MEGARIPPLES AT GREAT SAND DUNES NATIONAL PARK AND THE PUNA PLATEAU AS TERRESTRIAL ANALOGS FOR AEOLIAN BEDFORMS IN GALE CRATER, MARS. M. M. Baker[1], J. Zimbelman[1], S. P. Scheidt[2], C. M. Weitz[2], R. Sullivan[3], S. L. deSilva[4], M. E. Banks[5], [1]Smithsonian Institution National Air and Space Museum Center for Earth and Planetary Studies, Washington DC (bakerm@si.edu); [2]Planetary Science Institute, Tucson, AZ; [3]Cornell Center for Astrophysics and Planetary Science, Ithaca, NY; Oregon State College of Earth, Ocean, and Atmospheric Sciences, Corvallis, OR; [5]NASA Goddard Space Flight Center, Greenbelt, MD.

Introduction: Large aeolian ripples with crests coated in very coarse sand, granules, or pebbles (often termed "megaripples") are ubiquitous on both Earth and Mars [1-3]. Megaripples are characterized by a bimodal grain-size distribution hypothesized to be a result of grain sorting caused by differing transport modes (i.e., finer-grained sand undergoes saltation, while coarser material moves by surface creep). On Mars, different environmental conditions (e.g., ~30% Earth's gravity and ~1% Earth's atmospheric density) affect megaripple development and migration in ways that are not well understood. Here we describe data collected at two Mars analog field sites, which we hope will help identify the various factors controlling the morphologic evolution of terrestrial megaripples. Moving forward, we plan to extrapolate these findings to the diverse set of coarse-grained ripples that have been observed in Gale crater on Mars in an attempt to evaluate the formation mechanisms and stability of these bedforms, as well as characterize the dynamics of surface creep under modern martian surface conditions.

Methodology: *Terrestrial Field Work.* The field work component of this project involved studying megaripples at two Mars analog sites: Great Sand Dunes National Park (GSDNP) in Colorado, USA and the Puna Plateau (PP) in Argentina. Data collected on these bedforms included grain size, topographic relief, wavelength, and migration rate. In many respects, the megaripples studied at these sites are morphologically dissimilar (e.g., with respect to grain size and overall shape) and may be representative of two terrestrial extremes; together they can provide a more comprehensive view of the processes involved in megaripple formation on Earth. Slow motion and time lapse videos were also taken at GSDNP to document grain transport and bedform migration. Anemometer data acquired during periods of enhanced wind activity will also be used to constrain the relationship between wind speed and migration rates.

Mars Science Laboratory (MSL) Observations. Images acquired from the Mastcam and MAHLI cameras will be used to characterize coarse-grained ripples encountered along the MSL rover's traverse, including grain sizes, dust cover, and overall morphology. When available, stereo images will be used to obtain topographic profiles through ripple crests. Repeat "change detection" images showing migration of megaripple-like bedforms can also be directly compared to videos taken at GSDNP in order to understand how these processes differ between Earth and Mars.

Orbital Reconnaissance. Images acquired from the Mars Reconnaissance Orbiter (MRO) will be used to provide additional information on bedforms encountered along the traverse. Gale crater is one location on Mars where overlapping orbital and ground truth data exist and the comparison between these datasets can provide insights into the nature of bedforms that have been seen from orbit but for which we have no *in situ* information. Orbital images taken in different Mars years will provide a means to estimate ripple migration rates through long-baseline change detection.

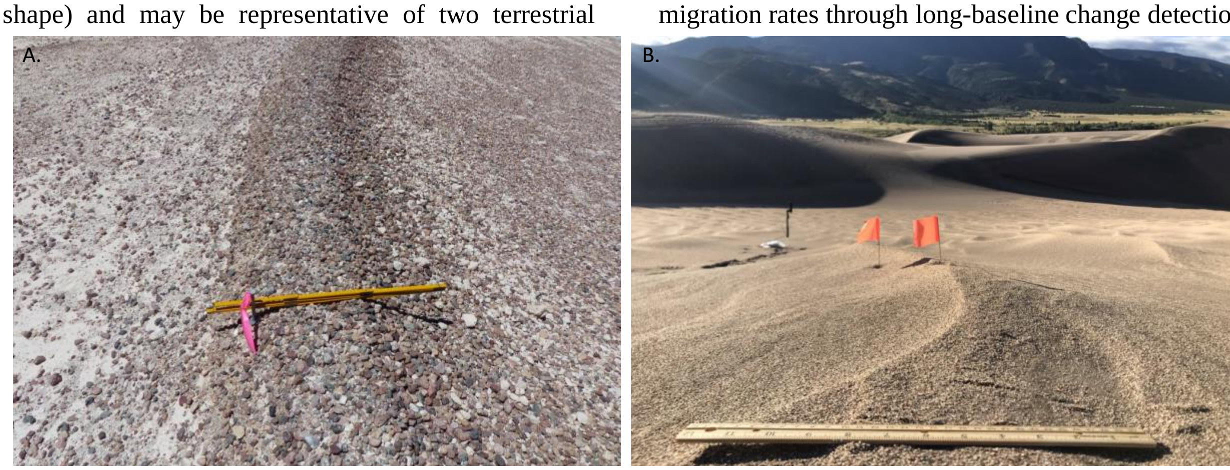

Figure 1: Megaripples studied at PP (left) and GSDNP (right). Rulers are 12" (30cm) in length.

