GRAIN SIZE MEASUREMENTS OF EOLIAN RIPPLES IN GALE CRATER, MARS. C. M. Weitz[1], R. J. Sullivan[2], M. G. A. Lapotre[3], S. K. Rowland[4], J. A. Grant[5], and R. A. Yingst[1]. [1]Planetary Science Institute, 1700 E. Fort Lowell, Tucson AZ 85719 (weitz@psi.edu) [2]Cornell University, Ithaca, NY 14853; [3]Harvard University Cambridge MA, 02138; [4] University Hawaii, Honolulu, HI 96822; [5]Smithsonian Institution, Washington DC, 20560.

Introduction: Grain sizes on eolian bedforms can be used to understand wind activity (e.g., active or non-active, wind strength, wind direction) under current or past environmental conditions. The size of the grains on ripples may be related to their location on the ripple (i.e., crest vs trough). The size and location of the ripple itself may also influence grain sizes, such as large isolated ripples compared to small impact ripples on larger linear dunes. In order to explore how grain sizes vary as a function of these many parameters, we used Curiosity's Mars Hand Lens Imager (MAHLI) [1] to measure the size and shape of grains on or near ripple crests at several locations within Gale Crater (Fig. 1).

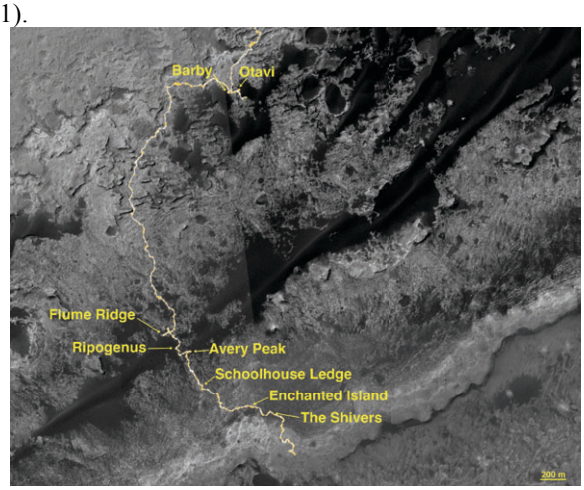

Figure 1. HiRISE mosaic showing the Curiosity rover traverse with the ripple locations labeled.

Ripple Locations: The Barby target (Sol 1184) is on the side of a ripple crest on the lower stoss slope of the barchan High dune (Fig. 1). The Otavi target (Sol 1242) is on the crest of one of the many small ripples along the lower lee slope of the Namib barchan dune, about 100 m away from the Barby target (Fig. 1). Both targets were part of the Bagnold Dunes Campaign Part I [2,3]. During the Bagnold Dunes Campaign Part II, Flume Ridge (Sol 1603), Ripogenus (Sol 1638) and Avery Peak (Sol 1651) targets were studied (Fig. 1). These targets are situated on the crests of smaller ripples on larger longitudinal dunes named Nathan Bridges and Mount Desert Island. Following the Bagnold Dunes Campaign Part II and along the traverse to Vera Rubin Ridge (VRR), three targets at different ripples were examined (Fig. 1). Schoolhouse Ledge (Sol 1688) is an isolated megaripple not associated with either a dune or ripple field. Enchanted Island (Sol 1749) is a linear ripple contained within a larger ripple field near VRR. The Shivers (Sol 1793) target is on a ripple crest within a small field of ripples also near VRR.

Analysis: Grain sizes were measured using the same procedure detailed in [4] where the length of the longest axis for each grain particle was measured. We performed these measurements manually using the software ImageJ. Circularity and Aspect Ratio for 100 grains larger than 150 µm in length from each ripple target were also calculated after their shapes were outlined in ImageJ. The pixel scale resolution in µm/pixel, number of grains measured, minimum and maximum grain size, median size, median circularity, and median aspect ratio for the eight ripple crest targets are listed in Table 1. MAHLI figures for each of these targets are shown in Figure 2. Based upon observed grain movements in multiple MAHLI, Mastcam, and/or MARDI images [5] as well as APXS data that show low values of S, Cl, and Zn for active sands [6], all ripples except Schoolhouse Ledge are interpreted as active.

Results: Flume Ridge, Otavi, and Avery Peak are dominated by 75-150 µm grains. Both The Shivers and Ripogenus have a large population of grains between 200-350 µm in size, and Ripogenus also has a large number of grains that are 50-150 um in size. The Barby ripple surface is dominated by 250-450 µm grains. The MAHLI image was actually taken ~7 cm away from the ripple crest but the grain sizes on the crest appear similar in lower resolution MAHLI images. The Enchanted Island target has slightly larger grains than Barby, with most grains between 300-500 µm in size. The grains have some dust aggregates on their surfaces, suggesting they have been less active recently compared with ripples examined within the Bagnold dune field. Grains along the crest of Schoolhouse Ledge are the largest, 400-600 µm, and most circular of the 8 ripples. All of the grain surfaces have a thin dust coating, indicating the ripple is not currently active.

