INVESTIGATION OF THE EXTENT OF THE APOLLINARIS PATERA ASH DEPOSITS: IMPLICATIONS FOR THE ORIGIN OF THE COLUMBIA HILLS. H. A. Dalton[1] and P. R. Christensen[1], [1]Department of Geological Sciences, Arizona State University, Box 871404, Tempe, AZ 85287-1404 (heather.dalton@asu.edu).

Introduction: The rocks of Gusev Crater around the *Spirit* landing site are mainly olivine-bearing basalts [1-3], and are thought to have crystallized from lava with low viscosity [4]. These rocks are dark in color, vesicular, fine-grained, and have coatings of dust in varying degrees [5, 6].

However, the bedrock outcrops of the Columbia Hills are remarkably different from those near the landing site. These rocks are layered and the beds dip in the same direction as the topography. They have a granular texture and are rich in alteration products such as hematite and goethite, suggesting modification by an acidic aqueous fluid. The Columbia Hills are thought to be older than the surrounding basaltic plains [3], and therefore could have resulted from an eruption from Apollinaris Patera. While the floor of Gusev Crater has been extensively studied, the deposits from Apollinaris Patera have not been traced from the volcano and potentially to Gusev. This study sought to map the Apollinaris Patera ash deposits in order to determine whether or not the ash traveled far enough to be a possible source of the Columbia Hills ash in Gusev Crater, leading to greater understanding of the processes involved in the formation of the Hills.

Approach: The area is too dusty to use TES data for mineralogical comparison between Apollinaris Patera and the Columbia Hills. Nighttime infrared THEMIS images [7] of Apollinaris Patera, Gusev Crater, and the surrounding plains were compiled to create a large mosaic image. This image was used to distinguish between finer-grained deposits, such as dust, that cool quickly at night and rocks, which retain heat longer. The darker units in the image are interpreted to be unconsolidated and/or fine-grained material, while the lighter areas are rock. Morphology of the area was also studied using MOLA and MOC data to examine the extent of the ash deposits. MOLA shaded relief maps were used to determine changes in elevation while albedo and morphology differences were studied in MOC images. All images were taken from the THEMIS website [7]. Geologic units were defined using all three data sets. The surface features such as roughness, craters, channels, and flow lobes were described using the MOLA and MOC data while the surface textures of the different units (unconsolidated and/or fine-grained material or rocky) were determined using the THEMIS nighttime infrared images.

Results: Close examination of THEMIS visible images of the Apollinaris Patera vent reveals several different eruption events (Figure 1). The deposits from these events can be traced using a combination of THEMIS, MOC, and MOLA data.

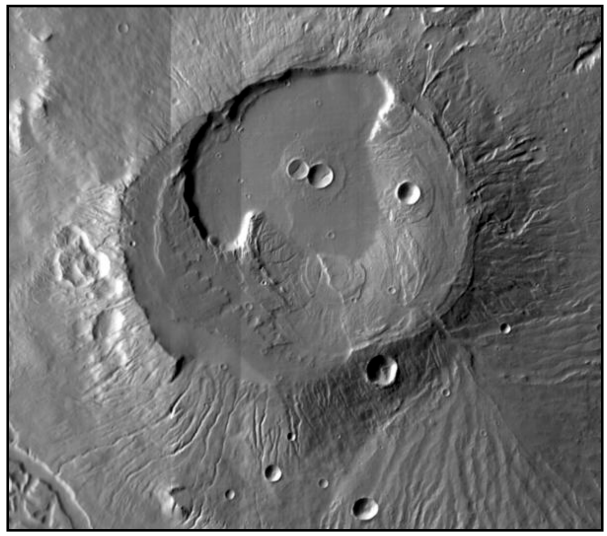

Figure 1. THEMIS visible mosaic of the Apollinaris Patera vent [7]. The image is 186.9 km wide by 177.8 km tall.

Figure 2 is a map compiled of numerous layers: a MOLA shaded relief map shows the base layer; a MOC image of the area depicts albedo variation; the mosaic of THEMIS nighttime IR images illustrates the differences in thermal inertia; and finally shaded, numbered areas indicate different geologic units. The map units are described in the figure caption with the youngest unit at the top and the oldest unit at the bottom.

There are several large flows composed of unconsolidated and/or fine-grained material that appear to lead away from Apollinaris Patera, mainly to the north and east. Older flows are more heavily cratered, and many of the flows have channels present. The flows are overlain by a smooth unit to the northwest. Cratered terrain composed of rocky material lies to the south of the volcano.

