THE SILICA-RICH HYDROTHERMAL DEPOSITS OF THE COLUMBIA HILLS: A KEY CANDIDATE MAX-C LANDING SITE. J.W. Rice, Jr., Mars Space Flight Facility, School of Earth and Space Exploration, Arizona State University, Tempe, AZ 85287, jrice@asu.edu

Introduction: The next Mars surface mission in the Mars Exploration Program is the proposed Mars Astrobiology Explorer-Cacher (MAX-C). The MAX-C rover is the next logical step for addressing the goals of astrobiology and geology objectives. NASA's Mars exploration strategy consists of the following themes: *Following the Water* (MGS, ODY, MER, MEX, MRO, PHX); *Understanding Mars as a System* (All missions); *Seeking Habitable Environments* (MER, MSL); and *Seeking Signs of Life* (MAX-C, MSR).

The primary science objectives of the MAX-C mission are to investigate a site interpreted to represent both high habitability potential and high preservation potential for physical and chemical biosignatures. The MAX-C rover will collect, document, and package the samples necessary to achieve the scientific objectives of the proposed future Mars Sample Return Mission (MSR).

The proposed MAX-C mission would be launched in May of 2018 and arrive at Mars in January of 2019 at Ls325 (late northern winter). Based on programmatic and engineering considerations as of April, 2009, the potential mission would use the Mars Science Laboratory (MSL) sky-crane landing system and would include a single solar-powered rover. Candidate landing sites would have to be at altitudes below ~0 km altitude, between 25°N to 15°S latitudes, landing ellipse size of 15 km, have a mobility range of at least 10 km (~200 m/sol), MER-like slope/rock access, and would have a lifetime on the martian surface of at least one Earth year [1].

Landing Site with Ultimate Ground Truth: I am proposing that the MAX-C rover land on the relatively smooth basaltic plains just west of the Columbia Hills and then immediately traverse to the primary objectives in the Columbia Hills.

On January 3, 2004 Spirit landed on the basaltic plains west of the Columbia Hills. Recall that no difficulty was encountered on Spirit's 3 km traverse across the plains to the Columbia Hills. Spirit has been exploring the diverse and complex geology of the Columbia Hills region of Gusev Crater for nearly six years now.

Spirit's ongoing mission could double as a trailblazer for MAX-C by providing the ultimate in ground truth. Spirit has already located numerous geologically significant outcrops and sampling sites that MAX-C could take advantage of by acquiring samples for the eventual return to Earth.

MAX-C can investigate, collect, document, and package samples from the Noachian age Columbia Hills as well as the Hesperian age basaltic plains. The primary materials to be acquired on this mission are the silica–rich hydrothermal deposits discovered by Spirit in the Eastern Valley between Home Plate and Mitcheltree Ridge [Figure 1].

Home Plate, a roughly circular shaped, layered plateau structure rises 2 to 4 m above the surrounding plains and is 90 m diameter. Home Plate consists of laminated–to–crossbedded tephra that shows evidence for a hydrovolcanic explosive origin, including a bomb sag produced when an ejected 4-cm clast fell into deformable ash deposits [2,3].

The opaline silica deposits (as much as 91 weight percent SiO_2) are interpreted to have formed in a hydrothermal environment because they are found in close association with volcanic materials such as Home Plate. The silica-rich deposits are found as both light-toned soils and as bedrock [Figure 2]. Two types of environments could have been responsible for forming these materials: fumaroles or hydrothermal sinter deposits produced by hot springs [4]. This discovery is of paramount importance for understanding the past habitability of Mars because terrestrial hydrothermal environments support thriving microbial ecosystems.

MAX-C will also be able to investigate features that Spirit wasn't able to explore. For example, von Braun Butte and Goddard Crater which may be a volcanic vent [5].

An extra incentive for revisiting this site is that Spirit can be located and inspected (i.e., Apollo 12 and Surveyor III). By this time Spirit would have been exposed to the martian environment for 15 years. Thereby making for an excellent long duration exposure experiment providing long-term data on the martian environment, including weathering, micrometeorites, and its effects on materials degradation and other systems (including power, propulsion, and optics). This data will aid in the design of surface systems, equipment and structures for the future robotic and manned exploration of the planet.

