GEOLOGIC MAPPING IN XANTHE TERRA, MARS. Daniel C. Berman, J. Alexis Palmero Rodriguez, Cathy M. Weitz, and David A. Crown; Planetary Science Institute, 1700 E. Ft. Lowell Rd., Suite 106, Tucson, AZ 85719; bermandc@psi.edu.

Introduction: We are currently producing a 1:500,000-scale geologic map of MTM quadrangles 00042 and 00047 in the Xanthe Terra region of Mars (2.5°S - 2.5°N, 310° - 320°E) (Fig. 1). This region has been extensively modified by outflow channels and chaotic terrains and includes vast highlands deformed by subsidence [e.g., 1]. The main goal is to develop an understanding of how regionally integrated hydrologic systems have been affected by (1) impact crater formation, (2) generation of subsurface cavity space leading to subsidence, and (3) the types and ages of erosional and depositional flooding events.

Here we present preliminary results of our mapping (Fig. 1), in particular the southeastern portion of the study region (Fig. 2). Our results indicate that intrusive magmatism may have been an important causative factor in the history of catastrophic flooding in Ravi Vallis, an immense outflow channel that extends to the northeast from Aromatum Chaos. Some previous geologic models evoke intrusive magmatic dikes as triggers for catastrophic floods into nearby Shalbatana Vallis [2,3].

Results: The floor of Ravi Vallis includes topographically pronounced grooves and streamlined landforms, characteristic of the higher channel levels of the southern circum-Chryse outflow channels [3]. The formation of these types of bedforms likely occurred as a consequence of episodic catastrophic flooding and glacial erosion [4] during the Late Hesperian [1] and Middle Amazonian [4] Epochs. The source of the floods likely included water-filled conduit networks generated by the melting of ice-rich sedimentary deposits, which connected to an elevated water table in Valles Marineris [5].

Geologic mapping combined with geomorphic analyses using CTX and HiRISE images have revealed that flooding inundated highland surfaces above the margins of the grooved floor (Fig. 2), where the floods deposited widespread smooth deposits, locally marked by small-scale streamlined landforms.

We find that while Shalbatana and Ravi Valles extend from the same area of subsidence [3,5], the excavation of the outflow channels was the result of intermittent discharges, of which only the higher dissectional levels in Shalbatana Vallis and the lower levels in Ravi Vallis (Fig. 2) exhibit surface erosional morphologies consistent with either catastrophic floods or glacial erosion. Some channel floors appear to have formed mostly as a result of sedimentation and without significant fluvial bedform formation. In Ravi Vallis, these smooth floors flank the lower scoured sections and their origin may be related to earlier floods that were not topographically constrained within a channel and thus spread (and thinned out) over the intercrater plains, rapidly losing velocity, indicating a possible transition from non-catastrophic floods (depositional) to catastrophic (erosional) floods in time. The lowest floors of Shalbatana Vallis also lack bedforms; however, this could be the result of mantling by mass wasting from the steep-sided canyon flanks or aeolian debris.

Volcanic and hydrologically resurfaced terrains in Aromantum Chaos: Our mapping shows that Aromantum Chaos is unique in that it forms the source area of both a lava flow and an outflow channel. The lava flow (Fig. 3) likely erupted from a fissure parallel to the southern margin of the chaotic terrain that was subsequently destroyed during ongoing collapse and retreat of the canyon wall. Craters impacted into the lava flow exhibit high thermal inertia ejecta blankets with large boulder deposits (Figure 4). Close examination of the southern wall of Aromatum Chaos in HiRISE images reveals evidence for possible buried lava flows that form low-albedo bouldery outcrops. Episodic volcanic activity in the region could have provided high geothermal conditions conducive to potential melting of subsurface ice and groundwater outburst leading to catastrophic flooding.

Age dating: Crater count analyses have been performed on three units, the Ravi Vallis lower floor, the northern Ravi Vallis upper bank, and the lava flow to the south. Size-frequency distributions (Fig. 5) for craters larger than 250 m in diameter show ages for upper and lower Ravi Vallis of 3.3 Ga and 2.8 Ga respectively, although statistically they overlap. The surface lava flow shows an age of ~1 Ga. For craters below 250 m in diameter the SFD converge for the upper Ravi floor and the lava flow at approximately the 2.4 Ga isochron, suggesting contamination by secondary craters from a single impact event. The lower Ravi floor exhibits a steeper rolloff of small craters, suggesting continued erosion, perhaps by subsequent minor flooding events.

References: [1] Tanaka et al. (2014) USGS SIM-3292. [2] Cabrol et al. (1997) Icarus, 125, 455-464. [3] Rodriguez et al. (2003) GRL, 30, 1304. [4] Rodriguez et al. (2015), Icarus, 257, 387-395. [5] Rodriguez et al. (2015), Nature Scientific Reports, 5, 13404.

