AN EMERGING VIEW OF THE STRATIGRAPHY OF THE COLUMBIA HILLS IN GUSEV CRATER FROM HIRISE AND MINI-TES DATA. S. W. Ruff[1], A. S. McEwen[2], and the Athena Science Team [1]School of Earth and Space Exploration, Arizona State University, Tempe, AZ 85287-6305, steve.ruff@asu.edu, [2]Lunar and Planetary Lab, University of Arizona, Tucson, AZ 85721-0063.

Introduction: An image of the Mars Exploration Rover (MER) Spirit landing site in Gusev crater acquired by the High Resolution Imaging Science Experiment (HiRISE)[1], displays the Columbia Hills and adjacent terrain (Fig. 1) in unprecedented detail (~25 cm/pixel). Certain geomorphic units traversed by the rover can now be correlated with comparable ones elsewhere in the Columbia Hills and beyond. Using spectra from the Miniature Thermal Emission Spectrometer (Mini-TES)[2] we have begun to correlate rocks separated by >0.5 km and place them into a larger context via the HiRISE image. Additional imaging data from the rover cameras, especially the Panoramic Camera also contribute to the emerging picture. Preliminary results suggest that much of the Columbia Hills may have been covered by olivine-rich layered rocks that were subsequently eroded and stripped back to their current discontinuous and patchy distribution. Evidence from the HiRISE image demonstrates that this material may have once extended well beyond the limits of the Columbia Hills, predating the emplacement of the plains.

Rubble Terrain: The southwestern-most portion of the Columbia Hills appears morphologically and thermally distinct from the rest of the Hills and adjacent plains based on orbital images. Prior to the advent of HiRISE, Mars Orbiter Camera (MOC) images of this terrain showed a heavily eroded, etched-looking landscape embayed by the plains unit, and a nighttime "warm" signature in THEMIS images [3]. The HiRISE image of this terrain confirms its heavily eroded character but further reveals abundant boulders (1-2 m) amidst small hills and knobs (<20 m diameter) whose rubbly appearance suggests that they are the source for the boulders (Fig. 2). For convenience we describe it as rubble terrain (RT). The characteristics of the RT are so distinctive that it appears to be a stratigraphic/geomorphic unit that can be mapped elsewhere in the HiRISE image.

Although the rover has not yet visited the main occurrence of RT approximately 1 km south of Home Plate (Fig. 1), it appears that the rover's traverse off of Haskin Ridge passed through a northern outlier of RT (Fig. 3). The rover encountered outcrops, boulders, and rubbly knobs of layered, perhaps volcaniclastic rocks rich in olivine whose appearance in the HiRISE image is strikingly similar to that of the type area of RT. No additional examples of these rocks were observed between Haskin Ridge and Home Plate.

Mini-TES Observations: At the time of writing, two new Mini-TES observations of boulders ~35 and 70 m from the rover's current position at Low Ridge south of Home Plate are the first to display the spectral characteristics of the olivine-rich rocks of Haskin Ridge >0.5 km to the north. A rock named Scott Base, one of a few 10s of similar appearing rocks on a small hill to the west of the rover, spectrally resembles the outcrop called Comanche at the bottom of Haskin Ridge (Fig. 3). The other rock, named Gurruchaga, appears down slope from a portion of McCool Hill that is littered with similar appearing boulders. It is a good match to the Haskin Ridge outcrop called Seminole (Fig. 3). We speculate that both belong to the RT unit and are vestiges of a formerly extensive stratigraphic package that is being eroded off of the Columbia Hills basement rock.

Additional Examples: The MOC and THEMIS image characteristics of the RT are evident in multi-km-scale isolated occurrences separated from the Columbia Hills by a few to 10s of km. One of these occurrences is contained in the HiRISE image and displays features that are indistinguishable from those of the Columbia Hills type example of RT (Fig. 4). Expanding further, much of the southeast quadrant of Gusev crater contains a terrain that is similar to the RT of the Columbia Hills by virtue of its etched appearance and nighttime warm THEMIS signature. It should be possible to establish whether the diagnostic morphologic features of the RT are evident in this region once HiRISE images of it become available.

Summary: We have observed sufficient morphological and spectral evidence to suggest that the Columbia Hills, and perhaps elsewhere in Gusev crater, hosted a formerly extensive package of olivine-rich rocks, perhaps volcaniclastic in origin, that were laid down on top of the Columbia Hills prior to the emplacement of the plains basalt. Additional rover-based and HiRISE observations are planned to test this working hypothesis.

References:

[1] McEwen A. S., et al. (2007) *JGR*, in press. [2] Christensen P. R. et al. (2003) *JGR*, 108, E12, doi:10.1029/2003JE002117. [3] Christensen P. R. et al. (2005) *Icarus*, 176, 12-43.

