HOUSEDON HILL – A CHEMCAM RMI MEGA MOSAIC TO INVESTIGATE DISTANT FEATURES IN GALE CRATER. S. Le Mouélic[1], O. Gasnault[2], W. Rapin[2], A. B. Bryk[3], W. E. Dietrich[3], G. Dromart[4], R. C. Wiens[5], G. Caravaca[1], N. Mangold[1], H. Newsom[6], E. Dehouck[4], P. Pinet[2], and K. E. Herkenhoff[7] . [1]LPG, CNRS UMR6112, Univ. Nantes, France. [2]IRAP, Toulouse, France. [3]UC Berkeley, CA, USA. [4]Univ. Lyon, LGLTPE, France. [5]LANL, NM, USA. [6]Univ. of New Mexico, NM, USA. [7] USGS, Flagstaff, USA

Introduction: The ChemCam Remote Micro-Imager (RMI) onboard Curiosity was originally designed to document the tiny areas analyzed by the instrument's laser-induced breakdown spectroscopy (LIBS) technique on rocks within a few meters around the rover [1, 2]. The RMI produces 1024x1024 pixel black and white images directly from ChemCam's telescope focal plane. Early in the mission, it was recognized that, thanks to its powerful optics, RMI could also play a role as a long-distance reconnaissance tool, complementing other cameras on the remote sensing mast, and taking advantage of its very long focal length [3].

The Housedon_Hill long distance imaging experiment: Between sols 2878 and 2921, Curiosity stayed parked at the Mary Anning/Groken site to perform various rock sampling analyses. This opportunity was used to observe distant outcrops of interest and progressively build a very large RMI mosaic, named "Housedon_Hill" after the initial outcrop targeted on sol 2878. In the end, a total of 216 overlapping images were acquired, covering an area ranging from the bottom layers of Mount Sharp to the edge of Vera Rubin Ridge (~50° in azimuth). This product is the largest RMI mosaic acquired in the entire mission. Fig. 1 (top) shows the viewshed of the RMI mega-mosaic, indicated from the rover's imaging location on a CTX orbital mosaic.

Results: Fig. 2 shows the 216 RMI images stitched into a single panorama of 46947 by 7260 pixels, which covers various geologic landforms. A dune field with sand ripples appears at 2 km in the vicinity of Vera Rubin ridge on the leftmost part (Fig. 3). By stretching the contrast of the image in the middle of the panorama above the foreground (which is up to 19 km away), one can recognize in the distance features corresponding to large blocky rocks that rolled partway down from Gale's crater wall (Fig. 1 bottom and Fig. 4). When compared to orbital imagery, these blocks appear to be 59 km from the rover – a distance record for a ChemCam/RMI observation.

