**VOLCANIC VENTS IN HESPERIA PLANUM, MARS: SOURCES FOR AN EXTRATERRESTRIAL LARGE IGNEOUS PROVINCE.** Tracy K.P. Gregg[1], [1](tgregg@buffalo.edu), Dept. of Geology, 126 Cooke Hall, University at Buffalo, Buffalo, NY 14260-3050).

**Introduction:** Hesperia Planum, Mars (centered at 21.4°S, 109.9°E) is a large (> 2 x $10^6$ $km^2$) plains region that is characterized by intersecting mare-type wrinkle ridges, and contains the volcano Tyrrhenus Mons (21.6°S, 105.9°·E). Based on the presence of wrinkle ridges, and the relatively flat-lying surface (generally 0.5 – 2.0 km above mean planetary radius) of Hesperia Planum, it has long been interpreted to be composed of layered flood basalts [e.g., 1]. However, no vents or source areas for these flood basalts have been previously identified. A preliminary survey of the plains around Tyrrhenus Mons reveals potential vents for Hesperia Planum lavas.

**Background:** Hesperia Planum ridged plains embay the surrounding Noachian-aged highlands and the main volcanic edifice of Tyrrhenus Mons (centered at 21.6°S, 105.9°·E) [2], and are overlain by a lava flow field emanating from the Tyrrhenus Mons summit [3]. Using ridge-rings and partially buried impact craters, the maximum thickness of the Hesperia Planum deposits is constrained to be around 2.5 km [4, 5] with thicknesses of 1.0 – 1.5 km being more prevalent [6]. This gives a volume of around $10^6$ $km^3$ for the Hesperia Planum ridged plains.

A terrestrial flood basalt is a type of Large Igneous Province (LIP) defined by area, volume, and emplacement duration (Table 1) [7, 8]. Hesperia Planum, Mars easily meets the terrestrial size requirements for a LIP but less is known about the duration of Hesperian Planum emplacement. Recent work [9] suggests that the entire Hesperia Planum surface has a similar impact crater size-frequency distribution, indicative of a geologically short emplacement interval, consistent with terrestrial LIP emplacement durations.

Table 1. Characteristics of Hesperia Planum ridged plains and terrestrial Large Igneous Provinces.

| Characteristic | Terrestrial LIPs[a] | Hesperia Planum, Mars[b] |
|---|---|---|
| Area ($km^2$) | > $10^5$ | > $10^6$ |
| Volume ($km^3$) | > $10^6$ | 0.4 – 0.7 x $10^6$ |
| Emplacement duration (yr) | $10^6$ - $10^7$ | $10^7$ - $10^8$ |

[a][7, 8] [b][3, 6]

Tyrrhenus Mons is a central-vent volcano whose nature (explosive, effusive, or some combination) is currently debated [e.g., 1, 2, 10]. Analysis of gravity data suggest that Tyrrhenus Mons is underlain by a volume of high-density material, consistent with mafic cumulates within a solidified magma chamber [11]. The only other gravity anomalies within Hesperia Planum [11, 12] are associated with impact craters. This suggests that the main magmatic source for both Tyrrhenus Mons and Hesperia Planum is located in the same region.

**Methods:** For this preliminary survey, I used Google Earth Pro to view the "CTX Mosaic" found under the "Global Maps" tab. Where possible vents or source regions were identified, I used JMars to find the individual ConTeXt (CTX) Images [13]. Source areas were identified by finding lobate margins within Hesperia Planum that I interpreted to be lava flow margins, and following these uphill. I began by identifying lobate deposits surrounding the Tyrrhenus Mons edifice [2, 10] and expanding the search radially away from the Tyrrhenus Mons summit.

**Results:** In most cases, a vent or source region could not be identified by following a lobate deposit uphill. In this preliminary survey, <10 possible vents or source regions were identified. These range from partially buried spatter ridges (Fig. 1) to depressions located at the upslope ends of sinuous rilles (similar to lunar sinuous rilles [14] (Fig. 2). The likely source regions found as of this writing are located proximal to Tyrrhenus Mons (Figure 3).

