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Surface-based 3D measurements of small aeolian bedforms on Mars

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Recent aeolian bedforms such as dunes and ripples are common on Mars and occur across a scale range of centimetres to kilometres. Aeolian bedforms provide a mobility hazard to Mars rovers, such as the ESA ExoMars rover, which will launch in 2020 to either Mawrth Vallis or Oxia Planum. However, both sites contain numerous aeolian bedforms, mainly with simple ripple-like morphologies, and wavelengths of meters to tens of metres. The larger examples are 'Transverse Aeolian Ridges' (TARs), a few metres high and up to a few tens of metres across. TARs present a serious, but recognized and (hopefully) avoidable, rover mobility hazard that can be assessed using orbital data. Both sites also host smaller (1-4 m across) bedforms of similar ripple-like morphology, but it is unknown whether these bedforms will be traversable by the ExoMars rover: they are too small to be resolved in even the best Digital Terrain Models (DTMs) available.

Here, we estimate the heights of these small bedforms by comparison with similar features observed by previous Mars rovers. We use rover-based stereo imaging from the NASA Mars Exploration Rover (MER) Opportunity and PRo3D software, a 3D visualisation and analysis tool, to measure the size and height of ripple-like bedforms in the Meridiani Planum region of Mars. These are good analogues for the smaller bedforms at the ExoMars rover candidate landing sites.

We find that bedform height scales linearly with length (as measured across the bedform, perpendicular to the crest ridge) with a ratio of about 1:15. Using 25cm/pixel HiRISE images, we measured small aeolian bedforms at the Oxia Planum candidate landing site, finding them to be similar in length and morphology to those at Meridiani Planum. This allows us to infer the heights of bedforms at the ExoMars sites simply by measuring their lengths in HiRISE images. These data can then be used to explore the traversability of this site.

Our method suggests that most of the bedforms studied in Oxia Planum have ridge crests higher than 15 cm, but lower than 25 cm. Hence, if the tallest bedforms the ExoMars rover will be able to safely cross are only 15 cm high, then the Oxia Planum site studied here contains mostly impassable bedforms. However, if the rover can safely traverse 25 cm high bedforms, then most bedforms here will be smaller than this threshold. Finally, our results show that the mini-TARs have length/height ratios similar to TARs in general. Hence, these bedforms should probably be classified simply as 'small TARs', and are not a discrete population or sub-type of aeolian bedforms.