GEOLOGICAL MAPPING OF HAVEL VALLIS, XANTHE TERRA, MARS: STRATIGRAPHY AND RECONSTRUCTION OF VALLEY FORMATION. M. Voelker[1], T. Platz[1], K.L. Tanaka[2], C.M. Fortezzo[2], R. Fergason[2] and T.M. Hare[2], [1]Institute for Geological Sciences, Freie Universität Berlin, Germany (thomas.platz@fu-berlin.de), [2]U.S. Geological Survey, Astrogeology Science Center, Flagstaff, AZ, USA.

Introduction: Havel Vallis is a ~450 km long, SW-NE trending valley. It is adjacent to Juventae and Baetis Chaos systems, which are the sources for Maja and Havel Valles. The elevation of Havel Vallis ranges from approximately 0-800 m above the Martian datum. Because this previously unnamed valley did not receive much attention, our motivation was to map and study this valley and its fluvial deposits and reconstruct its formation history.

Mapping: This work is based on photogeologic mapping using primarily the THEMIS IR nighttime dataset. Furthermore, MOLA, CTX, HRSC, and MOC data were utilized. Data storage, visualization, and mapping were carried out in a GIS environment.

Geology: The valley system is divided into four areas: 1) crater A, 2) a wide valley, 3) a basin-like feature, and 4) Mutch crater. All four sections are connected by narrow channels. Valley floors in all four areas are covered by several sheet deposits embaying each other. Thus, more than one flood event must have taken place in this valley system. We assume that these sheet deposits originated from hyperconcentrated flows. Nighttime THEMIS IR data show high thermal inertia for these deposits. Geomorphological features such as flow channels or front lobes also indicate deposition of sediments by a more viscous, sediment-loaded flow.

The valley system is embedded in the old Noachian cratered highland materials (*ohm*) of Xanthe Terra [1]. Figure 1 shows the contact between highland material (*ohm*; upper left) and the sheet deposit *sd3*. Western parts of this unit within the study area were eroded by fluvial processes. Today these relatively smooth plains materials (*spm*) are covered by dark smooth materials (*dsm*). The nearby highlands around crater A (~40 km) partially cover the oldest sheet deposits (*sd1*). The floor of this crater is marked by smooth crater fill (*scf*), which we interpret to be the result of sedimentation from a temporary standing body of water. Hence, the sediments were deposited in a lacustrine environment. Several areas of this unit have a polygonal appearance. Probably the peak-topped polygons emerged by desiccation of the sediments. Farther downstream there are two additional sheet deposits (*sd2*, *sd3*), which are younger and more widespread (Fig. 2). They are located on the valley floor. Outside of the valley (separated from the main valley), older and younger isolated patches of fluvial deposits originated from the surrounding highlands (*yhc*, *ohc*). The channels connecting the different parts of Havel Vallis are marked as fluvial channels (*fc*). The southern part of Mutch crater is divided into old highland material (*omh*) as a part of the ancient inner crater structure and the older lowlands (*oml*). Unit *oml* is partially covered by exterior deposits (*exd*) which are very similar to *sd1-sd3*. However, those units are not related to Havel Vallis.

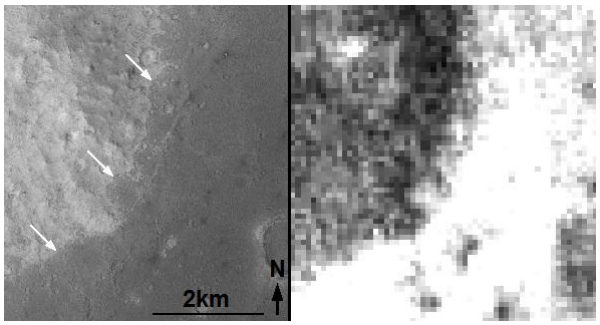

Fig. 1: Comparison between CTX and THEMIS data. White arrows show a contact between *ohm* and *sd3*.

Stratigraphy and reconstruction of valley formation: As seen in the preliminary geological map (Fig. 3), we assume that both Juventae and Baetis Chaoses are the main sources of water that formed Havel Vallis. In addition, there is also evidence for smaller water source regions such as channels emanating from adjacent highland regions--perhaps the result of ancient precipitation. It is possible that these smaller sources had formed parts of Havel Vallis before sediment-loaded currents originating from Juventae and Baetis Chaos covered the valley. Thus, the channel between the basin and Mutch crater probably already existed and is older than Havel Vallis. Mutch crater has a diameter of ~185 km and has been filled with several hundred-meter-thick deposits. This impact basin was either flooded by lava flows from interior or exterior sources and/or fluvial sediments. A 20-km-diameter crater within Mutch crater developed a significant rampart structure, which indicates a former wet intra-basin subsurface.

When the outlfows from both chaoses were released, the water overtopped the crest between Baetis Chaos and crater A. As crater A is the topographically lowest area east of this chaos, this depression was completely filled by the incoming water. Duration of the flooding events is supposed to be on the order of

several months and occurred between 1.22 Ga and 3.68 Ga [2, 3]. When the water level reached the crest of crater A, the NE rim was breached. Subsequently, water flooded across a plain to the northeast. A < 100-m-deep channel was eroded into the plains.