Preliminary results: GSDNP megaripples were found to be significantly more active than PP counterparts. During strong wind conditions at GSDNP, saltation of fine sand was able to produce observable (albeit sporadic) impact-driven creep of surface granules, resulting in megaripple migration of several cm over the course of one day; PP ripple crests were immobile over a period of 6 years and migrated only ~20 cm over the subsequent 2.5 years (Figure 1). Although thorough comparison between terrestrial and martian bedforms is not yet complete, preliminary results suggest that under current climatic conditions within Gale crater, impact-driven creep is likely a slow process, particularly for grains > 1 mm; megaripples coated with these granule populations are often significantly dust covered and frequently lack secondary ripples, suggesting that they either migrate very slowly or not at all under current conditions. In this sense, the processes controlling evolution of these bedforms may be more analogous to those observed at PP. Other bedforms observed more recently along the MSL traverse were coated with 2-3 mm grains and may be more similar in morphology to some PP megaripples or terrestrial "zibars," which typically have lower relief and less well-defined ripple crests [4]. On the other hand, there is evidence that bedforms containing 0.4 – 1 mm grains at their crests may be currently undergoing transport more similar to that seen at GSDNP, although scaled accordingly to account for potentially lower saltation fluxes compared to Earth [5].

Conclusions: Integrative studies combining available orbital and ground truth data from Mars with field work at terrestrial analog sites can inform interpretations of martian aeolian bedforms. Here we utilize this approach to identify the processes controlling the formation and evolution of megaripple-like bedforms within Gale crater, which have been found to be generally stable over the duration of the MSL mission. These findings may have broader implications for our understanding of aeolian features observed across Mars, including ubiquitous Transverse Aeolian Ridges (TARs) [7], which appear similar from orbit to Gale bedforms containing > 1 mm surface grains. Only one instance of potential TAR migration has been recorded thus far on Mars ([8]), suggesting that these features are relatively stable in the modern climate. Although local conditions (e.g., wind speeds, topography, and sediment availability) in Gale crater may not be representative of all locations on Mars, our observations underscore the potential importance of grain size in overall stability of bedforms. If the present-day stability of TARs (and analogous bedforms in Gale crater) are an effect of grain size, it may suggest that these features were formed in a paleoenvironment that was significantly more effective at mobilizing granules into surface creep (e.g., higher wind speeds or atmospheric density [9]). Alternatively, it may be that the gradual trapping of fines within the interior of these bedforms decreases the availability of saltators needed to continue driving surface creep, thus further promoting stability.

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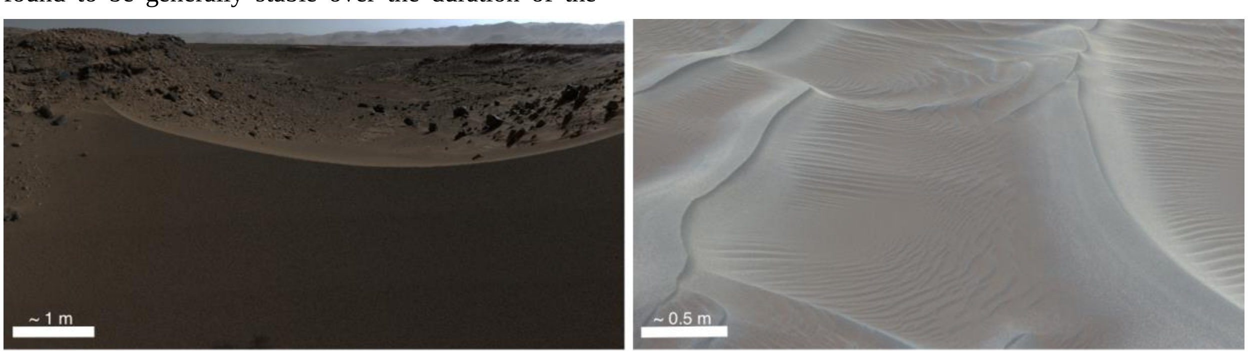

Figure 2: Examples of megaripple-like bedforms encountered along MSL's traverse. Left: Dingo gap megaripple is coated in mm-sized granules and dust [3] (mcam02105, sol 530). Right: large ripples that contain ~400 μm grains at their crests, are relatively dust free, and exhibit secondary ripples (mcam09139, sol 1752). These have been interpreted by some as megaripples [6], but grains are finer than typical for terrestrial megaripples.