ENIGMATIC LARGE BEDFORMS ON THE FLOOR OF JEZERO CRATER. R. Sullivan[1], M. Baker[2], M. Golombek[3], K. Herkenhoff[4], C. Newman[5], and C. Tate[6] [1]CCAPS, Cornell University, Ithaca, NY, 14853, rjs33@cornell.edu [2]Smithsonian Institution, Washington DC, [3]Jet Propulsion Laboratory, Pasadena, CA, [4]USGS, Flagstaff, AZ, [5]Aeolis Research, Pasadena, CA, [6]Dept. of Astronomy, Cornell University.

Introduction: Large, light-toned aeolian bedforms were known to be abundant on the floor of Jezero crater prior to the arrival of the Mars Perseverance rover [1-3]. However, higher resolution images from Perseverance reveal many of these bedforms have enigmatic flat-topped morphologies (Figure 1). These large, flat-topped ripples have not been encountered on Mars at any previous lander site, nor along any previous rover mission traverse. To our knowledge, they have no clear terrestrial analogues. This presentation describes bedform characteristics, discusses potential factors in their origins, and solicits collaboration to help us better understand how these features develop.

Figure 1. Flat-topped ripple observed by Mastcam-Z sol 113, x m long, x m wide, and ~x cm high. Note surface textures (wind tails) on both flanks indicating sand migration from left (ESE) and right (WNW) helping to shape the feature.

Morphological characteristics: Flat-topped ripple morphologies were apparent in images from the EDL camera at low altitudes before touchdown, and confirmed by Navcam [4] and Mastcam-Z [5] images soon after landing. Numerous additional examples have been observed along the rover's traverse that has reached ~1 km from the landing site as of this writing (sol 318). Flat-topped ripples are not confined to a specific unit or area visited by the rover, and in some places are located near large ripples with similar surface textures and sizes but having conventional triangular or rounded crests. Flat-topped ripples vary in size, but lengths 5-20 m, widths 1-4 m, and heights 10-20 cm are common. The largest examples of flat-topped ripples, ~70 cm high, are found in local depressions along the margins of the Séítah unit. Flat-topped ripples can occur in continuous crest-trough-crest groupings, but more commonly occur as individual features isolated from others (e.g., Figure 1). Flat crest areas are not always level, and in some examples change to more conventional crest morphology along bedform length. Ripple surfaces are covered mostly with grains typically 1-5 mm (except where partly obscured by mantling dust or, sometimes, by small superposed ripples of darker, much finer sand, e.g., Figure 2.) Rover wheel interactions reveal the presence of surface crusts, indicating induration. Ripple interiors exposed in rover wheel "roadcuts" appear to have abundant finer grains; however, none of these exposures was seen closely by the rover, so it is uncertain to what extent coarser grains might also be present within these bedforms.

The closest terrestrial analogues are large ripples of poorly sorted sand in which crests (and sometimes flanks as well) are covered with very coarse, creep-limited grains, known as "megaripples" (and several other terms), and having a range of internal configurations [e.g., 6-8] but all sharing the same characteristic of creep-limited grains covering crests. On Mars, conventional megaripples similar to terrestrial examples have been recognized at the Viking Lander 1 and Pathfinder sites, and along every rover traverse (including at Jezero), but megaripples with flat tops are known to us only on Mars, on the floor of Jezero crater. Even if flat-topped megaripples might be a peculiarly martian bedform, they could be common at many other locations on Mars not yet visited by landers or rovers so remain unresolved by orbital imaging and unknown.

Potential Origins: We cannot offer an entirely satisfactory explanation for these prominent aeolian bedforms. Probably an important factor in their origins is the potential on Mars for long periods of arid surface exposure without much bedform migration (in which strong wind events would be locally rare, local saltating sand supply lacking, or both), leading to induration of existing bedforms. Long surface exposures leading to induration, alternating with periods of increased wind activity and/or increased sand supply, should create conditions that could allow multiple stages of bedform development and evolution. This type of long-term sequence of environmental conditions might be difficult to replicate on Earth, where weathering mechanisms are more diverse and more active, and wind dynamic pressures are much greater. On Mars, collisions and interactions between a stabilized megaripple that is too indurated ever to be reactivated, and a newer generation of actively migrating ripples, might have the potential to develop

