**SPIRIT'S WINTER CAMPAIGN IN THE INNER BASIN, COLUMBIA HILLS, GUSEV CRATER.** R. E. Arvidson[1], S. W. Squyres[2], S. L. Murchie[3], A. S. McEwen[4], and the Athena, CRISM, and HiRISE Science Teams, 1. Dept. of Earth and Planetary Sciences, McDonnell Center for the Space Sciences, Washington University, St. Louis, MO, 63130, arvidson@wunder.wustl.edu; 2. Dept. of Astronomy, Cornell University, Ithaca, NY, 14853, 3. Applied Physics Laboratory, Johns Hopkins University, Laurel, MD, 20723, 4. Dept. of Planetary Sciences, University of Arizona, Tucson, AZ, 85721.

**Introduction:** This abstract focuses on the observations and results from Spirit's Winter Campaign and associated coordinated orbital observations with the CRISM and HiRISE instruments on the Mars Reconnaissance Orbiter.

**Campaign Overview:** During its first winter season, Spirit remained mobile and was directed to drive to north-facing slopes as needed to ensure maximum receipt of solar energy on the solar panels [1]. Spirit's right front wheel drive actuator failed during its second fall season thus leading to reduced mobility capability, particularly for soil-covered slopes. Given the reduced mobility Spirit was parked on sol 805 on Low Ridge for the winter season in a configuration with a 11 degree northerly tilt to maximize solar energy (Figs. 1-2). A "Winter Campaign" plan was developed and implemented for Spirit to take advantage of the long time during which the rover was parked. The campaign focused on: 1. Tracking atmospheric and surface dynamics by periodically surveying the surface and atmosphere, 2. Extensive examination of surrounding terrains, rocks, and soils using Pancam and Mini-TES, coupled with long duration measurements (Alpha Particle X-Ray and Mössbauer Spectroscopy) of rock and soil targets within the Instrument Deployment Device work volume, and 3. Coordinated observations with the CRISM [2] and HiRISE [3] imaging systems during which Spirit characterized the surface and atmosphere from its vantage point while the two orbital instruments imaged the Columbia Hills (including the rover) and the surrounding plains. Very low energy values (typically less than 300 W-Hr/sol) meant that weeks were required to complete IDD experiments, particularly since overnight observations were largely precluded by low energy conditions. Spirit "bumped" to a nearby outcrop (rock target King George Island) on sol 1022 to close the Winter Campaign and begin a new period of exploration of the Columbia Hills.

**Atmospheric and Surface Dynamics:** A highlight associated with monitoring experiments is the discovery of high altitude water ice clouds through periodic sky imaging. In fact these clouds were not observed by Spirit during its first winter, implying significant interannual variability in cloud formation. Spirit also documented surface albedo and color changes in locations such as the El Dorado dune field located to the north of the Winter Campaign site (Fig. 1). These changes testify to the dynamic nature of the surface layer due to deposition and subsequent entrainment of dust and sand by aeolian processes.

**Surface Science:** Low Ridge is a northeast-southwest trending feature located to the south of Home Plate within the Inner Basin between Husband Hill and McCool Hill (Fig. 2). A major element of the surface science portion of the Winter Campaign was acquisition of the McMurdo Panorama using Pancam's 11 geology filters and images acquired with high spatial fidelity (e.g., Fig 3). This panorama was complemented with numerous rock and soil observations by Mini-TES. Together with acquisition of superresolution Pancam images for selected targets, the ensemble of data are being used together with the 0.31 m/pixel HiRISE images (e.g., Fig. 2) acquired of the Columbia Hills and surrounding plains to decipher the stratigraphic record of the rocks examined and their geological history. Several hypotheses are being pursued, including impact emplacement of units. However, the granular nature of the rocks, the presence of graded bedding, cut and fill structures, and cross-bedding for units in Home Plate [4], together with the basaltic compositions and variable mineralogy of rocks and the presence of vesicular basalt boulders, argues for volcaniclastic and flow emplacements. Extraction and analysis of CRISM-based spectra from 1 to 2.6 micrometers show that the surface materials are dominated by nanophase iron oxides and basaltic materials, consistent with Spirit's observations [5].

Long duration *in-situ* measurements acquired during the Winter Campaign and shortly thereafter included the rock targets Halley and King George Island (Fig. 3). Halley is a complex rock that shows a positive correlation between Ca and S, evidence for gypsum or anhydrite. King George Island is a granular rock target with an abundance of hematite. These observations will be placed in a broader geologic context as Spirit traverses to other outcrops within the Inner Basin, using HiRISE and CRISM observations as guidelines for traverses, measurements, and complementary data sets for interpretations of results.

