

MER SURFACE GEOLOGIC TRANSECT MAPPING IN THE PLAINS AND HILLS, GUSEV CRATER.

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Introduction. Sufficient traverse distance and outcrop characterization has occurred by the Spirit rover in the Gusev plains and Columbia Hills of Mars that “field maps” may now be prepared showing the distribution of the bedrock geology from surface observation along the entire traverse. Analysis of panoramic and position data show that the plains preserve some large-scale primary characteristics of lava flows, including possible inflation plateaus and related structures, and topography typical of multiple flow units on long lava flows. Within the Columbia Hills, the geologic units observed to date are more diverse yet are consistent with draping of subaerially-deposited materials on an existing hills relief the bedrock of which is as yet uncharacterized.

Background. Spirit has executed over 6 km of traverse (wheel odometry) from the landing site to its current position within the Columbia Hills as of sol 717. 2.5 km

has been within the plains [1, 2, 3, 4, 5], and 3.5 km of that traverse has been within the Columbia Hills. More than 30 sites have been analyzed using the suite of in situ Athena instruments on the Instrument Deployment Device from outcrops (Columbia Hills [6]) or rocks representative of the local bedrock Gusev plains [7]).

Methods. Throughout the traverse outcrop-scale characteristics have been determined with accuracy out to the limit of appropriate resolution of panoramic images, which varies depending on the dimensions and compression of the image data. For purposes of transect mapping, the average limit of the Navcam panorama stereo ranging provides a convenient reference [5], which is on the order of 20 m. Using this value, a corridor of mapping approximately 40 m wide can be defined along the entire traverse (Figure 1). This corridor is populated in map-perspective with the results of both in situ observations and geologic

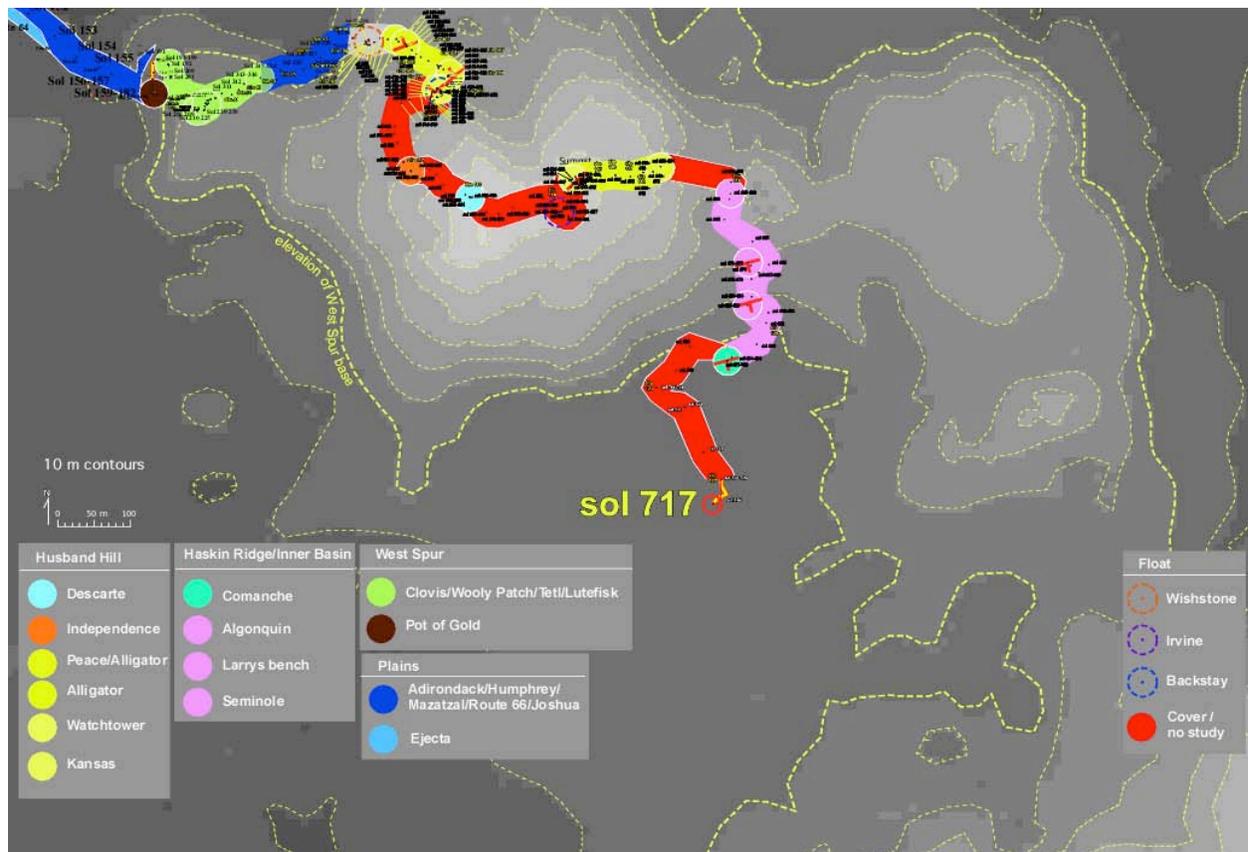


Figure 1. Bedrock lithologies determined from along-track observations within the Columbia Hills part Spirit's traverse. Legends identify rock/outcrop names, and the colors show sites with correlative mineralogy and chemistry of differing samples. Legend on the right indicates the samples that are float of unknown source and areas undifferentiated (covered or not studied during traverse, shown in red). Note that strike and dip measurements have been determined for many of the outcrops on Husband Hill. The digital elevation and contour (10 m interval) base map was derived by the USGS from MOC stereo data.

contacts derived from mapping in perspective-based panoramas. Within the plains, when compared with MOC data and rover-derived altimetry surface observations, these results also permit details of the lava flow primary relief to be compared with apparent large-scale relief along the traverse.