**Interpretation & Discussion:** Vents are difficult to find in terrestrial flood basalt provinces, and, where identified, are commonly expressed as fissures [15]. To date, one fissure-like vent has been discovered for Hesperia Planum (Fig. 1) although there are many graben and other lineaments west and southwest of the Tyrrhenus Mons summit that may be the surface expressions of dikes [e.g., 16]. The majority of possible sources for Hesperia Planum are sinuous rilles; the abundance of lunar-like sinuous rilles in the plains surrounding Tyrrhenus Mons suggests a similar style of emplacement for Hesperia Planum and the lunar maria. To date, the identified source regions are all proximal to Tyrrhenus Mons, consistent with the gravity data [11, 12]. These observations suggest that Hesperia Planum was fed by multiple vents, active at approximately the same time, and tapping into the same magma source region as the Tyrrehnus Mons edifice.

**Conclusions & Future Work:** Vents and source regions for Hesperia Planum have been identified for the first time. The preliminary investigation suggests that Tyrrhenus Mons and Hesperia Planum were both fed from the same general magma source region. The morphologies and spatial distributions of possible vents around Tyrrhenus Mons suggest that Hesperia Planum lavas were emplaced similarly to the lunar maria. I will continue to search for additional vents and source regions within Hesperia Planum, distal to Tyrrhenus Mons, to further constrain the emplacement of Hesperia Planum.

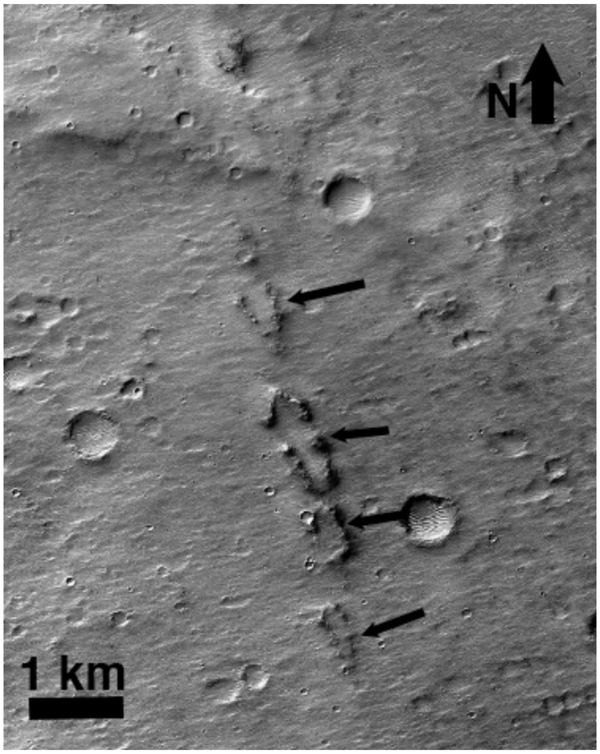


Figure 1. Black arrows point to putative spatter ridges, which are possible sources for some of the Hesperia Planum lavas. Spatter ridges located at 105.6°E, 21.2°S. Portion of CTX image P18_008201_1502_XN_21S254W, courtesy of NASA/JPL/MSSS.

