SURFACE PROPERTIES OF THE MARS SCIENCE LABORATORY LANDING SITE GALE CRATER: CHARACTERIZATION FROM ORBIT AND PREDICTIONS. R. L. Fergason, United States Geologic Survey, Astrogeology Science Center, 2255 N. Gemini Drive, Flagstaff, Arizona 86001; rfergason@usgs.gov.

Introduction: The main science objective of the Mars Science Laboratory (MSL) is to explore and quantitatively assess the habitability and environmental history of a local region on the martian surface. The objective of this work is to improve the understanding of the physical characteristics of the surface and assess the scientific potential and engineering safety of the Gale landing site and surrounding region. This objective was addressed by identifying and assessing surface materials using Thermal Emission Imaging Spectrometer (THEMIS)-derived thermal inertia and Context Imager and High Resolution Imaging Science Experiment (HiRISE) visible images. THEMIS-derived thermal inertia values were used to interpret the surface characteristics of the sites and identify potential hazards for lander safety and traversability. Examples include the presence of dusty surfaces, and the presence of hazards, such as rocky and dusty materials. In addition, features, such as layered materials observed in high-resolution visible images and regions where phyllosilicate-bearing surfaces have been identified, were assessed for their scientific importance. A similar analysis was performed for all MSL candidate landing sites to aid in the selection of a final landing location. However, only the results from Gale will be presented.

Background: Gale is an Early Hesperian crater on the dichotomy boundary between the heavily cratered southern highlands and northern lowlands. There is a prominent mound in its interior that is ~5 km high. The landing ellipse is centered at 4.5° S, 137.4° E and is located to the northwest of the mound. This mound is extensively layered and is broadly considered to be sedimentary in origin [1, 2]. In addition, these layers contain alternating sulfate- and phyllosilicate-bearing beds that indicate changing aqueous environmental conditions throughout Gale's history [3].

Gale is similar to many filled craters on Mars and can potentially help better understand the family of craters with layered mounds in their interior. The layers in Gale's central mound provide an opportunity to study an extensive sedimentary stratigraphic section that records the local geologic, climatic, and possibly biologic history. These layers may also record the transition from a climate favorable to clay mineral formation to one more favorable to forming sulfates and other salts [3], which may represent global transitions in aqueous and climactic conditions on Mars [4].

Results: The mean thermal inertia in the Gale landing ellipse is 365 $Jm^{-2}K^{-1}s^{-1/2}$ with a standard deviation of 50 $Jm^{-2}K^{-1}s^{-1/2}$ (Figure 1). The majority of the ellipse has a modrate thermal inertia (250 to 410 $Jm^{-2}K^{-1}s^{-1/2}$). The surface texture is consistent throughout the majority of the ellipse, and a standard deviation of 50 $Jm^{-2}K^{-1}s^{-1/2}$ further supports the interpretation that this surface is fairly uniform. This typical, moderate thermal inertia surface appears extensively degraded in visible images and is hummocky in places, likely indurated, possibly layered, has varying amounts of dark, unconsolidated material intermixed, and in places has a smoothed appearance suggestive of a surface mantle. Outcrops of higher standing material are observed throughout the ellipse, and suggest that this area was once covered by a layer of material that was more extensive. It is therefore possible that this observed surface degradation was caused by the burial and removal of mound material that previously filled Gale [e.g., 1].

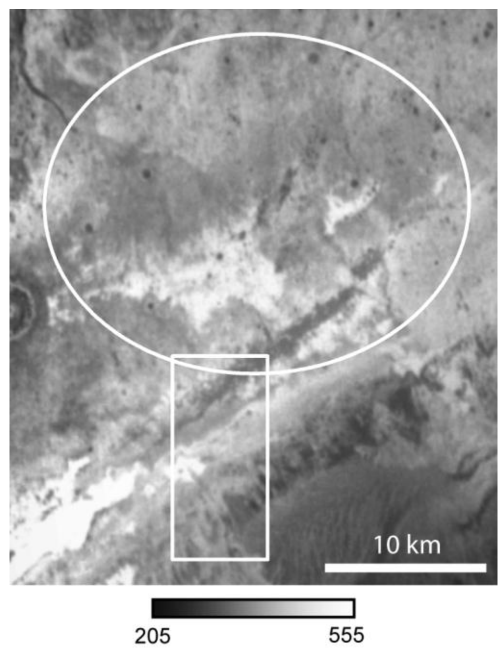

Figure 1. *THEMIS derived thermal inertia map of the Gale landing ellipse (white ellipse) and potential drive locations (white box). Units are in* $Jm^{-2}K^{-1}s^{-1/2}$.