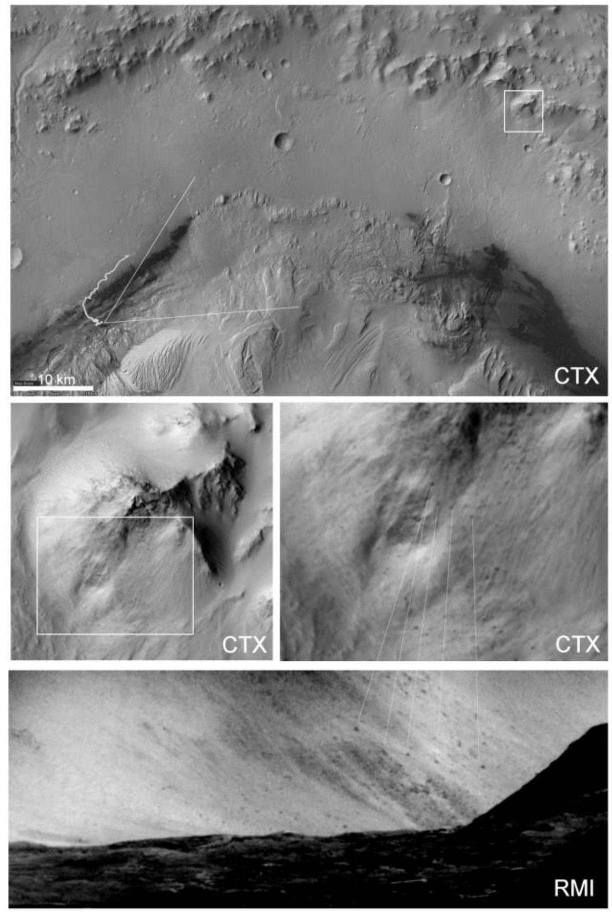

Fig. 1: Context image of the most distant feature seen in the RMI mosaic. The top image is a global CTX mosaic (source https://mars.nasa.gov/maps/location/?mission=Curiosity). The MSL rover's traverse is indicated in white, and the viewshed of the RMI mega-mosaic is indicated from the rover's imaging location. The white box indicates the location of the zoomed-in panels displayed in the middle. Distant rocks fallen partway down from Gale's crater wall are seen as dark specks in both the CTX and the contrast-stretched inset of the RMI mosaic (bottom) taken from 59 km away.

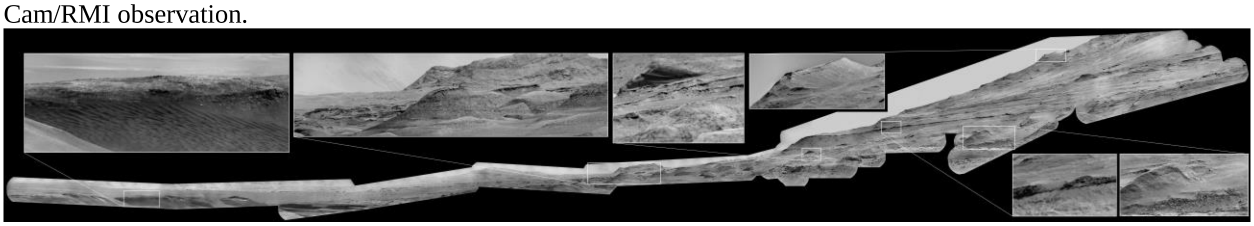

Fig. 2: Housedon Hill ChemCam/RMI mosaic, with selected zooms on areas of interest (original file 46947x7260 pixels).

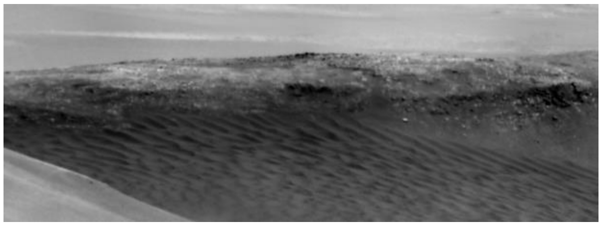

Fig 3: Dune field next to Vera Rubin ridge, 2 km away from the rover. The interval between ripple crests is ~1 m.

This indicates that despite the dust in the atmosphere, which varies significantly during seasons, the sky at this time was clear enough to perform such distant imaging. The images were taken between Ls ~275 and ~302, so during the dust storm season, but in between the two peaks of atmospheric opacity usually observed at Gale (see Fig. 4A in [4]).

Fig. 4: Exposure of layered rocks in the foreground. The hill at the top center is ~20 km away. The light-toned upper background is Gale crater's wall, seen through the hazy atmosphere (see stretched version in Fig. 1).

On the middle and rightmost part of the panorama, a wide variety of layered units, some with crossbedding, illustrates the complex depositional history of the sedimentary rocks comprising Mount Sharp. Fig. 5a shows an example of crossbeddings outcropping ~7 km from the rover. Fig. 5b shows meter-scale laminations revealed on a mesa seen 16 km from the rover.

