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The origin of transverse instability of aeolian megaripples

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Two different kinds of sand ripples, normal ripples and megaripples which differ in their sizes, grain-size compositions and morphology are observed in nature. While normal ripples form almost straight lines, megaripples have greater sinuosity due to their transverse instability, a property that causes small undulations to grow in time. The physical origin of this pronounced transverse instability has remained elusive. We studied ripple development in a series of wind tunnel experiments with different mixtures of sand. For unimodal fine sand, initial differences in height diminished in time leading to straight ripples. In contrast, for bimodal sand initial perturbations in height remained and even grew in time resulting in more wavy patterns. The results indicate that the differences in sinuosity between normal and megaripples are due to grain size segregation at three dimensions with a positive feedback between coarse grains and ripples height. The accumulations of coarse particles at the crest allow further growth of the ripples at these locations thus decreasing their migration rate. This in turn allows further accumulation of coarse grains. This mechanism leads to variations of the thickness of the armoring layer along the ripple crest which correlates with crest height. Field measurements of grain size distribution and sinuosity index along megaripple crests support the findings. In addition, the sinuosity of megaripples and TARs (Transverse Aeolian Ridges) on Mars at several locations was calculated from images taken from High Resolution Imaging Science Experiment (HiRISE). These images provide the capability of obtaining orbital images of Mars with a resolution down to 25 cm/pixel. The preliminary results show that due to their bimodal grain-size distribution megaripples are more undulated than TARs. This new look at aeolian bedforms on Mars can help in a better classification of them and improve the understanding of the aeolian processes involved in their formation.