Anaylsis of four potential Mars Science Laboratory landing sites using HiRISE

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Introduction:

Four landing sites remain under consideration for the 2011 Mars Science Laboratory (MSL) after review of 60+ potential sites at the first three MSL landing site workshops (June 2006, October 2007 and September 2008). After the third workshop and subsequent review by the MSL Project, the list of sites remaining under consideration was narrowed to four that include: Holden Crater, Mawrth Vallis, Eberswalde Crater, and Gale Crater [1]. These sites emphasize a range of science themes including mineralogy (i.e. phyllosilicates, sulfates and hematite), layered materials, and the presence of fluvial, erosional or depositional landforms.

The High Resolution Imaging Science Experiment (HiRISE) onboard the Mars Reconnaissance Orbiter (MRO) began acquiring data in the fall of 2006 at resolutions up to 26 cm per pixel scale. Targets include locations proposed at the first three MSL landing site workshops: a 20km by 25km landing ellipse was proposed for each site. In addition, most of the sites are "go to" sites that have a safe landing site adjacent to the science target of interest.

Sufficient HiRISE images have now been acquired, including stereo pairs, to cover the four remaining landing ellipses and the go-to science targets for the final four sites (if applicable). Each HiRISE image is approximately 6 km wide and at least 10 km long and includes a 1.2 km-wide blue-green and NIR swath down the middle of the image. The stereo pairs are currently being used to create topographic maps for analyzing slopes at the 2-5 meter scale. The HiRISE images show a variety of intriguing landforms at high resolution in each of the sites, such as layered deposits, dunes, ripples, channels, ridges, rocks, polygonal terrain and craters. Each of these sites is being extensively studied to assess which is safest for landing and is best suited to achieving mission science objectives. For example, it is expected that HiRISE imagery will be the primary data set for assessing rover-scale slopes and boulder distributions. The images will also play a role during surface operations, serving as basemaps for identifying traverse targets and safe traverse paths. A brief overview of each of the four sites follows.

Holden Crater:

(Ellipse center: -26.37°N, 325.10°E) Holden Crater is a ~150 km diameter crater in SW Margaritifer Terra where at least 150 meters of light toned layered deposits are exposed. This site provides a snapshot of conditions during the Noachian-Hesperian transition. Bedding in the crater is thin, laterally continuous and mechanically weak and there is spectroscopic evidence for aqueous alteration. Geologic studies of the deposits suggest an early lake episode occurred in the crater that was followed by a catastrophic flood. Flooding occurred when part of the crater rim that was holding back water ponded in Uzboi Vallis to the south failed. Science targets at this site include lithology of alluvial sand, gravel and boulders in the landing ellipse. As MSL traverses out of the ellipse, additional targets include the light-toned, phyllosilicate-rich layered lacustrine/distal alluvial deposits, flood deposits and bedrock just to the east of the ellipse. The rover would examine detailed sedimentary sequences and structures and the relative timing of the major stratigraphic units, and fluvial transport processes and environmental implications.

Gale Crater:

(Ellipse center: -4.49°N, 137.42°E) Gale Crater is a low elevation (-4.5 km), equatorial site along the dichotomy boundary. The target for MSL is the ~5 km layered central mound containing diverse mineral signatures (iron, olivine, sulfates, and phyllosilicates) and morphologies. A variety of bedding thicknesses and styles imply changes in depositional conditions, but the depositional setting(s) remain to be resolved. MSL would test hypotheses regarding the origin of the fill, composition, mode of deposition, depositional environments, timing, and the role of water in the crater. After landing, MSL would investigate fan material from a channel off the northwest crater wall, although the ultimate target would be the mound of layered material ~10 kilometers south of the center of the ellipse. The first targets reached are iron oxides and olivine-rich dunes, although as MSL traversed up the stack, it would then reach phyllosilicate-bearing rocks overlain by sulfates.

Eberswalde Crater:

(Ellipse center: -23.86°N, 326.73°E) Eberswalde is a 65 km diameter crater containing an ancient deltaic system that is evidence for the persistent flow of a river into a standing body of water. The fan is composed of layered sediments, inverted channels and meandering channels. Multiple lobes of the delta indicate several stages of construction over time. Eberswalde crater forms a closed basin with no outlet channels and it is likely that a lake occupied the crater floor when the delta

was actively forming. The main delta is located to the west of the landing ellipse, yet other fluvial and/or lacustrine deposits are accessible within the ellipse. Science targets in this ellipse include escarpments of layered sedimentary rocks and inverted channels that may protect softer clay-rich sediments from erosion, light toned deposits that may be phyllosilicate-rich, and light-toned deposits with polygonal fractures.