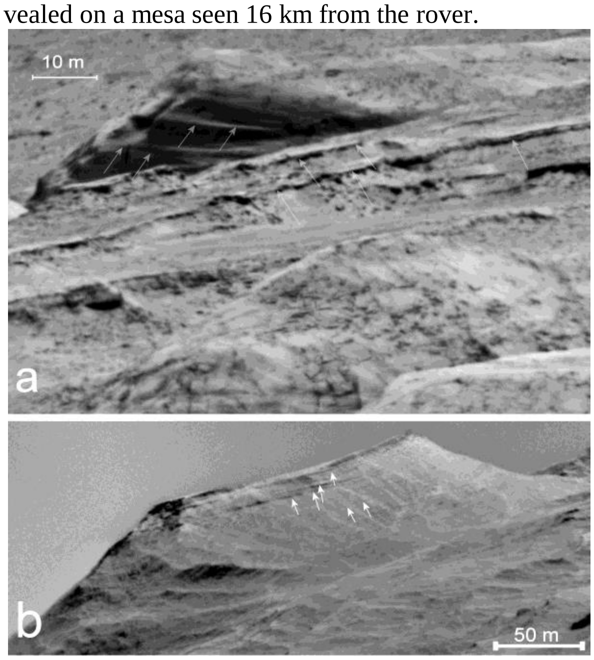

Fig 5: Example of layering. (a) cross bedding: Layers in the front dip from right to left while the layers in the background dip the other way. (b) This mesa at 16 km shows evidence of fine- meter-scale bedding (arrows).

Fig. 6 shows a part of the "Marker Bed", with its characteristic irregular thickness and blocky morphology. The "Marker Bed" is a single landform that can be traced across a long distance, allowing long-range correlations across remote areas of the Mount Sharp. This feature extends almost all along its base over tens of kilometers.

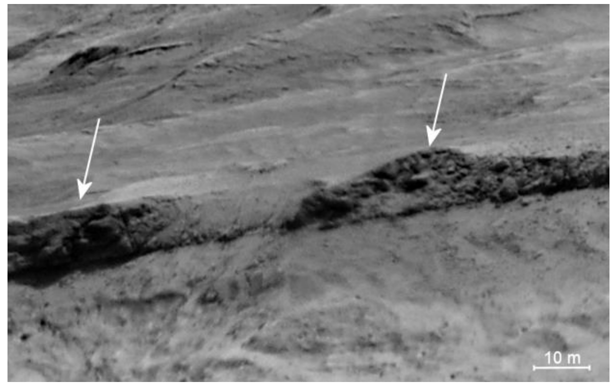

Fig. 6: The erosion-resistant lip identified as a "Marker Bed" transition (~9 km away).

This darker rocky bed of strata potentially represents a key transition within the ancient depositional environment of the sediments as it marks the upper boundary of the crossbedded interval visible on outcrops such as the one illustrated in Fig. 7.

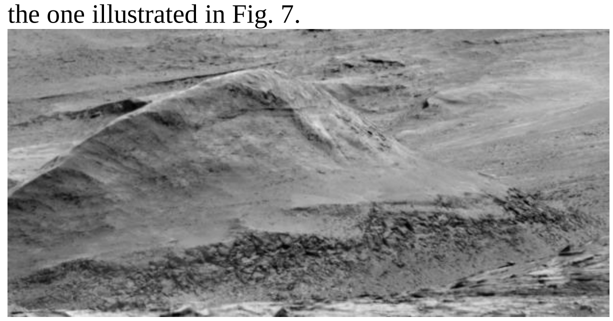

Fig. 7: Eroded butte within the lower crossbedded section or transition interval.

Conclusion and future work: Imaging areas several kilometers from the rover with RMI provides pictures that are very complementary to orbital observations and gives a more human-like, ground-based perspective. It is particularly useful for steep and subvertical faces that orbital data cannot show well. It also shows higher detail at greater distances than we would otherwise have ever been able to identify with other cameras. RMI imaging provides insights into the morphologic and stratal components of Mount Sharp such as the yardang [5] or the sulfate-bearing unit [6].

Bibliography: [1] Maurice et al., Space Sci. Rev., 170, 95-166, 2012. [2] Wiens et al., Sapce Sci. Rev. 170, 167-227, 2012. [3] Le Mouélic et al., Icarus 249, 93-107, 2015. [4] Moore et al., Icarus 329, 197-206, 2019. [5] Dromart et al., EPSL, 554, 2021. [6] Rapin et al., Geology, in revision.