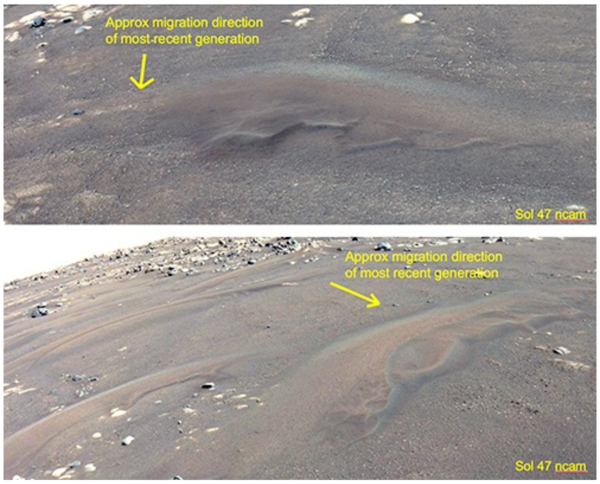

Figure 2. Examples of older, coarsely-surfaced megaripples being overtaken by younger ripples of finer, darker sand.

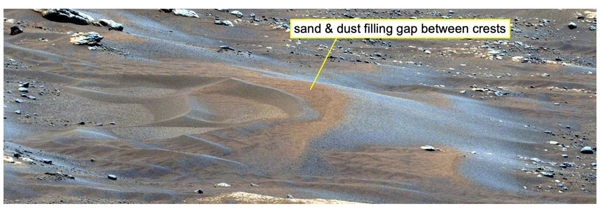

Figure 3. Example of material filling gap between megaripple crests.

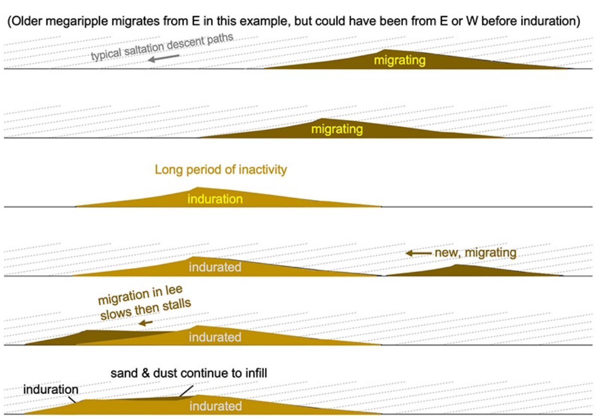

Figure 4. A suggested evolutionary sequence, incorporating a period of inactivity causing induration: younger ripples migrate over indurated older ripples but stall in the lee (shielded from most saltation) and indurate in place, adding to the volume of the original bedform; additional sand eventually fills intervening gap and indurates as well.

complex bedform morphologies. Figure 2 provides an example in which a previously active megaripple, now indurated and stabilized, has been overtaken by smaller, more recently active ripples of finer sand; as these active ripples migrate over the crest and into the lee, they become shielded from most high-speed saltating grains (which descend at low angles) so begin stalling in place, potentially indurating and adding to the volume of the older bedform. Figure 3 seems to show similar events involving a more recently active megaripple having overtaken an older, indurated example, stalling in the latter's lee; the gap between their crests is becoming filled with other dust and sand.

While this process, modeled in Figure 4, probably contributes to developing flat-topped ripple morphologies, almost certainly this is not a complete explanation. Systematic analysis of small sandy wind tails extending from behind small obstacles all along the Perseverance traverse shows that sand-driving winds in the current era blow predominantly from the ESE [9]. But ventifact orientations along the Perseverance traverse indicate formative sand-driving winds from the opposite, WNW, direction, suggesting different formative wind directions and/or sand supply locations in the past [9]. Wind tail surface textures along both flanks of the example flat-topped megaripple in Figure 1 suggest this bedform is old enough to have recorded both of these formative wind directions, suggesting the potential for gradual, complex development of these bedforms over a very long period of time.

Identification of terrestrial megaripples with similar, flat-topped morphologies (currently unknown to us) would be an invaluable aid for helping to understand the origins of these Jezero bedforms, and the aeolian history and erosional evolution of the crater floor.

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