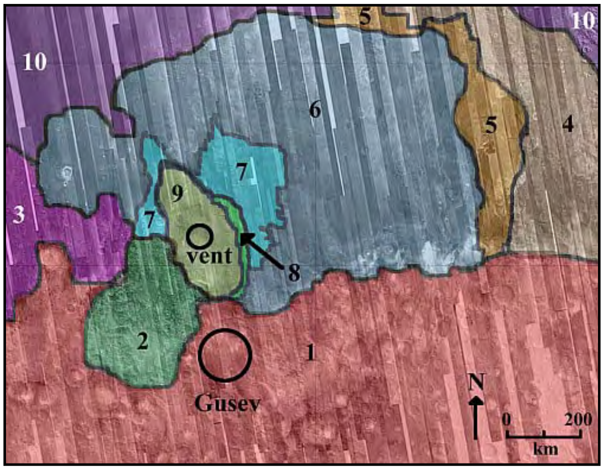

Figure 2. Map compiled of MOLA, MOC, and THEMIS data [7] with shaded, numbered areas indicating different units, defined from youngest to oldest: (10) smooth plains: flood lavas, few fresh craters, partially infilled craters present, unconsolidated/fine-grained material; (9) most recent flow from Apollinaris Patera: few craters, channels present leading away from vent, unconsolidated/fine-grained material; (8) next older flow: few small craters, smooth surface, unconsolidated/fine-grained material; (7) older flow: smooth plains, few medium craters, channels present at the edge of the flow, unconsolidated/fine-grained material; (6) large older flow: mainly smooth surface, few larger craters, large flow lobes at the edge of the flow, unconsolidated/fine-grained material; (5) smooth terrain: older flow, few medium craters present, unconsolidated/fine-grained material; (4) older terrain: older flow, rougher surface, more craters present, unconsolidated/fine-grained material; (3) rough terrain: older terrain, many craters, channels present, mainly unconsolidated/fine-grained material; (2) very rough terrain: many craters, ridges, more rocky material present; (1) cratered terrain: many craters of all sizes, overlapping and infilled craters present, very rocky.

Discussion: Apollinaris Patera erupted several times, creating large flows initially, followed by successively smaller flows. The younger flows are relatively smooth compared to the rocky terrain to the south, while the older flows have an appearance similar to that of the southern cratered terrain. This similarity indicates the older, widespread flows might have covered the entire region. The only difference between the older flows and the cratered terrain is the surface texture: the cratered terrain is rocky, while the flows are fine-grained. Younger flows appear to lie north of the global dichotomy separating the Southern Highlands from the Northern Lowlands, and their placement might result from being located at a lower topography. The youngest large flow from Apollinaris Patera is intersected by the youngest unit in the area. It is interpreted to be a flood lava unit that was emplaced recently, as evidenced by the lack of impact craters.

Summary and Conclusions: Because the oldest flows from Apollinaris Patera (unit 4) are seen as far as 1000km away from the vent of the volcano and have terrain similar to the Southern Highlands, it is possible that these flows reached as far south as Gusev Crater, which is located only 300-400km away. If the boundaries between units are depositional, it appears the flows did not reach Gusev Crater. Conversely, if the boundaries are erosional, the younger flows could have reached as far south as Gusev Crater, and the Columbia Hills could be erosional remnants of these flows. A later, low-viscosity basaltic lava flow flooded the Gusev Crater floor, leaving the previously-emplaced material visible only at a topographic high: the Columbia Hills.

Follow-up work on this project will include studying wind direction data to determine the dispersal of ash during eruption, which would indicate the location of the heaviest ash deposition. Also, the map area will be expanded to determine how far the older flows extend.

References: [1] Milam K. A. et al. (2003) *JGR, 108,* 8078, [2] Martínez-Alonso S. et al. (2005) *JGR, 110,* E01003, [3] Arvidson R. E. et al. (2006) *JGR, 111,* E02S01, [4] Greeley R. et al. (2005) *LPS XXXVI,* Abstract #2094, [5] Squyres S. W. et al. (2004) *Science, 305,* 794-799, [6] McSween H. Y. et al. (2004) *Science, 305,* 842-845 [7] Christensen, P. R. et al. *THEMIS Pub. Data Rel.*, <http://themis-data.asu.edu>.