Summary: The silica deposits should be considered the highest priority for sample return based on our present knowledge of Mars. These silica deposits are ideal for the preservation of biogenic materials. The exploration of the Home Plate region by Spirit indicates that this region was once a site of hydrothermal activity including hot springs and fumaroles. This a key environment for past life on Mars. Additionally, we have the ground truth information and geologic experience for this site and would know exactly where to sample based on nearly six years of experience here with Spirit.

References: [1] MEPAG MRR-SAG (2009) Mars Astrobiology Explorer-Cacher, 94 pp., posted at http://mepag.jpl.nasa.gov/reports/. [2] Rice, J.W. et al. (2006) AGU, 87 (52), P41B-1274. [3] Squyres, S.W. et al. (2007) Science, 316, 738-742. [4] Squyres, S.W. et al. (2008) Science, 320, no. 5879, 1063-1067. [5] Rice, J.W. et al. (2010) submitted LPSC 41.

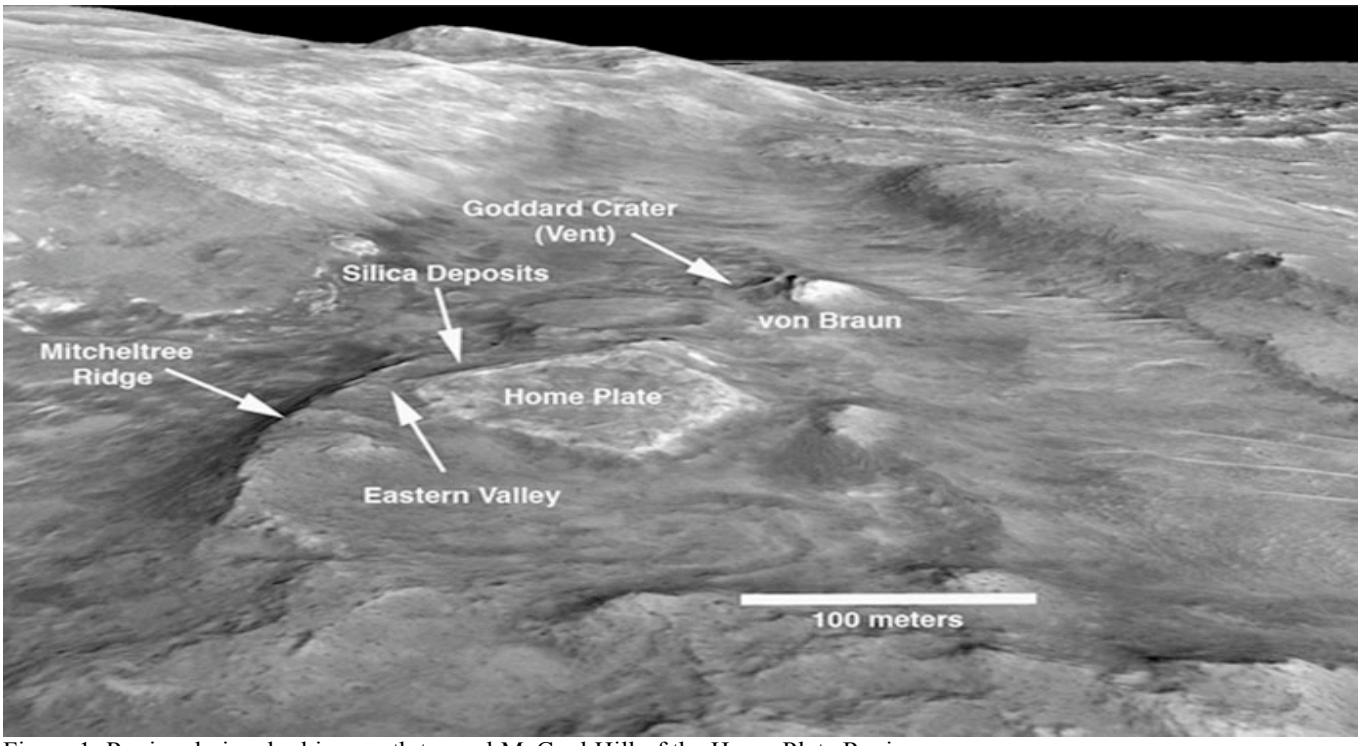

Figure 1. Regional view looking south toward McCool Hill of the Home Plate Region.

