THE COARSEST GRAVEL RIPPLES ON EARTH? PRELIMINARY OBSERVATIONS AND INTERPRETATIONS. S. L. de Silva[1], J. R. Zimbelman[2], N. T. Bridges[3], S. Scheidt[2], J. G. Viramonte[4], [1]Oregon State University, Corvallis, OR 97331 (desilvas@geo.oregonstate.edu), [2]CEPS/NASM MRC 315, Smithsonian Institution, Washington D.C. 20013-7012. [3] JHUAPL, Laurel, MD 20723, [4]UNSA, Salta, Argentina

Introduction. The predominance of aeolian (wind-driven) activity as a surface modifying agent on Mars has been recognized throughout the history of telescopic, satellite, and robotic investigation of the planet. The most obvious expressions of aeolian processes are manifested in dunes, yardangs (aerodynamic ridges in bedrock) [1,2], sand ripples [3,4], and Transverse Aeolian Ridges (TARs) [5]. TAR is a non-genetic general term proposed for linear to curvilinear aeolian features. Since their first recognition, the origin of TARs remains an area of healthy debate, are TARs small dunes or are they large ripples? The answer to this question is critical to understanding the way the wind works on the martian surface and this has implications for NASA strategic interests in area of sustained human and robotic exploration of Mars. The challenge is that to answer the questions of origin, we need to understand the details of shape, size, and spatiotemporal development of the bedforms, and the size and density of the grains that form them. Although the resolution of remotely sensed data improves rapidly, down to 25cm/pixel with HiRiSE, we are still not capable of resolving sediment-size distributions [6]. Until we can do this, our understanding of aeolian processes on Mars will remain limited to the few lander and rover sites. Thus, we still rely heavily on our understanding of similar features on Earth as analogs both in terms of form and process. Recent rover investigations of Martian TARs provide perhaps the most definitive data [7]. These observations have revealed granule ripples similar to those on Earth. Studies on Earth have confirmed that granule ripples on Earth are potential analogs for ripple-like TARs on Mars [8].

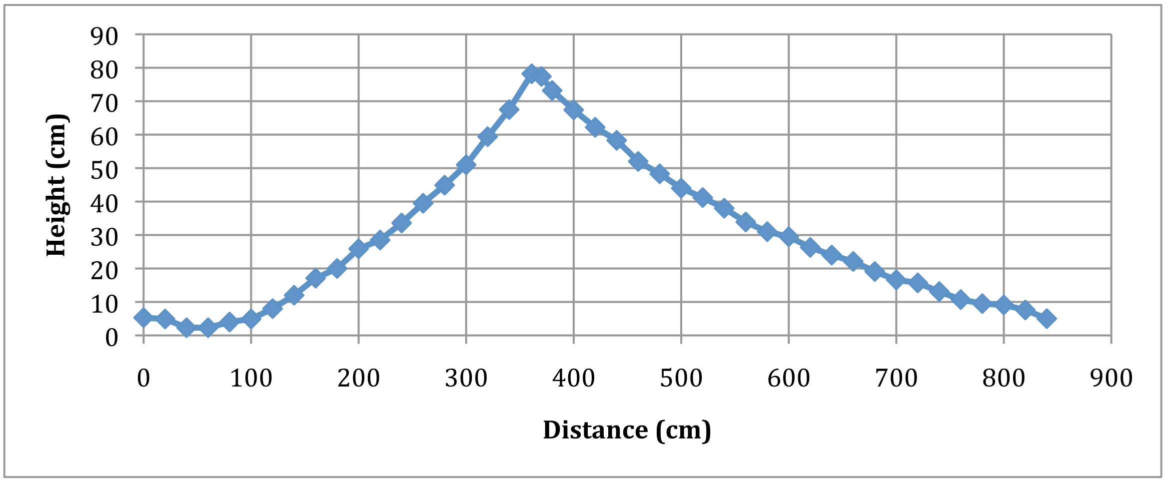
We report here the preliminary observations on gravel ripples in the Puna of Argentina conducted under the auspices of NASA MFRP grant NNX10AP79G Here gravel ripples are built on a bedrock of ignimbrites and composed of a bimodal association of dense (>2 g cm^{-3}) clasts (lava and metamorphic) up to 2.5cm and pumice (<1.5 g cm^{-3}) up to 5 cm making these the coarsest ripples yet described on Earth (Figure 1). While the mechanisms of origin and formation are debated [9,10,11], it is clear that these ripples must represent extreme conditions that define an end member of the spectrum of granule ripples on Earth. The relevance to Mars is twofold: First, these aeolian gravel bedforms consist of materials that have similar equivalent weight to those composing the granule ripples at Meridiani Planum, Mars. Second, analogous relationships between Martian TARs, topography, and bedrock are apparently duplicated in the Argentinean Puna.