Some of the ripple crests have similar grain sizes on both the stoss and lee sides (Schoolhouse Ledge, Barby, The Shivers) whereas other ripples showed larger grains concentrated on the stoss side (Enchanted Island) or lee side (Flume Ridge, Ripogenus, Avery Peak). The actual crest of each ripple tended to have slightly smaller grain sizes than the ripple lee and stoss sides at Barby, Flume Ridge, Ripogenus, Avery Peak, and The Shivers.

Figure 2. Ripple crest MAHLI images analyzed in this study. (a) Barby (b) Otavi (c) Flume Ridge (d) Ripogenus (e) Avery Peak (f) Schoolhouse Ledge (g) Enchanted Island (h) The Shivers.

Scuffing by the rover's front wheel revealed both Schoolhouse Ledge and Enchanted Island have coarser grains dominating the ripple surface with finer grains within the ripple interior. Scuffing at Otavi and Flume Ridge showed similar size grains within the ripple interior and along the crest surface.

The Otavi target, acquired on a small impact ripple along the lee side of the Namib dune, has a smaller population of grain sizes compared to Barby on the nearby High dune. Otavi also has a paucity of grains larger than 250 µm in size compared to the Bagnold Dune Campaign II targets.

In general, the surfaces of active ripples have smaller and more elongate grains compared to the inactive ripple Schoolhouse Ledge, which exhibits an armor of larger rounded grains analogous to desert pavements on Earth. Similar results were noted for the inactive ripple Rocknest located ~7 km away and not associated with the Bagnold Dunes [7].

Our results indicate grain sizes vary widely depending upon such factors as ripple activity, location along the ripple profile, ripple size, associated dune type (if any), and orientation relative to the prevailing NE to SW wind direction.

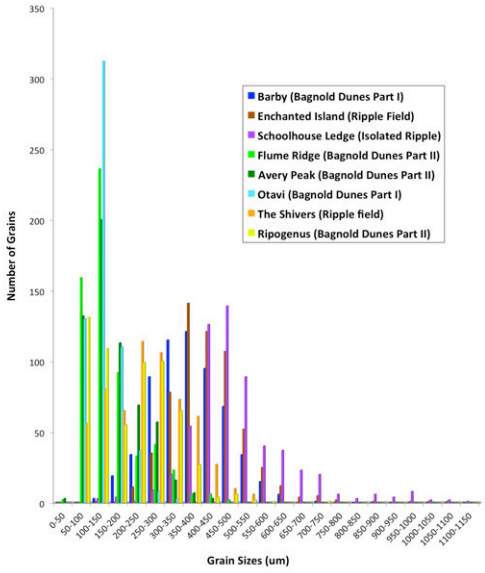

Figure 3. Grain size distribution up to 1150 µm in length for the 8 ripple targets.

References: [1] Edgett, K.S. et al., (2012) Space Sci. Rev., 170, 259-317. [2] Bridges, N.T. and B. L. Ehlmann (2017) J. Geophys. Res., doi: 10.1002/2017JE005401. [3] Ehlmann, B.L. et al. (2017) J. Geophys. Res., doi:10.1002/2017JE005267. [4] Rowland, S.K. et al (2017) in preparation. [5] Baker, M. et al. (2017) Fall AGU, New Orleans, P33F-04. [6] O'Connell-Cooper, C. et al. (2017) Fall AGU, New Orleans, P41E-2867. [7] Minitti, M.E., et al., (2013), J. Geophys. Res. Planets, 118(11), 2338-2360.

Table 1. Grain size properties for each ripple target.

Ripple Target	*Scale µm/pixel*	*# grains*	*Min µm*	*Max µm*	*Median µm*	*Circularity*	*Aspect Ratio*
Barby	22.3	838	105	729	363	0.95	1.20
Otavi	16.0	719	47	354	127	0.93	1.22
Flume Ridge	16.8	925	46	771	126	0.93	1.25
Ripogenus	20.4	853	52	734	235	0.95	1.22
Avery Peak	16.2	1005	43	480	136	0.95	1.22
Schoolhouse Ledge	20.7	654	120	1722	480	0.97	1.13
Enchanted Island	23.5	628	131	1407	414	0.96	1.15
The Shivers	23.0	887	75	686	264	0.95	1.18