin, as they are apparently directly related to fluvially formed channels, e. g., Grjotá Valles [4] or Havel Vallis [6]. Here we present a geomorphological study of sheet deposits at the lower reaches of Dao Vallis, an outflow channel which is linked to a shield volcano, Hadriacus Mons (HM).

Methods: In order to understand the sedimentary and stratigraphic behavior of sheet deposits, we mapped an area on the eastern Hellas floor at the lower terminus of Dao Vallis at a scale of 1:100,000 in a GIS-environment. We used THEMIS nighttime imagery with complementary CTX images for detailed analyses. Preliminary model age determinations are based on crater counts [8-11]. The thickness of the deposits was estimated with MOLA single shot data.

Results: The geologic map shows a stratigraphy of five distinctive layers of sheet deposits in the study area named AHsd1-5 (Fig. 3). All of them are of late Hesperian or Amazonian origin (~660 to ~3,300 Ma). The source of these deposits is apparently Dao Vallis, and they occur on both the banks and the bottom of the channel. On the banks, they often cover plains of a probably volatile-rich material [6, 12]. Today, the deposits are partially covered by a thin blanket of the latitude-dependent mantle [6]. Most of the sheet deposits show clear, and often lobate, flow fronts with a thickness ranging from several meters to tens of meters; e. g., AHsd5 has a thickness ranging from 29 to 33 m along its flow front. The surface appears mostly smooth at CTX resolution. Besides, all of the units, except for AHsd5, show tenuous conic flowbands diverging from one location, which are oriented parallel to the flow direction (Fig. 2). The width of these subparallel bands rarely exceeds 50 m, and their length can be up to several hundred meters to kilometers.

Discussion: The layers AHsd1-5 indicate five depositional events in the area. There are two possible scenarios for the evolution of these deposits:

Volcanic origin. The study area is located at the end of an outflow channel that is, in turn, connected to a large volcanic edifice (HM). Moreover, the flow fronts of the sheet deposits show significant similarities with other flow structures, e. g., of volcanic origin around Arsia Mons. The magmatic sheet deposits of Arsia Mons are much thicker, with thicknesses from 50 to 170 m. The difference might be caused by a varying viscosity of the released magma. Hence, the lava of HM might be much less viscous (more mafic) than those at Arsia Mons (more intermediate to felsic). HM has been dated to be of Noachian to Hesperian age [12, 13], thus the sheet deposits are much younger than the main phase of volcanic activity.

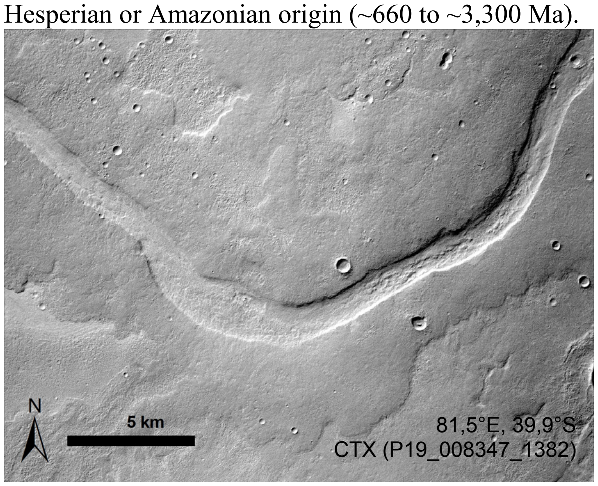

Fig. 1. Sheet deposits cover the banks of Dao Vallis.

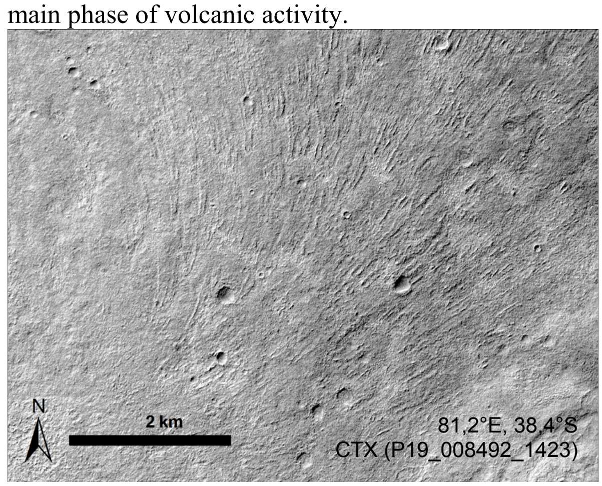

Fig. 2. Conic flowbands on sheet deposit AHsd1.

However, the oldest units might be Hesperian, and hence, related to the last stages of magmatism at HM. If HM is the source of the sheet deposits, the volcanic currents must have been in motion over a distance of 700 to 1,000 km. However, there is a lack of features indicative for volcanic flows, like a platy-ridged surface [15]. This morphology is the result of a cooled, and hence, indurated surface of lava flows, making it possible to run the flow over more than 100 km under a protective crust [15]. Alternatively, the surficial flowbands might be the result of internal shear stress within a pyroclastic mass, as they can occur on volcanic debris avalanches or pyroclastic flows too. These flows are composed of a mechanically weak material and are typically emplaced at high flow velocities [14]. But they also lack characteristic morphologies (e. g., friable material, internal layering, and eolian erosion).