Figure 1. Large lithic dominated gravel ripple bedform of the Purulla field. Note concentration of large pumice on the lee side of the bedform.

Observations and Interpretations. The gravel ripples are distributed in five distinct fields in close proximity to each other in the region of Catamarca, Argentina centered around 26°45'S 67°45'W. The fields vary in area extent from 300 km^2 to 50 km^2 representing the largest areas of gravel ripples yet described. Each field is a separate "basin" demarked by bounding volcanic and basement (metamorphic) highlands. Each field is distinct in lithological characteristics and macroscopic appearance reflecting variable source of the lithic clasts.

The largest of the fields is the Campo Piedra Pomez field which is built on bedrock of the 70 ka Campo Piedra Pomez ignimbrite (CPP). Other significant fields are found to the east of Laguna Purulla, east of Cerro Purulla, both these are built on the 13 ka Purula ignimbrite. The coarsest ripples are found to the south of Laguna Blanca, again built on the CPP ignimbrite.

Trenching through the bedforms reveals that the largest gravel bedforms are approximately 30cm in height above the bedrock ignimbrite. The upper 20cm is dominated by crudely bedded coarse gravels, while the lower portion contains significantly more sandy material. The coarsest particles are concentrated at the surface and peak of the ripple. Large pumice, upto 2.5x the size of associated lithic fragments, is loosely concentrated on the lee of the bedform. No evidence of slip faces were found in the sections we made confirming that these bedforms are indeed ripples and not dunes. Rare internal sandy beds suggest ephemeral sand sheets swept through the area. Profiles of the ripples made using laser profiling and brunton measurements show significant variability, with ripples in the Purulla area showing more symmetry (Figure 2a) between lee and stoss slopes than those in the Campo Piedra Pomez (Figure 2b). Preliminary wind profile measurements were made with a three anemometer set up over a vertical range of 1.6 m. These data yield z_0 measurements significantly smaller than the typical gravel sizes at the crests of the ripples at all measured sites within the study area; the gravels thus experience non-zero winds that can contribute to their movement, both through impact creep (via saltating sand and pumices) and through rolling (or at least wiggling) of the particles themselves by very strong winds. This is consistent with the "smoothed" appearance of the gravel surfaces.



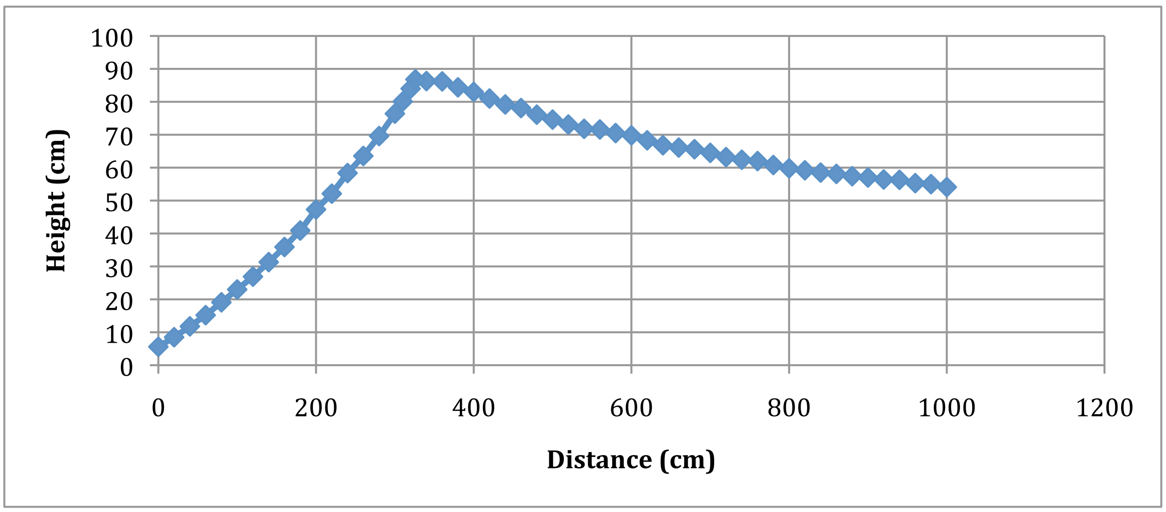


Figure 2. Profiles across gravel megaripples at Purulla (upper) and Camp Piedra Pomez (lower). Note the distinct difference in the symmetry of the ripples. At Purulla the ripples show little difference between the lee and stoss sides and are symmetric, while the Campo Piedra Pomez the ripples are clearly asymmetric.

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