Lower thermal inertia material represents a small fraction of the ellipse and is observed in two locations. First, low thermal inertia material is found infilling craters and depressions (205 to 250 $Jm^{-2}K^{-1}s^{-1/2}$). This material exhibits bed forms, and is likely unconsolidated or weakly indurated. It has a brightness similar to the surrounding region, suggestive of a thin surface mantle. Second, lower thermal inertia surfaces are associated with dark, unconsolidated material observed in the southern portion of the ellipse as a prominent NE-SW-trending deposit (250 $Jm^{-2}K^{-1}s^{-1/2}$ to 315 $Jm^{-2}K^{-1}s^{-1/2}$). This thermal inertia value suggests that these bed-forming materials are coarser grained than expected for mobile sand [5], and may instead be ripples.

The highest thermal inertia value observed in Gale is 555 $Jm^{-2}K^{-1}s^{-1/2}$. Therefore, there are no bedrock exposures present at 100 m-scales. Bedrock exposures could be present at scales below the resolution of the THEMIS instrument. However, to remain consistent with observed thermal inertia values below 600 $Jm^{-2}K^{-1}s^{-1/2}$, those exposures must be relatively small. The higher thermal inertia surfaces (~450 to 555 $Jm^{-2}K^{-1}s^{-1/2}$) typically have a scoured appearance with little dark, unconsolidated material present. The thermal inertia range and degraded appearance of the surface suggest the presence of bedrock material that may be heavily weathered [6]. The degree of induration/weathering, the amount of dark, unconsolidated material, and the variable thickness of the surface mantle are likely responsible for the range of observed thermal inertia values.

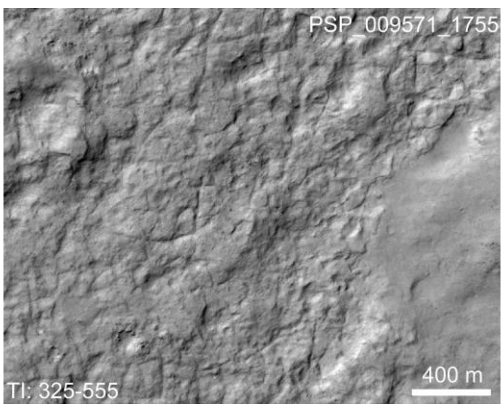

Figure 2. *HiRISE image showing a typical boundary between a courser, higher and smoother, moderate thermal inertia surface.*

Figure 2 illustrates one boundary between high and moderate thermal inertia surfaces. There is a difference in surface texture, where the moderate thermal inertia surface is smoother than the higher thermal inertia surface. This smoothing may be caused by a mantling material that is present over much of the ellipse. To produce the degree of smoothing observed, this mantling material is likely several cm to decimeters thick, and may be moderately indurated to remain consistent with the thermal inertia values observed. It is likely that the majority of the ellipse is a complex mix of materials where the crater floor material (“bedrock”) is overlain by a mantling material that may be moderately indurated, and a thin (few microns) dust layer is present as the top-most layer. This scenario would explain the observed thermal inertia values, the smooth surface, and the uniform brightness. Therefore, the primary difference between higher and moderate thermal inertia surfaces may be due to the amount of mantling material present. This relationship suggests that similar processes may have formed the majority of the ellipse surface, and the post-emplacement deposition of material is the primary distinguishing factor.

To the south of the landing ellipse is a prominent mound that is a desirable drive destination by MSL. Individual mound layers are distinguished in the thermal inertia data. Thus, the MSL rover could be traversing through materials that are compositionally diverse with distinct surface properties associated with individual units. The mound has been previously divided into a lower and upper member [E.g., 3]. The lower member can be further divided into five thermophysical units that correspond to both morphological and mineralogical boundaries [7]. The entire lower mound has a thermal inertia ranging from 265 to 490 $Jm^{-2}K^{-1}s^{-1/2}$. The upper portion of the mound has a thermal inertia of 120 to 260 $Jm^{-2}K^{-1}s^{-1/2}$, which suggests the presence of fine-grained, loosely consolidated material and a significant portion of air-fall dust covering the mound. There are, however, thermophysical variations in the upper formation that correspond to specific layers and terraces observed in the mound. These variations may be caused by differing amounts of unconsolidated material and air-fall dust present, which may be controlled by topography.

Conclusions: The thermal inertia of Gale is higher than those observed at either MER landing site from orbit [8, 6]. Therefore the Gale surface will likely be a fundamentally different surface type than observed in situ previously. This site contains morphologic, chemical, and thermophysical variability, and this work has described the physical properties of the surface and determined how thermophysical variations correspond to morphology and mineralogical diversity when applicable. The additional insight gained through the integration of multiple data sets has enabled an improved analysis of the physical characteristics of the surface and an improved understanding of the causes of observed variations.

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