Just before driving to the Winter Campaign site Spirit was traversing toward McCool Hill to the southeast of Home Plate. The vehicle encountered mobility problems traversing in an area termed Tyrone and excavated light-toned soils as it attempted to reach its drive goals. Mini-TES data show that these deposits have a 6 micrometer water feature. Further, some of

the material was dragged by the inoperative right front wheel to the Winter Campaign site and analzyzed (Berkner Island 1). The material is rich is sulfur and contains ferric sulfates. These deposits are unresolved in CRISM data (Fig. 1) because they are beneath a thin cover of basaltic soils. HiRISE data (Fig. 2) show that the Tyrone area is at the base of a terrace that in part surrounds the northwestern portion of McCool Hill. This terrace can also be seen in the McMurdo Panorama as a slight rise to a dissected plateau. One interpretation being debated by the Athena Team is that these deposits formed as groundwater leached McCool Hill with water rising at the surface at bottom of the Hill to form sulfate-rich evaporite deposits.

**References:** [1] Arvidson R. E. et al. (2006) *JGR,111*,E02S01,doi:10.1029/2005JE002499. [2] Murchie S. L. et al. (2007) *JGR*, in press. [3] McEwen A. S. et al. (2007) *JGR*, in press. [4] Squyres S. W. et al. (2007) *Science*, submitted. [5] Morris R. V. et al. (2007) *LPS XXXVIII*, this issue.

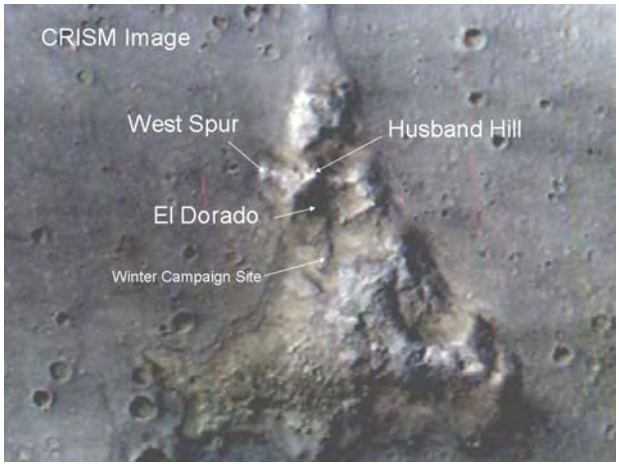


Figure 1 – CRISM false color IR view (2.5, 1.5, and 1.1 μm I/F) of the Columbia Hills and surrounding plains. North is to the top and the image covers 5.7 km in width. Spirit's Winter Campaign site is to the south of Husband Hill, in the Inner Basin. McCool Hill is to the southeast of the Campaign site. Frame: FRT00003192_07_SC165L.

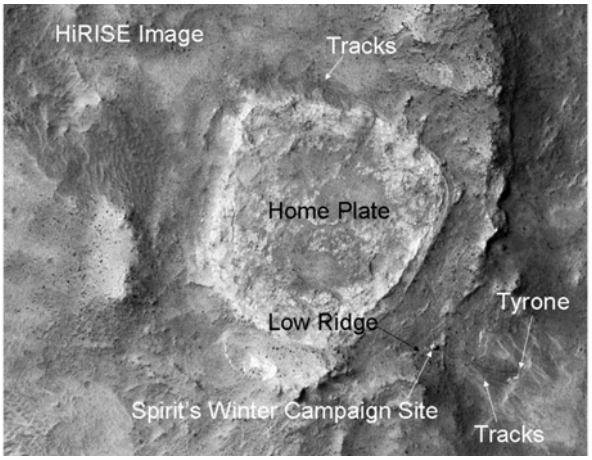


Figure 2 – HiRISE red frame image showing Spirit's Winter Campaign site on Low Ridge, Home Plate, and the Tyrone area where sulfate-rich soils were exposed by the rover's wheels. Small portion of frame: PSP_001513_1655_red.


Figure 3 – False color IR view of a portion of the McMurdo Panorama acquired by Pancam during the Winter Campaign, focusing on rocks and soils examined by Spirit during and immediately after the Campaign, together with the Tyrone disturbed soils. Note the light-toned soils extending from Tyrone to the rover. This material was embedded in the right front wheel and deposited onto the surface as the rover drove backwards from Tyrone to the Campaign site.