MAPPING FLUVIAL SYSTEMS ON MARTIAN VOLCANOES: INVESTIGATIONS OF ALBA MONS AND AMPHITRITES PATERA. S. P. Scheidt[1,2,3], D. A. Crown[1], D. C. Berman[1], D. A. Williams[4], and H. Bernhardt[4]. [1]Planetary Science Institute, Tucson, Arizona 85719, [2]University of Maryland, CP, Department of Astronomy – Center for Research and Exploration in Space Science & Technology II, College Park, MD 20742. [3]NASA Goddard Space Flight Center, Greenbelt, MD 20771, (stephen.scheidt@nasa.gov). [4]School of Earth & Space Exploration, Arizona State University, Tempe, AZ 85287.

Introduction: Widespread fluvial dissection peaked in the Late Noachian to Early Hesperian and is recorded as valley networks on the Martian surface predominantly in highland terrains [e.g., 1]. Martian volcanoes are a significant sub-population of the global distribution of valley networks [2] due to the dissected volcanic substrate of their flanks (in contrast to the cratered highlands), the younger ages of some dissected volcanic surfaces, and some occurrences at high altitudes and/or high latitudes. We used high-resolution images from CTX [3] and THEMIS [4] and topographic data from MOLA [5] to map and characterize fluvial systems associated with Alba Mons (40.5°N, 111.6°W, 6.8 km elevation), a shield volcano in northern Tharsis, and Amphitrites Patera, a highland paterae located on the southern rim of Hellas basin (58.7°S, 60.6°W, 1.3 km elevation). Here we highlight the results of our investigation of drainage basins on the flanks of Alba Mons and discuss the implications of our ongoing work to understand the potential fluvial history and origin of valleys on the flanks of Amphitrites Patera.

Alba Mons: Fluvial dissection has been used as evidence of pyroclastic deposition on the flanks of volcanoes [2,6], but as shown for Alba Mons, this association is not required to explain fluvial incision [7]. Neither photogeological mapping (Fig. 1A) [8] nor hydrological modeling based on MOLA topography alone revealed the likely full extents of fluvial valley networks at Alba Mons [8,9], but the combination of these techniques and careful interpretation produced improved, well-defined topology and morphometric characterizations of two large drainage basins on the flanks of Alba Mons (Table 1; Figure 1A) [7]. Our method increased the estimated dissection by 50%, determined Strahler orders between 1-6, and yielded morphometric values with greater confidence, such as drainage densities of 0.16 and 0.21 km^{-1} for the NW and W basins [7].

Amphitrites Patera: Pyroclastic volcanism on Mars is commonly associated with highland paterae, including those found in the Circum-Hellas Volcanic Province [10]. Initial hydrological modeling of the flanks of Amphitrites using MOLA topography [see 7,8,11] indicates parallel patterns of valleys radial to the summit (Fig. 1B). These belong to a larger group of valleys called Axius Valles, and include Mad Vallis to the east, all extending north to the floor of Hellas basin. The southern rim of Hellas in the Axius Valles region is smoother at the km-scale, but is more highly dissected than and distinct from the surrounding cratered terrain. Previous mapping of valleys that dissect the region [12] resulted in a cumulative total of ~20 10^3 km and a drainage density of ~0.08 km^{-1} and suggest the source of dissection is from glacial meltwater/mud or low-viscosity lava sourced from Amphitrites' summit. Scarps, ridges, and crater materials are all topographic elements that appear to control the flow path of most modeled valleys, but several appear to have clear fluvial dissection.

Future Work: Further investigation of fluvial dissection of Amphitrites will combine mapping valleys from photogeological interpretation, determining drainage divides from topography, and hydrological modeling. Quantitative basin-scale morphometric characterization allows direct comparisons of watersheds (topology, morphometry) on Martian volcanoes with and other previously documented fluvial systems across Mars and Earth.

Table 1. Watershed statistics for Alba Mons basins. A = Area (10^3 km^2); L = total valley network length (10^3 km); Dd = drainage density; Rb = average bifurcation ratio; HI = hypsometric integral or basin relief ratio. See Fig. 1A.

Location	A	L	Dd	Rb	*HI*
1: NW basin	92.9	19.9	0.21	3.8	0.36
2: W basin	122.4	19.2	0.16	3.0	0.30

Acknowledgments: This research was supported by award numbers NNX15AM44G and NNX16AJ50G from NASA's Mars Data Analysis Program. Work by S. P. Scheidt was partially supported by NASA under award number 80GSFC17M0002.

References: [1] Hynek, B.M. et al. (2010) *J. Geophys. Res.* [2] Gulick, V.C. and Baker, V.R. (1990) *J. Geophys. Res.*, *95*(B9), 14325. [3] Malin, M.C. (2007) *NASA PDS.* [4] Christiansen, P.R. et al. (2002) *NASA PDS.* [5] Smith, D.E. et al. (2003) *NASA PDS.* [6] Mouginis-Mark, P.J. et al. (1988) *Bull. Volcanol. 50*(6), 361–379. [7] Scheidt, S.P. et al. (2023, in review) *J. Geophys. Res.* [8] Scheidt, S.P. et al. (2018) *LPSC XLIX*, No. 1570. [9] Scheidt, S.P. et al. (2019) *LPSC L*, No. 2014. [10] Zimbelman, J.R. et al. (2020) *The Volcanoes of Mars, Elsevier.* [11] Mest, S.C. et al. (2010) *J. Geophys. Res.*, 78, 4037-4047. [12] Bernhardt, H. and Williams, D.A. (2021) *Icarus,* 114518.

