ORBITAL AND IN-SITU OBSERVATIONS IN SUPPORT OF THE EXISTENCE OF AN UNKNOWN STABLE AEOLIAN BEDFORM REGIME ON MARS.

M. G. A. Lapotre[1], R. C. Ewing[2], M. P. Lamb[1], W. W. Fischer[1], K. Lewis[3], M. Ballard[2], M. Day[4], D. Rubin[5], J. P. Grotzinger[1]. [1]California Institute of Technology, Pasadena, CA 91125, [2]Texas A&M University, College Station, TX 77843, [3]Johns Hopkins University, Baltimore, MD 21218, [4]UT Austin, TX 78759, [5]UC Santa Cruz, Santa Cruz, CA 95060.

Introduction: A bedform is topography emerging from interactions between a granular bed and a fluid, typically water or air [1,2]. Preserved bedform cross-stratification in sedimentary rocks provides a record of hydrologic or atmospheric conditions under which it was formed, and are critical to our understanding of the geologic history of planetary bodies [e.g., 3,4].

On Earth, two main classes of bedforms are found in desert environments – decimeter-scale ripples, and hundreds-of-meters-to-kilometer-scale dunes [5]. On Mars, orbital observations also indicate the existence of both ripples and dunes, although the ripples seen from orbit are much larger than on Earth, with wavelengths of several meters [6].

The Mars Science Laboratory (MSL) Curiosity rover is currently visiting the informally named Bagnold Dunes of Gale Crater, documenting for the first time the spatial and temporal coexistence of three distinct scales of bedforms – decimeter scale ripples, meter-scale ripples, and yet larger dunes (Figure 1A). Based on observations of bedform morphology and an orbital compilation of bedform wavelengths, we report on the discovery of a third type of stable bedforms on Mars, herein refered to as the large sinuous-crested ripples.

Methods: We first use rover stereo images to describe and characterize the morphology of the large Martian ripples and their coexistence with small ripples and large dunes. We then build a histogram of Martian aeolian bedforms across scales by measuring the wavelengths of large ripples, transverse aeolian ridges, and dunes from Mars Reconnaissance Orbiter HiRISE images within eleven dune fields across the planet (*N*=1751), and the wavelengths of small and large ripples at the Bagnold Dunes from MSL Mast Camera (Mastcam) stereo images (Figure 1B). Further wavelengths data was compiled from [7] and [8].

Results: *Rover Observations.* The morphology of ripples observed by Curiosity is unlike anything we know on Earth (Figure 1). In contrast with terrestrial impact ripples [9], the large Martian ripples have sinuous crests. They have sharp brinks, and grain flows are observed at their lee faces. Indications of grain fall and secondary deflected flow suggest a strong aerodynamic feedback between the topography and the wind. Moreover, the wavelength of the large ripples appears to be constant across the stoss slope of the dunes they override, which makes them different from Earth's compound dunes. In contrast, smaller ripples on the stoss slopes of the large ripples have straighter crestlines, are spaced ~7cm apart, and are interpreted as impact ripples. The straightness of the crest of impact ripples was suggested to be the signature of lateral splashing of grains during the impact process [10].

Distribution of Martian bedforms wavelengths. We distinguish at least three modes in the distribution of Martian aeolian bedforms wavelengths: a mode for small scale ripples (~**7** cm), one for dunes (~ 300 m), and one corresponding to large ripples at about 3-4 meters. The latter is alien to terrestrial aeolian landscapes.

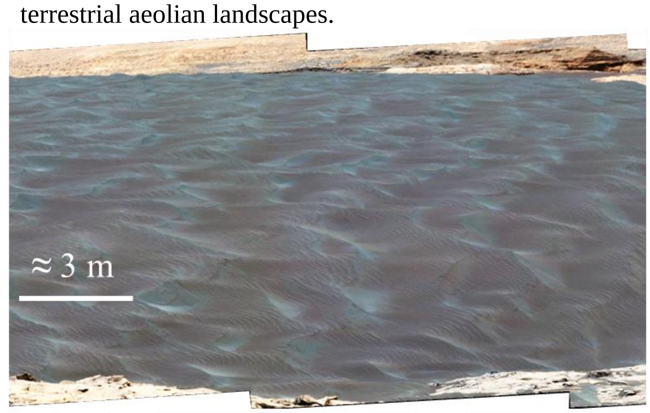

Figure 1: Mastcam mosaic of the Namib Dune, Gale Crater, Mars (mcam_05311, sol 1173) showing three distinct scales of bedforms – decimeter-scale and meter-scale ripples on a dune.

Discussion: We suggest that owing to the predominance of aeolian processes at the surface of Mars for the last several billion years, large sinuous-crested ripples should have left a stratigraphic imprint in the aeolian sedimentary rock record and may have been observed by rovers before. We argue that this discovery makes the interpretation of decimeter-scale trough cross-stratification on Mars non-unique, and especially ambiguous in the absence of additional paleoenvironmental markers. Altogether, the existence of a new large sinuous-crested ripples regime and its preservation in the Martian rock record bear significant implications for our understanding of paleoenvironmental conditions on Mars.

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