The complexity of material units, subtle stratigraphy, and steep slopes with mobile debris result in significant gaps in the bedrock geologic map within the Columbia Hills except where closely spaced in situ studies have occurred (for example, the West Spur, the Methuselah-Larrys Outcrop area on the northwest flank of Husband Hill, and the summit). In such areas the corridor map is broken into areas of known geology separated by zones of “covered” or undifferentiated bedrock material (shown in red in Figure 1).

Discussion. Petrologic, structural, and physical geologic characteristics deduced from the traverse data indicate that both the plains and the hills preserve a geologic record of diverse events from impact, volcanic, and structural origins. Correlation of a 4 to 9 meter high plateau within the plains between sols 121 and 142 with unusual local relief and surface rock morphologies suggests that this region of the traverse could be relict of a primary lava inflation plateau [5]. The relief lies on a regional gradient of 0.7 degrees and is comparable to some cross-flow relief characteristics observed on terrestrial lava flows [8, 9]

Outcrops within the Columbia Hills appear stratified and bear characteristics of air fall materials, either impact-derived or volcanic. Chemically, many of the samples appear altered, some possibly post-depositional, although pre- and syn-depositional alteration cannot be ruled out. Vertical variations in texture, mineralogy, and chemistry are identifiable in some cases between laterally separated outcrops hinting at the potential for regional stratigraphic correlations. For example, measured strike and dips in outcrops of similar mineralogy and texture on the northwest flank (the rock “Watchtower”) and summit (rock “Hillary”) of Husband Hill (Figure 2) imply that at least some of the stratified materials dip in directions that generally conform to the large-scale relief of Husband Hill. Whether this is a result of draping on an underlying topography, structural deformation of formerly flat-lying sediments, or some other arrangement remains to be determined. Additional outcrop observations at widely separated sites within the Columbia Hills will be necessary to address that question.

References: [1] Squyres et al., 2004, *Science*, 305, 794; [2] Arvidson et al., 2004, *Science*, 305, 841; [3] Li et al., 2005, *Photog. Eng. Remote Sen.*, Oct, 1129; [4] Crumpler et al., 2004, *Geology*, 33, 809; [5] Golombek et al., 2006, *JGR* 111; [6] Squyres et al., 2006, *JGR*, 111; [7] McSween et al., 2005, *JGR*, 111; [8] Zimbelman and Johnston, 2001, *Volc. in NM, NMMNHS Bull* 18; [9] Walker, 1991, *Bull. Volc.*, 53, 546

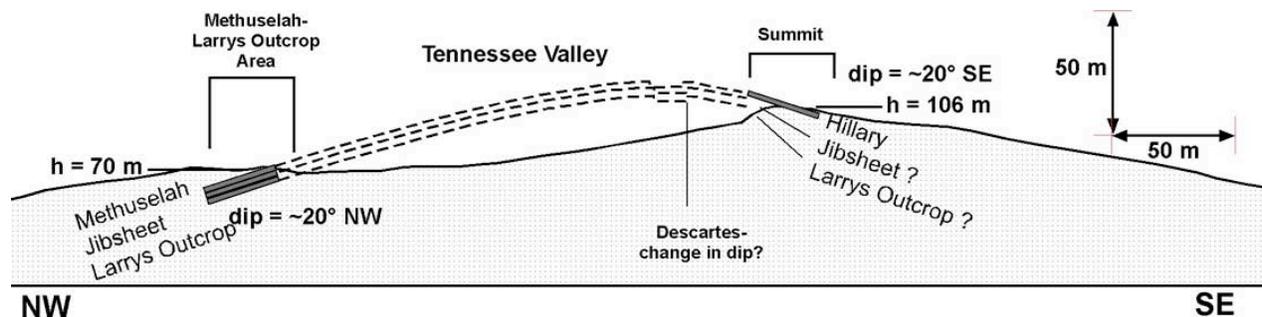


Figure 2. An example of a possible stratigraphic correlation within the Columbia Hills in relation to a topographic profile from northwest to southeast across the summit of Husband Hill (constructed from DEM data). “Methuselah”, “Jibsheets”, and “Larrys Outcrop” are all distinct layers within a dipping sequence on the northwest flank of Husband Hill. Exposures of similar lithologies with differing strikes and dips are identified at two places on the margins of the Tennessee Valley. The rock “Hillary” at the summit bears many similarities to those on the northwest flank. In general dips are approximately conformable with the overall relief of the hills. Strike and dip of materials on the west flank (an outcrop named “Descartes”) suggest that the materials there are at or close to flat lying. The stratigraphic position of the Descartes outcrops is undetermined. Similarity of summit rocks to those at the Methuselah outcrop might imply that the section identified in the Methuselah-Larrys Outcrop area underlies the summit.