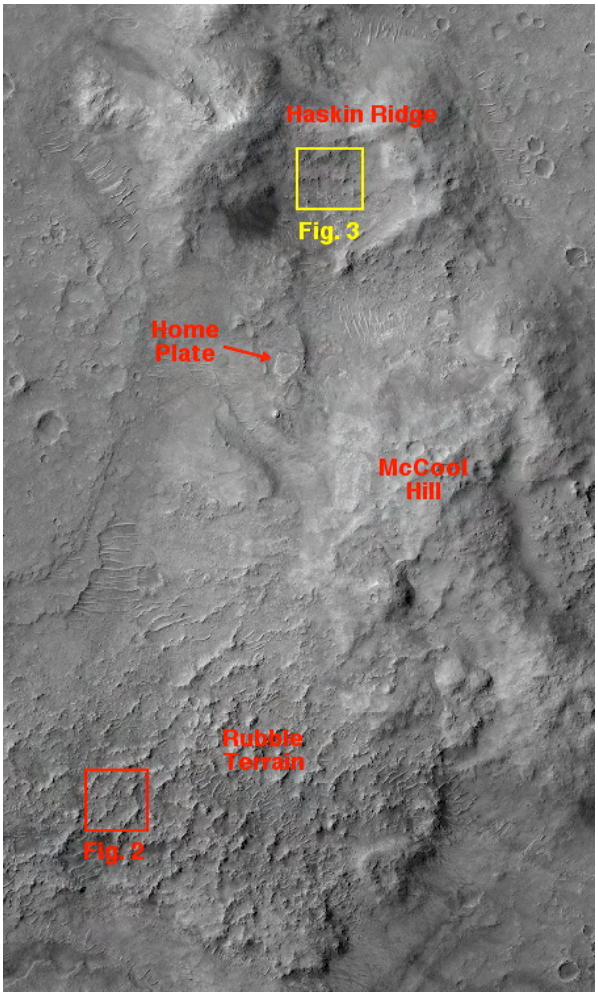

Figure 1. HiRISE image (~2 km across) of the Columbia Hills showing features described in the text.

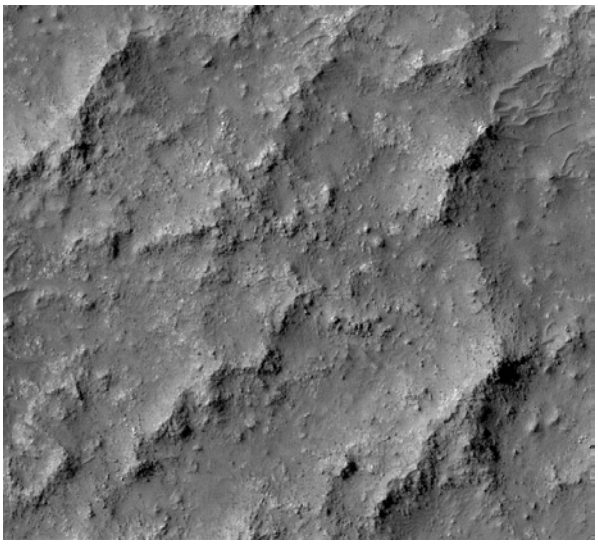

Figure 2. HiRISE image detail (~200 m across) showing rubble piles and boulders within a heavily eroded portion of the Columbia Hills ("rubble terrain").

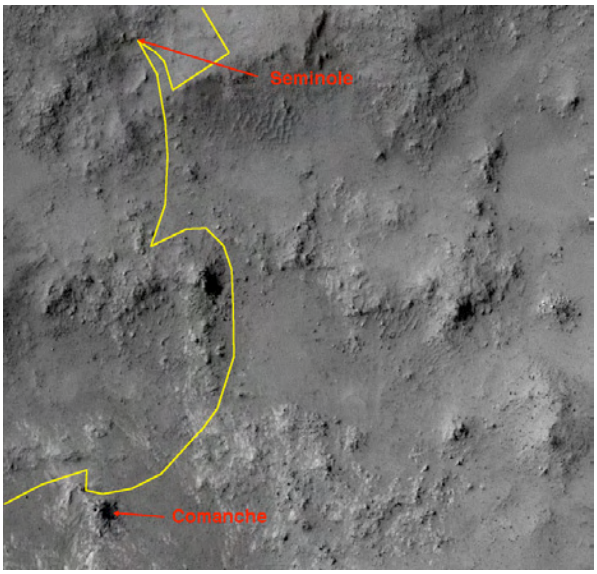

Figure 3. HiRISE image detail (~200 m across) showing rubble terrain similar to Fig. 2. Yellow line indicates approximate rover traverse. Rocks with Mini-TES spectral characteristics of Comanche and Seminole outcrops have now been observed near Home Plate.

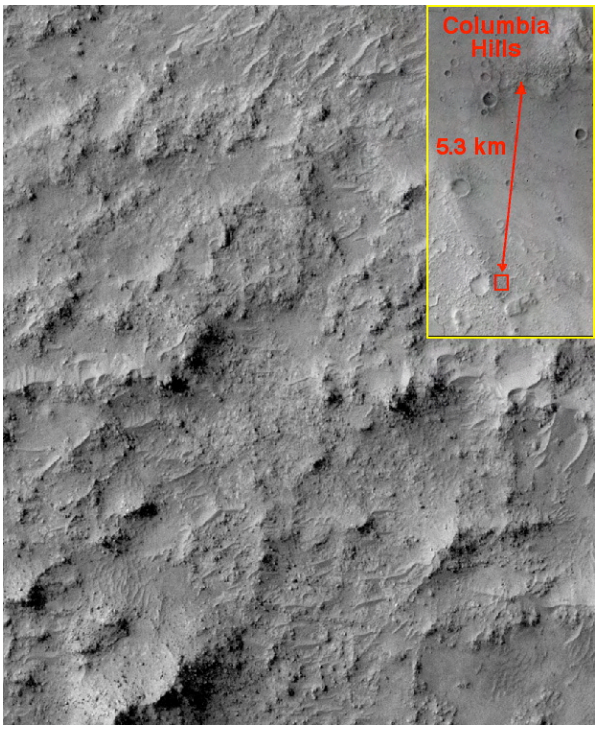

Figure 4. HiRISE image detail (~200 m across) showing rubble terrain similar to Fig. 2 and 3. This occurrence is found >5 km to the south of the Columbia Hills (inset), across the smooth plains unit that embays both the Hills and the large "island" of etched "rubble terrain" from which this image was taken.