(Cryo-)fluvial origin. It has been suggested by several authors [e. g., 16, 17] that the terrain south of HM contained at least one volatile-rich layer composed of ice and sediments. Activity at the adjacent volcano may have caused the release of water from this layer, which led to the development of Dao Vallis [16]. Multiple layers of subsurficial ice in the region have been suggested [16]. Hence, several flood events might have occurred, leading to deposition of the five units AHsd1-5. The sheet deposits might have been emplaced as a mixture of fluids and solid particles, e. g., hyperconcentrated sediment flows. These flows act as a non-Newtonian fluid, and show low shear strength [18]. Because of the low shear strength these deposits are able to move quickly over far distances.

Conclusions: We assume the lava flow hypothesis as least likely, as it lacks important features (e. g., platy-ridged surface) and close volcanic edifices. Pyroclastic deposits are possible [19], but lack indicative morphologies too. We suggest the cryofluvial scenario the most likely. Both the morphology of the deposits and their fluvial environment (Dao Vallis) indicate a redeposition of a liquefied and volatile-rich material.

Future Work: Future work will comprise volumetric analyses of sheet deposits, and their surficial grain size composition based on THEMIS-nighttime data.

References: [1] Fuller and Head (2002) *JGR* 107, E10, 5081. [2] Leverington (2011) *Geomorphology* 132, 51–75. [3] Hoffman and Tanaka (2002) *33rd LPSC*, #1505. [4] Burr and Parker (2006) *GRL* 33, L22201. [5] Keszthelyi et al. (2007) *GRL* 34, L21206. [6] Voelker et al. (2013) *44th LPSC*, #2886. [7] Marra et al. (2015) *GRJ* 8, 1–13. [8] Kneissl et al. (2011) *PSS* 59, 1243–1254. [9] Michael and Neukum (2010) EPSL 294, 223–229. [10] Hartmann and Neukum (2001) Space Sci. Rev. 96, 165–194. [11] Ivanov (2001) Space Sci. Rev. 96, 87–104. [12] Leonard and Tanaka (2001) *Geol. Inv. Series* I–2694. [13] Tanaka et al. (2014) *USGS Sci. Inv. Map* 3292. [14] Dufresne and Davis (2009) *Geomorphology* 105, 171–181. [15] Keszthelyi et al. (2004) *Geochem. Geophys. Geosyst.* 5, Q11014. [16] Crown and Bleamaster (2005) *JGR* 110, E12S22. [17] Kostama et al. (2010) *EPSL* 294, 321–331. [18] Costa (1988) *Flood Geomorphology*, Wiley, New York, 113–122. [19] Kerber et al. (2012), *Icarus* 219, 358–381.

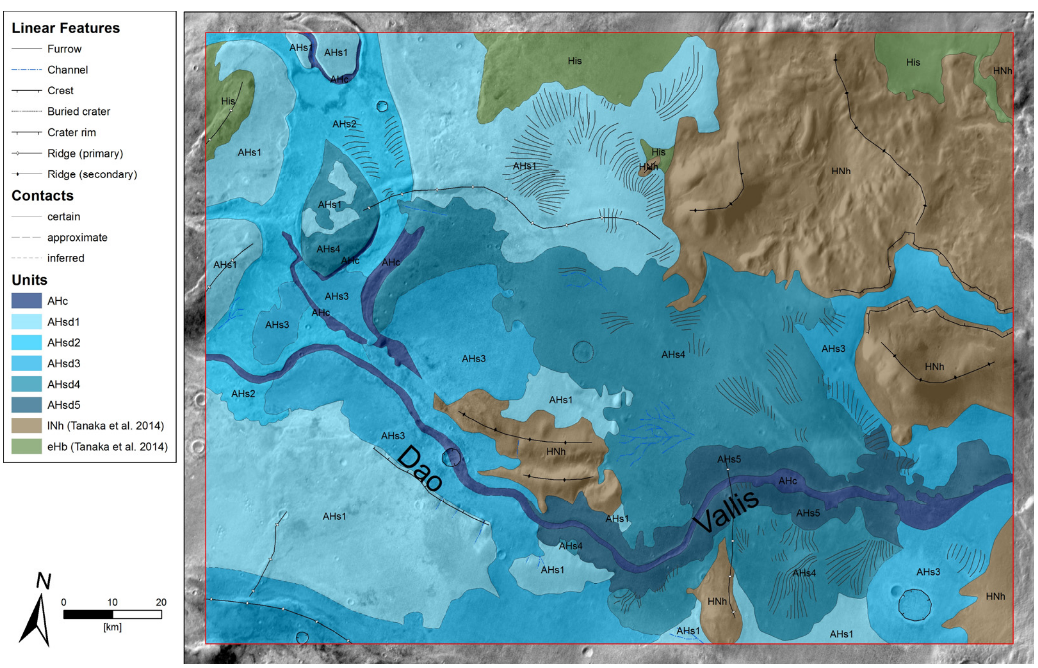

Fig. 3. Geologic map of lower Dao Vallis in eastern Hellas Planitia (Basemap THEMIS).