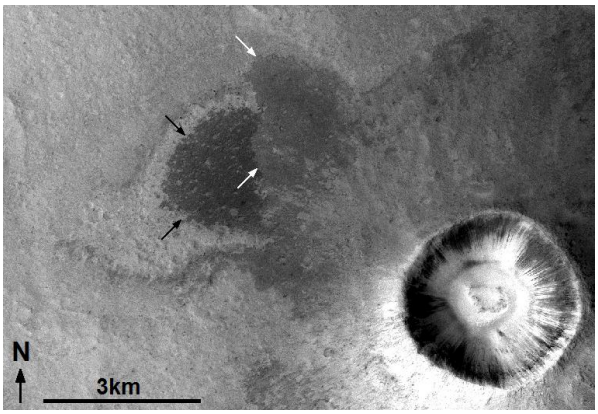

Fig. 2: Within the wide valley at least two different sheet deposits (black arrows: sd2; white arrows: sd3) cover the floor. The crater shows how thin these dark deposits must be. Its ejecta blanket overlies *sd3*.

Farther northeast, a shallow approximately 20 km wide and 100 km long valley formed due to continuous fluvial activity (wide valley). The valley floor is covered by the youngest fluvial units *sd2* and *sd3*. This area must have experienced at least two flood events. An impact crater within the valley shows that the examined sheet deposits are very thin. They are succeeded by a thicker and much brighter unit (Fig. 2).

Before the waters reached Mutch crater, they passed through a narrow channel into a basin. It probably originated from tectonic processes either from the nearby Tharsis uplift and/or lineaments caused by the Mutch impact event. Within Mutch crater, these flows merely covered the northern and easternmost areas of the impact crater.

Conclusions: We propose that at least three flooding events formed Havel Vallis which extends from crater A to Mutch crater. Prior to those flood events, some older channels probably formed by fluvial processes from different sources. Some of them are completely isolated, so their water source must have been subsurface aquifers. Terrestrial analogues to the observed hyperconcentrated flows show only a small amount of water in these sedimentary bodies [4]. Thus, portions of the Havel Vallis deposits could have been derived and eroded from the nearby chaos regions.

Future work: This mapping project will be complemented by detailed TI analysis and crater counts.

References: [1] Rotto S. and Tanaka K. L. (1995) Geologic/Geomorphologic map of the Chryse Planitia region of Mars. [2] De Hon R. A. and Pani E. A. (1992) 23th LPSC, p. 297. [3] Gross C. et al. (2009) LPSC #1890. [4] Pierson T. C. and Costa J. E. (1987) Geol. Soc. Am. Rev. Engineering Geol. 7, 1-12.

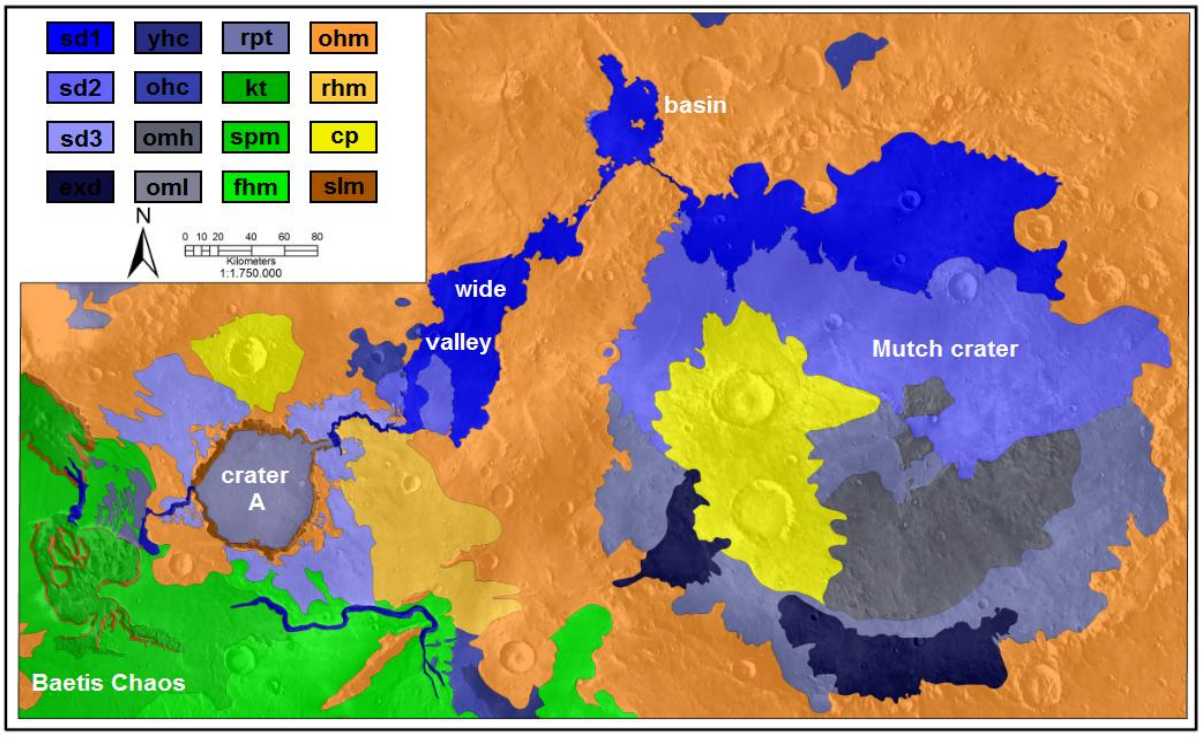

Fig. 3: Geological map of Havel Vallis northeast of Juventae Chasma, Xanthe Terra.