TEXTURES OF GALE CRATER AS VIEWED BY THE MARS HAND LENS IMAGER (MAHLI). R.A. Yingst[1], M.E. Minitti[1], K.S. Edgett[2], E. Heydari[3], L. C. Kah[4], K. Siebach[5], [1]Planetary Science Institute, Tucson, AZ (yingst@psi.edu), [2]Malin Space Science Systems, San Diego, CA; [3]Jackson State University, Jackson, MS; [4]University of Tennessee-Knoxville, Knoxville, TN; [5]California Institute of Technology, Pasadena, CA.

Introduction: During the first ~550 sols of the Mars Science Laboratory mission, the Curiosity rover acquired color images of over 70 individual rock and outcrop targets with the arm-mounted Mars Hand Lens Imager (MAHLI) [1] at pixel scales ≤31 μm/pixel (resolving very fine and fine sands). A subset of the rock and outcrop targets were further characterized at pixel scales between 16-22 μm/pixel (2.9-4.4 cm working distance), permitting study of grain-scale texture down to the boundary between silt and very fine sand-size particles. This dataset was used to compare and contrast textures of rocks interrogated by MAHLI and provide insight into the formation environment and history of the rocks encountered in Gale crater.

Texture Categories: We group rock textures into categories based on matrix texture, grain size and sorting, and vesicularity. Many categories exhibit variation of a particular characteristic within them, and several categories grade into one another.

Mudstones. This category is primarily represented by the Sheepbed member of the Yellowknife Bay formation (target names used herein are informal and utilized by the team for locational purposes). Viewed from orbit, the Sheepbed member is light-toned fractured material at distal end of an alluvial fan [2, 3]. Sheepbed material is characterized by nodules, sulfate veins, and Mg-enriched raised ridges set in a very fine-grained, light gray matrix. The matrix was most clearly observed in targets Ekwir and Wernecke that were brushed by the Dirt Removal Tool (DRT). Images at 16-17 μm/pixel resolution did not resolve grains in the matrix, leading to the classification of the Sheepbed as a mudstone (Fig. 1).

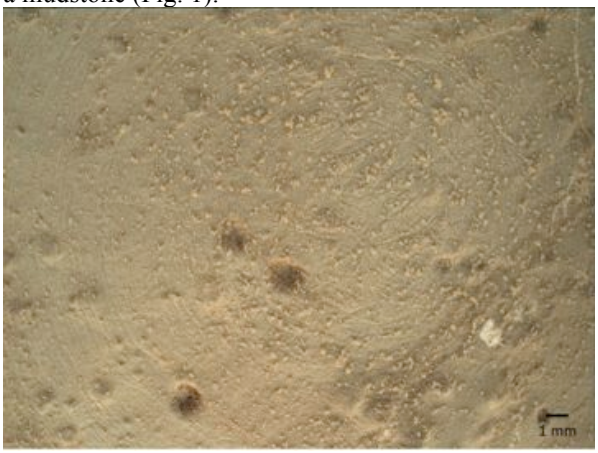

Figure 1. Sheepbed unit, acquired on sol 169. MAHLI image 0169MH0001630000102232R00.

Well-sorted sandstones. Rocks in this category are made of gray, fine-to-medium sand with little to no porosity (Fig. 2). Two examples also exhibit striations with sub-mm spacing that can be traced for centimeters across the rocks' surfaces. In a comprehensive study of the stratigraphy of the Shaler outcrop [2], Ailik was characterized as a cross-stratified sandstone.

Figure 2. Target Ailik, acquired on sol 322. Ailik is a portion of the Shaler outcrop, which contains straight and sinuous crested bedforms. MAHLI image 0322MH0001710000104037R00.

Poorly-sorted sandstones. This category represents the dominant texture from Yellowknife Bay along the traverse toward Aeolis Mons (informally known as Mt. Sharp), and can be subdivided into two sub-categories.

Figure 3. Target Gillespie Lake, acquired on sol 132. This poorly-sorted sandstone lies above the finer-grained Sheepbed member. MAHLI image 0442MH0001630000200181R00.

The first sub-category is represented by the Gillespie Lake member (Fig. 3) of the Yellowknife Bay formation, which sits stratigrapically above the Sheepbed member [2]. It is characterized by rounded, coarse to very coarse sand grains of variable colors and lusters, set in gray, fine sand. The second sub-category is dark gray, well-cemented, and fine grained (smaller than very fine sand-sized) (Fig. 4), with rare larger clasts embedded. This sub-category also exhibits large pores or vugs that may have resulted from weathering out of these larger clasts.