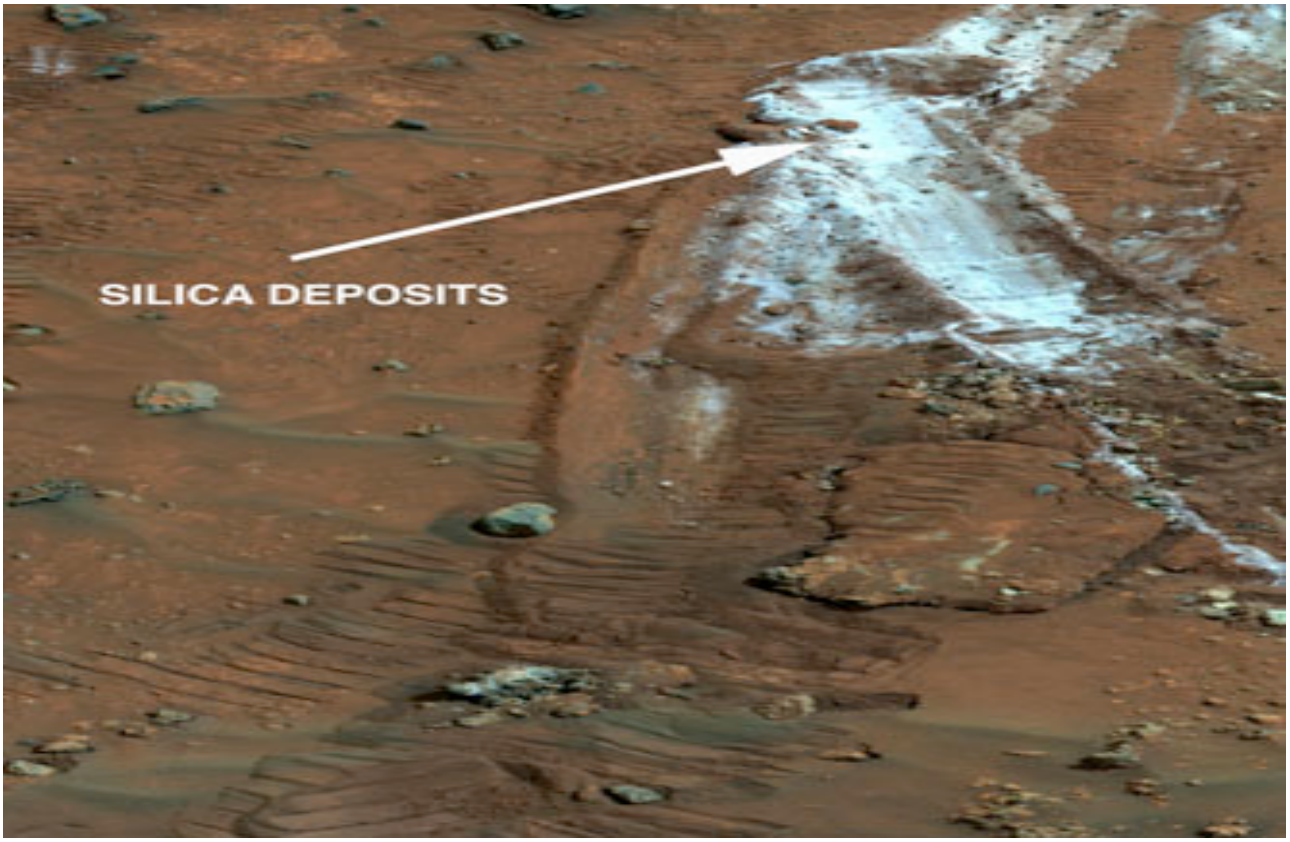

Figure 2. Silica deposits in the form of light toned soils .