**References:** [1] Greeley, R. and P.D. Spudis (1981) *GRL 19(1),* 13-41. [2] Greeley, R. and D.A. Crown (1990) *JGR 95(B5)*, 7133-7149. [3] Crown, D.A. and S.C. Mest (2015), LPSC 46th, #2122. [4] Goudy, C.L. (2002), M.S. Thesis, Universtiy at Buffalo. [5] Goudy, C.L., R.A. Schultz and T.K.P. Gregg (2005) *JGR 110(E10), doi: 10.1029/2004JE002293*. [6] Ivanov, M.A., and 7 others (2005) *JGR 110(E12S21), doi: 10.1029/2005JE002420*. [7] Bleeker, W. and R. Ernst (2006) in *Dyke Swarms: Time Markers of Crustal Evolution*, A.A. Balkema Publishers, Rotterdam. [8] Bryan, S. and R. Ernst (2007) *Earth Sci. Rev. 86(1-4), 175-202, doi: 10.1016/j.earscirev.2007.08.008*. [9] Mest, S.C., D.A. Crown and D.C. Berman (2012) LPSC 43rd, #2268. [10] Gregg, T.K.P., D.A. Crown and R. Greeley (1998) USGS Misc. Series I-2556. [11] Kiefer, W.S., 2003, *LPSC 34th*, #1234. [12] Grott, M. and M.W. Wieczorek (2012) *Icarus 221*, 43-52. [13] Malin, M.C. and 13 others (2007), *JGR 112(E5S04)*, doi: 10.1029/2006JE002808. [14] Head, J.W. and L. Wilson (1980) LPSC 11th, 426-429. [15] Bryan, S.E. and 7 others (2010), *Earth Sci. Rev. (102)* 207-229. [16] Fink, J.H. *(1985) JGR 90(B13),* 11,127-11,133.

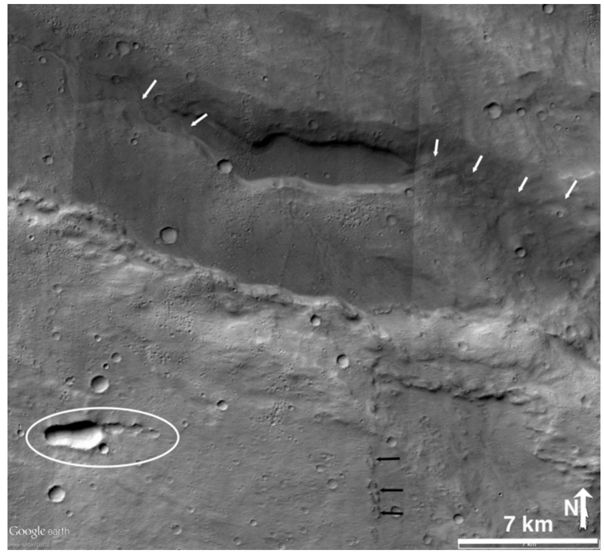


Figure 2. Black arrows point to spatter ridges (Fig. 1); white arrows point to a sinuous rille that leads into and leaves from an irregular flat-floored depression; white ellipse encloses aligned, irregular depressions that may be volcanic collapse pits (not mapped as a possible lava flow source). Mosaic of CTX images P18_008201_1582_XN_ 21S254W and P22_009704_1584_21S254W (courtesy of NASA/JPL/MSSS) as viewed through Google Earth Pro.

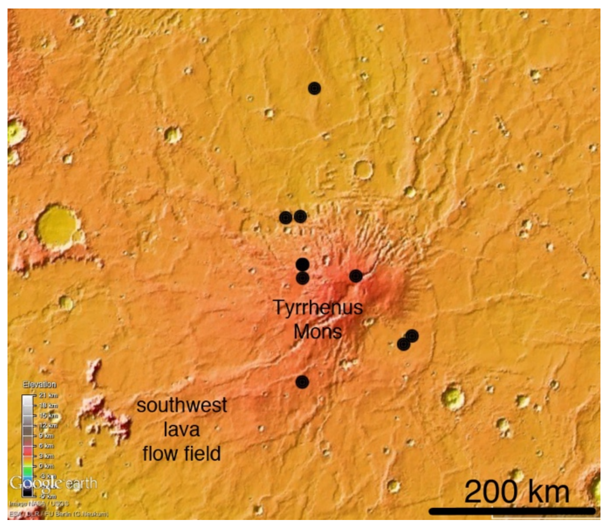


Figure 3. Distribution of possible lava sources (vents) around Tyrrhenus Mons (21.6°S, 105.9°·E); north is at the top of the image. (Mars Orbiter Laser Altimetry image as viewed through Google Earth Pro; data courtesy of JPL/NASA.)