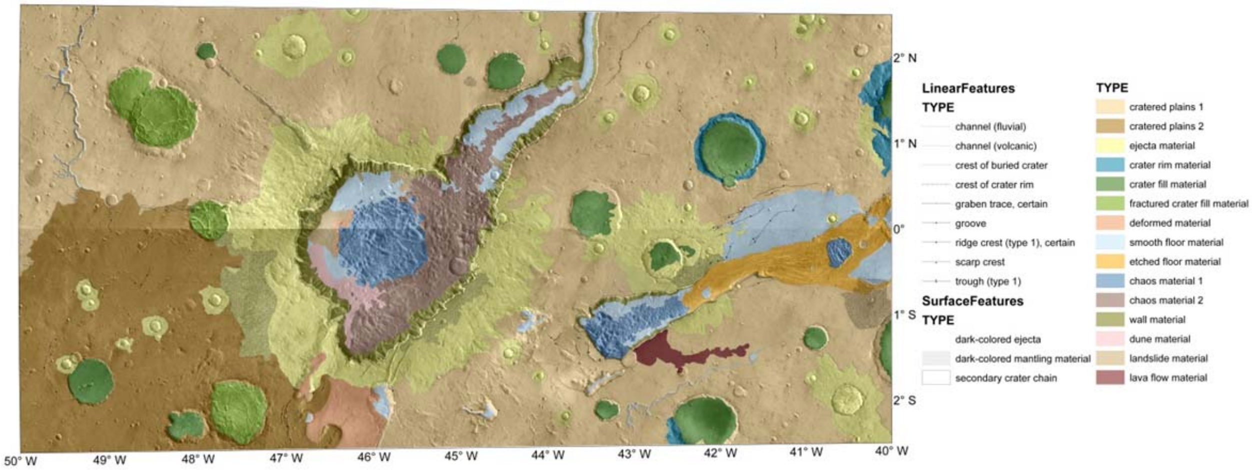

Figure 1. Preliminary geologic map of MTM quadrangles 00042 and 00047 as of 5/12/2016.

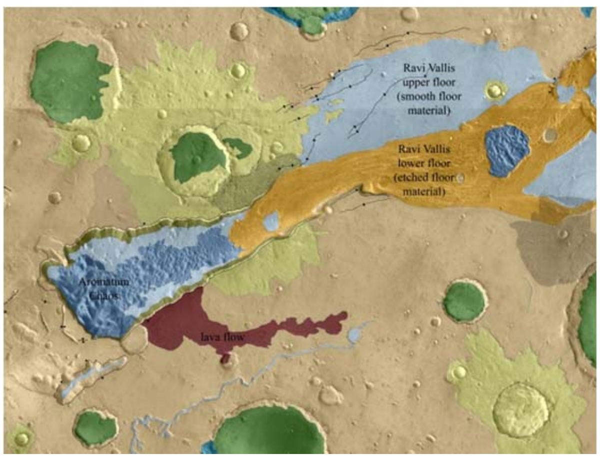

Figure 2. Preliminary geologic mapping for the Ravi Vallis region (from Figure 1), showing the upper and lower units as well as Aromatum Chaos and the lava flow.

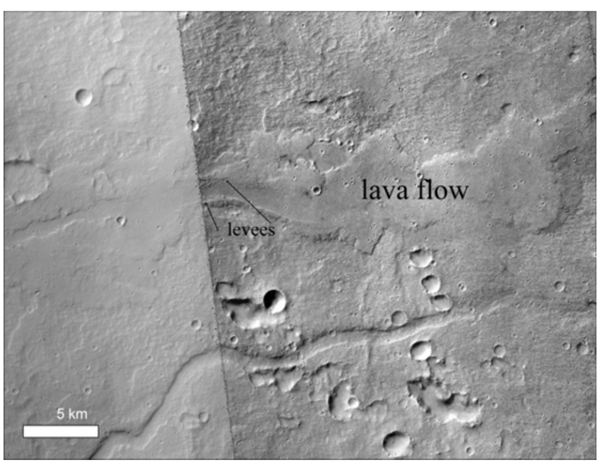

Figure 3. Lava flow exhibiting central channel and levees. CTX images G22_026891_1768 and D22_035884_1783.

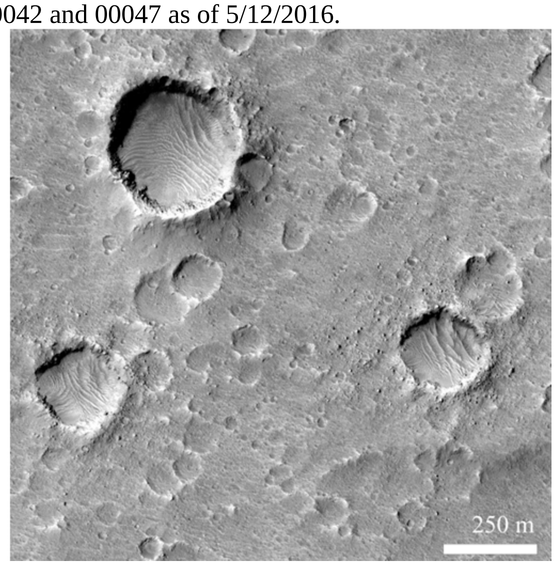

Figure 4. Close-up of lava flow surface, showing bouldery ejecta deposits. HiRISE image ESP_ 043572_1785.

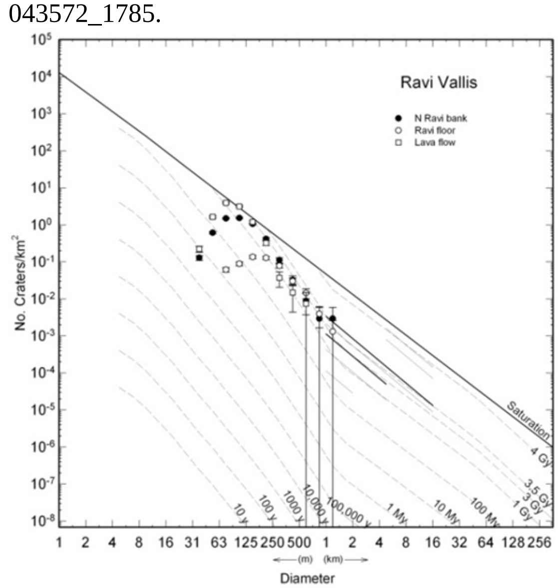

Figure 5. Crater SFD for Ravi Vallis and lava flow.