

Experiments on deformation of barchans under bidirectional water flows: Comparison with barchan dunes in Proctor Crater

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While Martian atmosphere are explored by telescopic observation or computer simulation, local winds near Martian surface were usually investigated from the information of dune morphology, based on the observation on Earth. Barchan, a movable sand dune in the crescentic shape, is a useful index for the local wind direction, because its horns point to the leeward direction. In Proctor Crater (170 km in diameter) in Noachis Terra, there is a dune field covering 60 km width and 70 km length, and many barchans form in the eastern area. Although an ordinary barchan has one slipface between two horns, the barchans in Proctor Crater have a secondary slipface facing reversely, referred to as rear slipface. This suggests the existence of the secondary wind opposite to the most prevailing wind. Fenton and Bondfield (2003) analyzed slip-face-orientations of barchans from the pictures of Mars Global Surveyor (MGS) Mars Orbital Camera (MOC) and concluded that the barchans of Proctor Crater were affected by alternating winds: the prevailing wind from ENE and the secondary wind from WSW.

Here we emphasize that barchans in Proctor Crater have two prominent features other than the slipface. One is wide-open horns pointing their tips obliquely to the wind direction and another is a waisted body with less roundness. Although barchans in deserts on Earth with seasonal wind variation have been studied and known to have a "rear slipface" unlike ordinary barchans, these two features of barchans in Proctor Crater have not been found. Barchans in Proctor Crater do not march from a clear sand source, which is unlikely on Earth. It is considered that the wind was too weak to migrate dunes and the sand was transported as suspension load to where barchans exist at present.

To examine whether the characteristic shape of the barchans can be related to the strength of flow, we carried out water tank experiments. After a barchan was formed by constant unidirectional flow in the flume, we generated alternating (normal and reverse) water flows. We conducted two types of experiment which were different in the flow velocity in forward (normal) flow direction; case (A): the velocity is enough fast to make the barchan migrate, and case (B): the velocity is too slow for migration of the barchan.

The results were as follow. In case (A), after a barchan was deformed by the reverse flow, the barchan could not maintain its shape and collapsed in the forward flow. In contrast, in case (B), the barchan maintained the peculiar features in the forward flow, wide-open horns and a waisted body which were similar to those in Proctor Crater. Our findings suggest that the characteristic morphology of the barchans in Proctor Crater can be attributed to weaker wind than the wind that can propel barchans forward.