Mawrth Vallis:

(Ellipse center: 24.01°N, 341.03°E) Mawrth Vallis is located at the transition between the southern Noachian highlands and the northern lowlands. There is a high surface area of bedded phyllosilicate exposures (covering tens of kilometers) in the bright-toned materials, which have a variety of inferred compositions (range of Mg-Fe smectites to Al-rich phyllosilicates). The Al-rich clays overlie the Fe/Mg clays in observations surveyed and no inter-bedding has been observed in CRISM data. Many of the bright, clay-bearing rocks are polygonally fractured, and there is evidence that the clays were deposited over a geologically significant period of time. Nevertheless, the depositional setting remains uncertain. Science targets include a large diversity of phyllosilicates, low and high calcium pyroxenes, compositional and structural layering at fine scales, possible folded layers, and filled craters.

Additional information:

While imaging is on-going for these four sites, the acquired HiRISE images have been released to the PDS and are available to all interested parties. These images will be used to help characterize potential hazards to safe landing at the sites, plan future operations, and to assess the science potential of the sites relative to stated mission objectives and planetary protection requirements.

http://marsoweb.nas.nasa.gov/landingsites
http://webgis.wr.usgs.gov/msl
http://hirise.lpl.arizona.edu

References:

[1] Golombek et al. LPSC 2009 (this meeting)

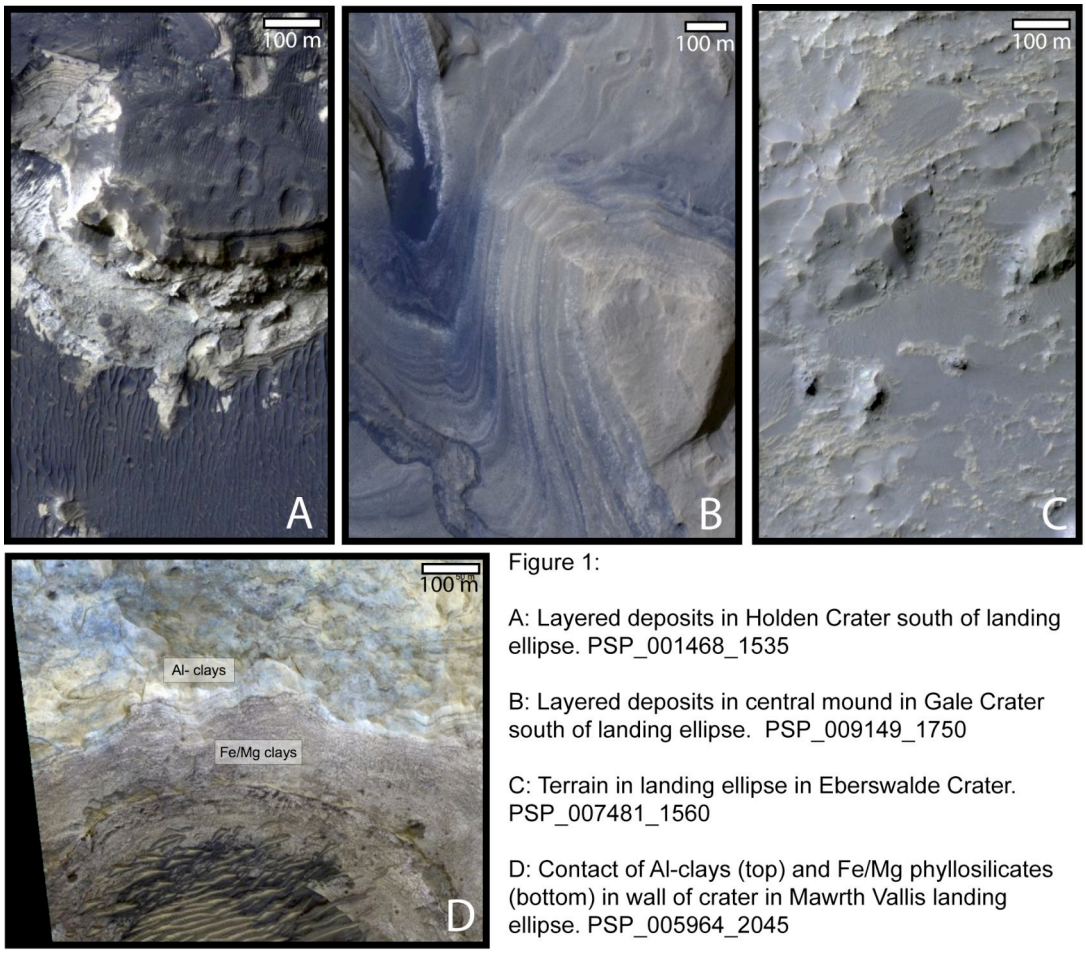

Figure 1:

A: Layered deposits in Holden Crater south of landing ellipse. PSP_001468_1535

B: Layered deposits in central mound in Gale Crater south of landing ellipse. PSP_009149_1750

C: Terrain in landing ellipse in Eberswalde Crater. PSP_007481_1560

D: Contact of Al-clays (top) and Fe/Mg phyllosilicates (bottom) in wall of crater in Mawrth Vallis landing ellipse. PSP_005964_2045