1. What This Is About

All three Mars rover missions have encountered coarse-grained ripples (aka “megaripples”) at various locations, including the Gusev and Meridiani Planum regions. In this study, we evaluate the method against a terrestrial field experiment to determine wind conditions prevailing when the ripples were last mobilized. The ripples used for this study are from the Meridiani Planum region, which has been the focus of several studies over the years.

2. Method

Our fieldwork and wind tunnel experiments [7] indicate that moving the largest grains downwind in crevice only when one of the coarsest grains available from the saltating population strikes an optimal location on the target grain. From this, our approach is to assume all kinetic energy from a “coarse-tail” saltating grain is converted to energy just sufficient to move the largest target grain from its resting place socket. One form of our derived relationship is:

\[ \nu = \frac{(M + m)}{2m} \left( R \frac{\sqrt{2g}}{R - h} \right) \]

where \( \nu \) is incoming velocity for a saltating grain of mass \( m \) needed to move a resting, larger target grain with mass \( M \) and radius \( R \) to a height \( h \) posed by an obstacle in front of it. The value of \( h \) depends on several factors. For simplicity, we adopt an idealized 2D scenario of identical spherical target grains, the target grain mass and radius \( m \) and \( R \) respectively. Figure 1 shows the results, where the deep blue curve of eq. (1), predicting that an impacting grain \( M = 0.5 \text{ mm} \) was required under the measured wind conditions. This size is consistent with the coarse tail of the saltating population measured by Jerolmack et al. (see Fig. 10 in [3]).

Gale crater. Grain size-frequencies of megaripple surfaces, megaripple interiors, and other sandy deposits show more variation at Gale crater than at other Martian sites. This might be due to the significant influence of fluvial processes affecting Gale crater floor deposits in the past, providing a diversity of source grain sizes for aeolian reworking. Four representative examples are shown here, to illustrate this diversity.

Dingo Gap megaripple (sol 534) at Gale crater was last mobilized with stronger winds and/or coarser saltating grains than the MER features. The sol 356 mid-drive and sol 387 Pyramid megaripples are but two examples of many encountered at Gale that have crests with surface grains 3-9 mm, implying the availability in the past of correspondingly coarser saltating grains (and wind events strong enough to drive them) when last mobilized. Chain reactions that mobilized a megaripple at Gale that have crests with surface grains ~0.1 mm were last activated by only modest winds \( \nu = 0.5 \text{ m/s} \), which were impassable to MSL, could involve a 0.2 mm grains driven by \( \nu = 1.0 \text{ m/s} \), winds, would receive far more energy than required to simply rotate downwind out of their sockets; numerical experiments suggest ejection speeds would be enough for 0.6 mm grains to increase hop size into sustained saltation, which could then drive 4 mm grains in creep.

References: