What is Hesperia Planum, Mars? An Examination of Multiple Working Hypotheses. Tracy K.P. Gregg[1] and D.A. Crown[2], [1]Dept. of Geology, 876 Natural Sciences Complex, University at Buffalo, Buffalo, NY 14260, tgregg@geology.buffalo.edu, [2]David A. Crown, Planetary Science Institute, Tucson, AZ, crown@psi.edu.

Introduction: Hesperia Planum, Mars, characterized by a high concentration of mare-type wrinkle ridges and ridge rings [1-4], encompasses a region of over 2 million square kilometers in the southern highlands (Fig. 1). The most common interpretation is that the plains materials were emplaced as"flood" lavas that filled in low-lying regions [5-10]. Deposit thickness, based on partially buried craters, is <3 km [4]. Its stratigraphic position and crater-retention age [e.g., 9, 11, 12; Tanaka, 1986] define the base of the Hesperian System. In addition, the mare-type wrinkle ridges on its surface make Hesperia Planum the type locale for "Hesperian-aged ridged plains" on Mars [e.g., 9]. In spite of this significance, there are still many unresolved issues surrounding the formation and evolution of Hesperia Planum.

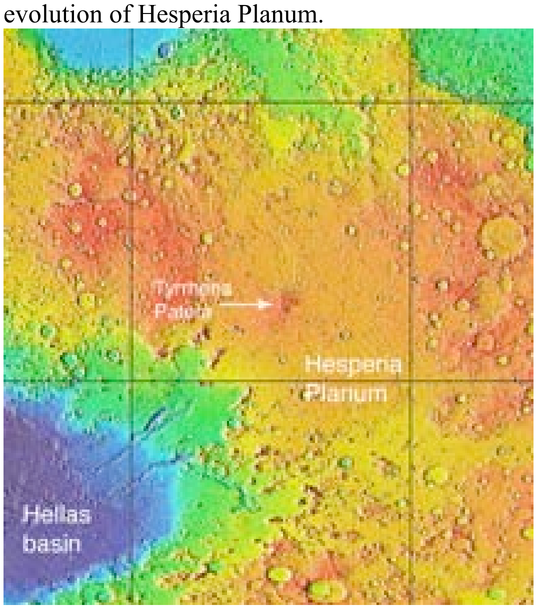

Figure 1. MOLA DEM indicating the location of Hesperia Planum, the smooth region to the northeast of Hellas basin. The volcano Tyrrhena Patera is indicated.

Most recent investigations have focused on the deposts of Tyrrhena Patera, a low-relief, central-vent volcano located within Hesperia Planum near the western boundary between Hesperian ridged plains and Noachian-aged highlands (as mapped by Greeley and Guest [9]. Greeley and Crown [13] determined that a significant portion of what had been mapped as Hesperia Planum is actually volcanic deposits from Tyrrhena Patera. They mapped a young lava flow field extending from the Tyrrhena Patera summit ~1000 km to the southwest. Subsequent mapping and crater size-frequency distributions suggested an Amazonian age for this flow field [14]. Subsequent work [13-16] suggested that easily eroded volcanic deposits (interpreted to be pyroclastic deposits, probably flows) from Tyrrhena Patera extend several hundred kilometers to the northwest. Thus, only about one-third of what had originally been identified as Hesperia Planum ridged plains remains as such. In addition, Mest and Crown [17] map a dissected plains unit to the south of Tyrrhena Patera that may be a portion of Hesperia Planum modified by fluvial activity, and Crown and Mest [18] note significant drainage from Hesperia Planum to the south, both in the source region of Reull Vallis and to the east.

Hesperia Planum Deposits: It has been proposed [1, 7] that Hesperia Planum was composed of fluid—probably basaltic—lavas. However, aside from Tyrrhena Patera, no obvious volcanic vents have been found [cf. 4, 13, 15, 17-19]. Detailed mapping of the upper reaches of Dao, Harmakhis and Reull Valles have revealed that although fluvial channels can be observed in or near the southern portions of Hesperia Planum, no lava flow lobes or lava channels can be seen [20]. This is also the case in southeastern Hesperia Planum [21]. Investigation of available THEMIS data (as of January, 2005) in both infrared and visible wavelengths, also does not reveal any volcanic vents or obvious volcanic flows. (Note that volcanic flows can be observed in VO, MOC, MOLA and THEMIS data within the Tyrrhena Patera lava flow field [e.g., 4].) This calls into question the interpretation of Hesperia Planum as being composed of fluid lava flows, or at least being exclusively volcanic in origin. Even on the ancient lunar maria, lava flow lobes and channels have been observed [e.g., 22]. It is useful, therefore, to critically evaluate other possible origins for Hesperia Planum, including (but not limited to) aeolian, sedimentary, or pyroclastic deposits. It is possible that a number of different geologic processes contributed to Hesperia Planum materials through time, and that Hesperia Planum may vary geographically in origin. The channels in the upper reaches of Reull Valles [17, 18] and those to the east suggest at least a partial sedimentary component to parts of the ridged plains.

Other Hypotheses: *Pyroclastic deposits from Tyrrhena Patera.* Current mapping of Tyrrhena Patera indicate that layered, easily eroded materials can be traced from the Tyrrhena Patera summit as far as 700 km to the northwest. The deposit characteristics are consistent over this distance, except that observed layers within the material become thinner distally. This is consistent with the behavior of pyroclastic flow deposits. Results from recent modeling [21] indicate that, all eruption conditions being equal, a martian pyroclastic flow should be able to travel 3 – 4 times farther than an identical flow on Earth. A difficulty with this hypothesis is that Hesperia Planum materials appear to embay the construct of Tyrrhena Patera on the eastern flanks of the volcano.

Lacustrine Deposits. Materials in western Hesperia Planum are layered (Fig. 2) and relatively flat-lying, with a regional slope of <0.1°. Layers are not observed in the eastern portion of Hesperia Planum, but the eastern portion contains a greater number of more closely spaced wrinkle ridges. Available evidence suggests that the formation of wrinkle ridges is enhanced in layered materials [4]. Sediments deposited in a standing body of water would generate flat-lying, layered sequences. No obvious shoreline has yet been identified, but we are examining Mars Obiter Laser Altimeter data to determine if the boundaries of Hesperia Planum deposits are at the same elevation. If so, this would be consistent with a lacustrine origin for at least some of the Hesperia Planum deposits [cf. 22]. However, this observation would not preclude flood lavas.

Reworked Volcanic Deposits. The layered materials in western Hesperia Planum are associated with Tyrrhena Patera. It is possible that they are reworked and redeposited volcanic deposits, rather than primary pyroclastic flow deposits. Water would be the most likely reworking agent, although the abundant dunes observed within Hesperia Planum indicate that wind is (or has been) an effective erosion and transport agent in the region.

Hypotheses Testing: The hypotheses presented will be difficult to distinguish without careful mapping of the region and characterization of the Hesperia Planum deposits. Furthermore, materials in western Hesperia Planum appear to have a distinct origin from those in the east. Western Hesperia Planum deposits are layered and eroded, with few wrinkle ridges; eastern Hesperia Planum materials do not display obvious layers or erosional scarps, and contain abundant, orthogonal and intersecting wrinkle ridges. If the layered Hesperia Planum materials are lacustrine sediments, the proximity of Tyrrhena Patera makes it likely that the sediments would be composed of volcanic materials from that volcano.

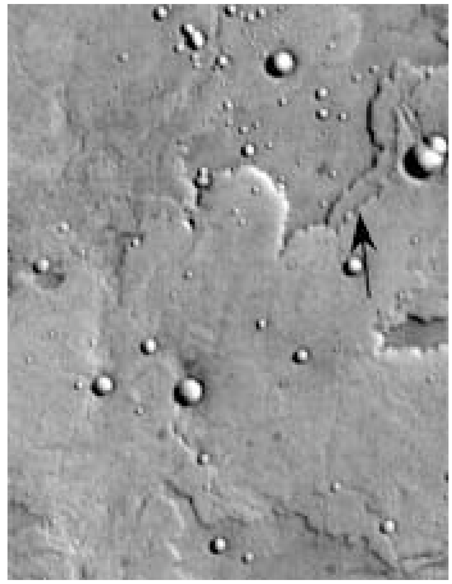

Figure 2. Portion of THEMIS daytime infrared image I01620002 from western Hesperia Planum showing layers (arrow) and erosional scarps. Image is ~32 km across.

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