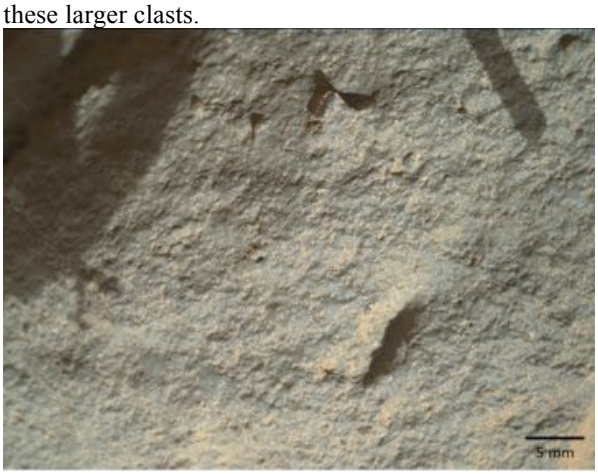

Figure 4. Target Rensselaer, acquired on sol 442, part of the Cooperstown sandstone outcrop. MAHLI image 0442MH0001630000200181R00.

Figure 5. Target Bardin Bluffs, acquired on sol 394. This is a portion of the poorly-sorted Darwin pebbly sandstone outcrop.

Pebbly sandstones. This texture occurs at the Darwin waypoint and is characterized by a less well-cemented, poorly sorted matrix of coarse sand to granules with a variety of colors and lusters (e.g., Fig. 5). While the two units in this category (Bardin Bluffs and Altar Mountain) both have a similar fine-grained matrix, they exhibit different populations and proportions of granules to cm-sized pebbles. Poor sorting suggests deposition in a low energy environment or rapid deposition. However, the Bardin Bluffs unit displays a fining upwards texture and grain-to-grain contact, while the stratigraphically lower Altar Mountain unit does not. Together, these characteristics suggest that textures in the upper unit are the result of fluvial or alluvial deposition [4, 5].

Massive, fine-grained. Rocks of this class are gray and exhibit almost no porosity, although one example (Oswego, Sol 472) exhibits 1-5 mm vug-like patches filled with white material. Grains are unresolved at pixel scales of 22 μm/pxl and are thus smaller than fine sand. Small (≤0.8 mm), irregular gray patches are visible across the rock surfaces. Multiple hypotheses (mineral or glass grains or fragments [6], dust-free patches [7]) exist to explain them.

Vesicular. Rocks in this category are uniform and dark gray, with grains finer than fine sand. They vary from more massive examples (e.g., Jake M. Sol 46 and 47) with mm-sized pores and no coarser grains readily resolved, to those with rough surfaces, cm-sized vugs and coarse sand-sized grains scattered throughout (e.g., Howells, Sol 324). The chemistry (alkalic basalt [8]) and vesicularity of many examples initially appeared to indicate an igneous origin [7,8], but the clear sedimentary context for examples like Howells and Jum Jum (Sol 550) suggest that differences in grain characteristics and relationships stem from variations in cementation and/or weathering history. A sub-category of this type is comprised of fine-sand grains with rare coarse sand grains intermixed, and variability in porosity; it also exhibits distinctive white patches (Larrabee, Sol 511). The indistinct surface expression of the patches makes assessing their origin challenging. One hypothesis is that they are feldspar crystals, but an igneous origin would not be consistent with the apparently sedimentary facies in which these rocks are found.

Future work: The next step after categorizing lithologies at the hand-lens is to look for linkages between microscale textures and observables such as macroscopic (outcrop-scale) character, chemistry and distribution within Gale crater, that will lead to potential lithologic interpretations.

References: [1] Edgett, K.S. et al. (201x) PSS [2] Grotzinger, J.P. et al. (2013) *Science,* DOI: 10.1126/science.1242777. [3] Edgar, L.E. (2014) *LPSC 45,* Abstract #1648. [4] Yingst, R.A. et al. (2014) LPSC 45, #1295. [5] Williams, R.M.E. et al. (2014) LPSC 45, #2401. [6] Sautter, V. et al. (2013) *LPSC 44,* Abstract #1985. [7] Minitti, M.E. et al., (2013) *LPSC 44*, #2186. [8] Cousin, A. et al. (2013), LPSC 44, #1409.