GRAIN SIZE ANALYSIS OF CONGLOMERATES IN GALE CRATER: PROVIDING INSIGHTS INTO THE HYDROLOGY OF EARLY MARS. F. Rivera-Hernández[1], M. Burdell[2], M. C. Palucis[3], G. Kim[1], K. M. Stack-Morgan[4], C. H. Seegler[5], [1]Georgia Tech, School of Earth & Atmospheric Sciences, Atlanta, GA 30332 (friverah@gatech.edu), [2]University of Georgia, Athens, GA, [3]Dartmouth College, Hanover, NH, [4]Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA, [5]California Institute of Technology, Pasadena, CA

Introduction: The *Curiosity* rover provided the first *in situ* evidence for past water flows on Mars when it landed on fluvial conglomerates at Bradbury Landing, Gale crater [1, 2]. There, conglomerates occur as isolated blocks of cemented pebbles and sand with sedimentary textures characteristic of river deposits (rounding and imbrication) [1, 2]. By measuring grain size in these deposits and calculating their distributions, paleoflow properties were estimated (flow depth and mean velocity) [1, 2]. While conglomerates occur along *Curiosity's* traverse at other sites [3-9], these have not been studied in detail and thus their depositional setting and paleohydrologic history have not been well constrained.

Our study builds upon previous work by performing grain size analyses of conglomerates imaged by the ChemCam Remote Micro Imager (RMI) in Bradbury Rise. Grain size results are placed in stratigraphic context to provide insights into possible changes in water availability on early Mars. Here we present a subset of these grain size results for 12 conglomerates imaged from sols 343-379 (pre-Darwin), spanning 2.33 m in stratigraphy.

Methods: Our analysis focused on conglomerates imaged by the ChemCam RMI and documented by [5]. The RMI has an angular pixel size of 0.0195 mrad/pixel, a circular field of view of 20 mrad over 1024 × 1024 pixels [10]. RMI images used in our analyses had spatial resolutions varying from ~50 to 80 µm/pixel. Thus, only grains 150 to 240 µm wide and larger could be resolved in images when in focus. The RMI mosaics were retrieved via the PDS Analyst's Notebook and visualized using the ImageJ software.

For each RMI image, a grid by point method was used for grain size analyses using grids with 15 mm^2 dimensions. At each grid intersection, grains that were resolved were traced to calculate properties such as the Feret diameter, sphericity, and roundness. If grains were not resolved they were recorded as having sizes smaller than 3 times the spatial resolution of the RMI. At least 100 grains were recorded for each RMI. Grains ≥ 2 mm in size we defined as clasts, and those < 2 mm as matrix. All grain size data was used to determine sorting and matrix to clast percent for each rock. Matlab was used to calculate grain statistics, such as D50 (median), D84, sorting, skewness, and kurtosis. For each rock, these metrics were placed into stratigraphic context by plotting them against their elevation in meters.

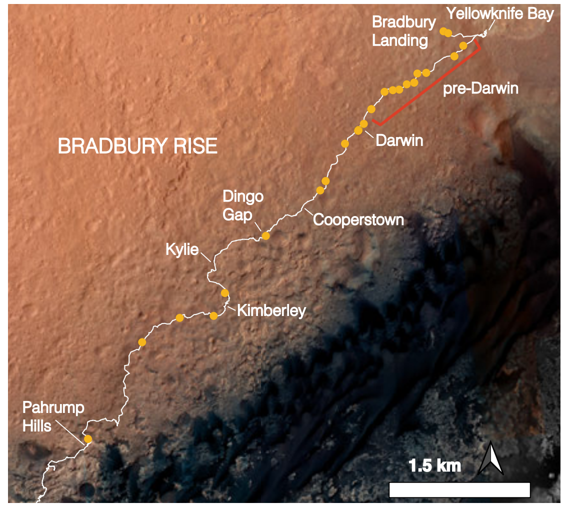

Figure 1. Location of conglomerates imaged by the RMI in Bradbury Rise, Gale crater.

Results: Preliminary results suggest that pre-Darwin rocks are generally well cemented, matrix supported conglomerates. Clasts typically make up 12-44% of the RMI scenes. Pre-Darwin rocks have D50 values ranging from 2.68-3.47 mm (very fine gravel) and D84 values from 4.63-7.45 mm (fine gravel). Maximum grain sizes range from 6.37-22.45 mm (fine to coarse gravel). The range in maximum grain size for the rocks at lower elevations is narrower (~10-15 mm) compared to higher elevations (~6-20 mm). For the same rocks, grains are generally subrounded to subangular, although some have angular clasts.