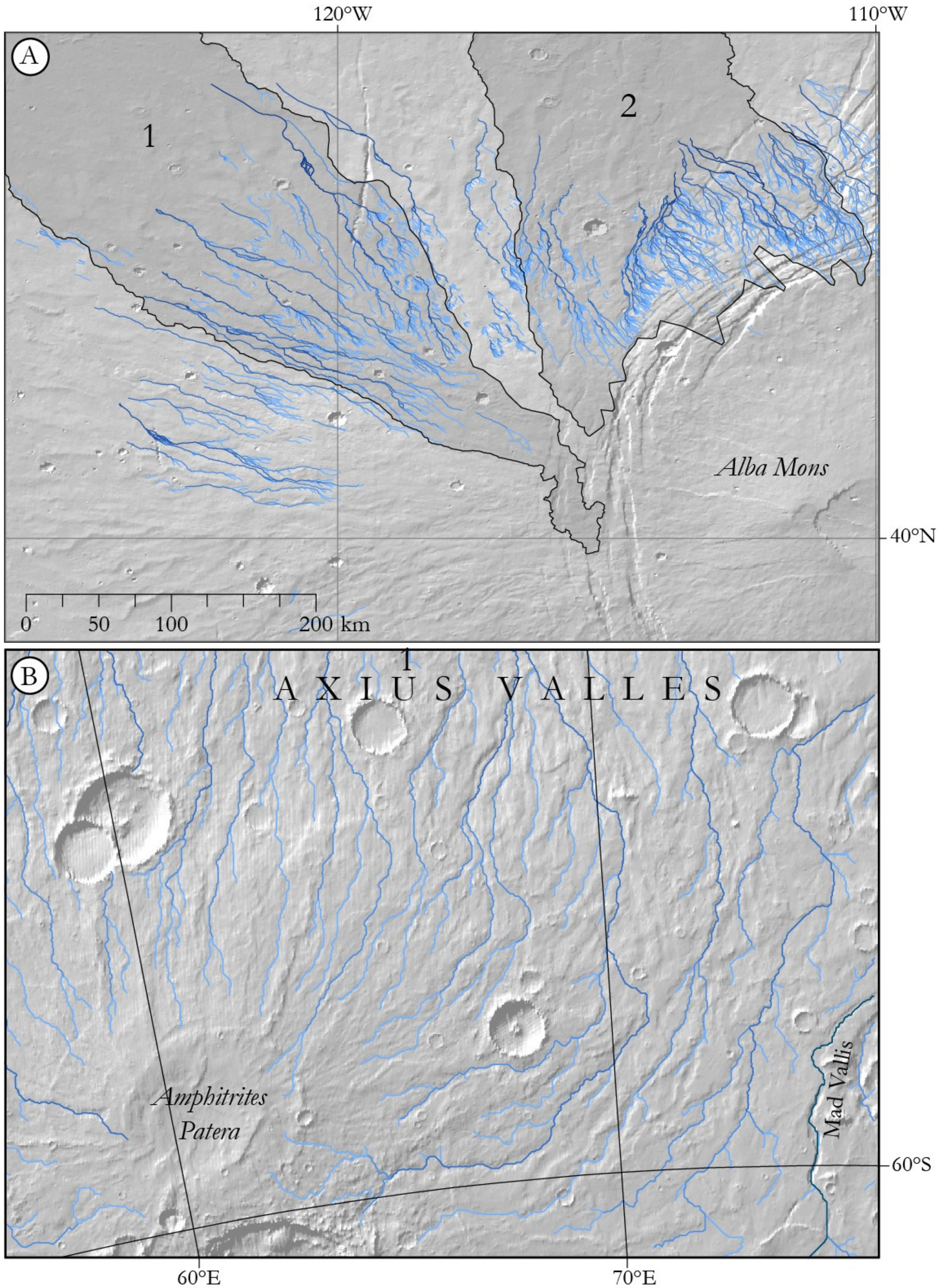

Figure 1. A) Excerpt of our photogeological mapping of parallel to dendritic, low Strahler order valley networks within the upper drainage basins on the flank of Alba Mons. Slightly darker shaded regions (labeled 1 (NW) and 2(W) indicate delineated watersheds based on MOLA topography. B) Hydrologically-modeled radial to parallel, high Strahler order valleys extend across Amphitrites Patera's shallowly-dipping northern flanks. Valleys are reoriented downslope by southern rim slope of Hellas sasin. A subdued hillshade model from MOLA is used for background imagery, and the relative Strahler stream order increases with the darker shade of blue lines representing valley networks.