Interpretations and Discussion: The small range in D50 with elevation for pre-Darwin rocks suggests that the typical energy of these ancient water flows in Gale crater was generally similar for this time interval. Variations in the maximum grain size between elevations may suggest drier/colder (lower values) or wetter/warmer (higher values) periods.

Pre-Darwin rocks have D50 values that are lower than those measured for Bradbury Landing rocks that range from 4.5-8.5 mm [1]. This suggests that the water flows that transported the grains in pre-Darwin rocks had lower flow energies compared to those for Bradbury Landing. Although it is also possible that the grains measured for Bradbury Landing are skewed to larger sizes as Mastcam images were used in those analyses and these have larger scenes and coarser spatial resolutions (e.g., smaller grains may not be resolved).

In contrast, conglomerates that are higher in stratigraphy near Pahrump Hills have lower D50 values (0.5 mm [11,12]) compared to those measured for Bradbury Landing and pre-Darwin rocks. This suggests that the younger water flows that transported the grains in the Pahrump conglomerates generally had lower flow energies compared to the older flows associated with the Bradbury Landing and pre-Darwin rocks.

We also have the opportunity to compare our results with those of conglomerates in Jezero crater imaged by the Perseverance rover [13]. Compared to Gale, the Jezero conglomerates have higher D50 values (16.4 cm [13]). This suggests that the water flows required to transport the grains in the Jezero rocks likely had higher energies than those required to transport the gravels in Gale and possibly reflect wetter/warmer conditions.

Future work: Future analyses will focus on extending our conglomerate grain size record to higher stratigraphic elevations in Bradbury Rise and using these data for paleohydraulic calculations. Additional detailed mapping of surrounding rock units to the conglomerates will help better constrain their depositional setting and main transport processes.

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References: [1] Williams et al. (2013) Science, 340 (6136), 1068-1072 [2] Dietrich et al. (2017) Gravel-Bed Rivers: Processes and Disasters, 755-783. [3] Grotzinger et al. (2015) Science, 350(6257), aac7575. [4] Le Deit et al. (2016) JGR: Planets, 121, 784-804 [5] Mangold et al. (2016) JGR: Planets, 121, 353-387 [6] Rice et al. (2016) JGR: Planets, 122, 2-20 [7] Stack et al. (2016) Icarus, 280, 3-21 [8] Williams et al. (2018) Icarus, 309, 84-104 [9] Tebolt et al. LPSC 53, this issue [10] Le Mouélic et al. (2015) Icarus, 249, 93-107 [11] Stack et al. (2018) LPSC 49, 1712 [12] Seegler et al. (2018) GSA 50, 15-6 [13] Mangold et al. (2021) Science, 374 (6568), 711-717.

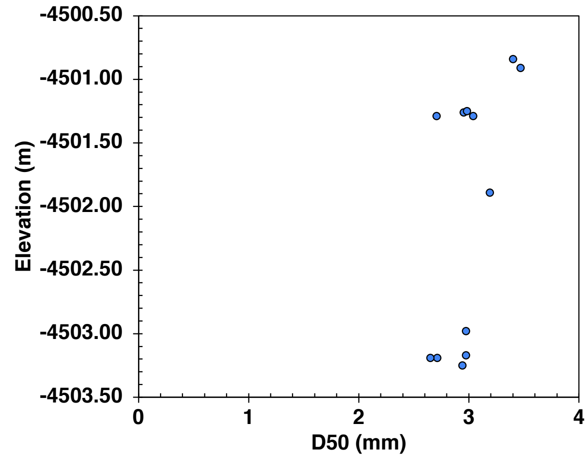

Figure 2. RMI based D50 values for pre-Darwin rocks.

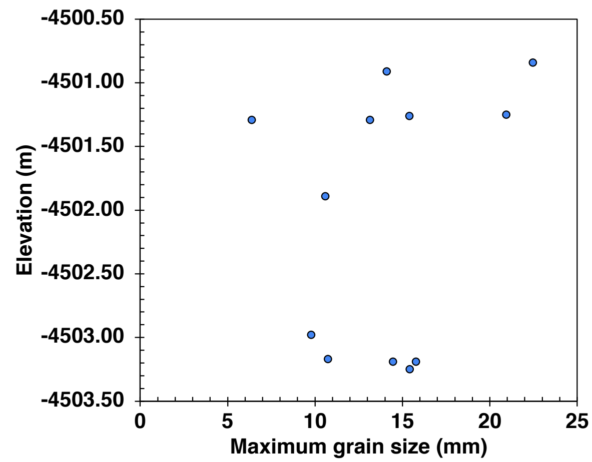

Figure 3. RMI based maximum grain size values for pre-Darwin rocks.