

Barchan and Linear Dunes on Earth and Mars - Comparative Research

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High resolution images from MGS and MRO reveal, in detail, ripples and dunes on Mars that were not discerned in old Viking images. The two basic dune types known on Earth, barchan (and transverse) and seif (linear), are also common on Mars, although seif dunes are quite rare on that planet. Some Martian barchan and seif dunes have a different morphology, particularly as evident in the Martian north polar region. Some of the barchans have an elongated, elliptical shape, while some of the linear dunes lack the sinuosity commonly associated with terrestrial seif dunes. These barchan and linear dunes occur together, side-by-side, and in some cases are merged to create a single bed-form. Induration of the dunes, or crust formation, can explain the occurrence of these dunes of unusual morphology in the Martian north polar region. Crusts may form as water vapor diffuses into and out of the fine-grained materials on the planet's surface. Salts would be deposited as intergranular cement. Because these bedforms occur in the polar region, the cementing agent could be ice instead of salts; indeed, the dunes spend more than half each Martian year beneath a covering of seasonal frost, mostly frozen carbon dioxide. Elliptical shaped barchans were created artificially in Saudi Arabia by spraying advancing barchan dunes with crude oil to stabilize them until the dunes reached a streamlined body shape. Simulation work indicates that the same process can occur on the indurated Martian barchans, but by cementation of grains rather than introduction of oil. Short lee dunes that have a linear shape with a sharp-edged crest are known to form from sand accumulation at the lee side of obstacles. Once a dune is stabilized by induration or crust, it functions as an obstacle to the wind. Linear lee dunes stabilized by ice (water or carbon dioxide) or mineral crust may elongate and form a long linear dune that aligns parallel to the wind. Melting of the ice will set up a straight linear dune, with loose sand, parallel to the dominant wind. Field observations on terrestrial deserts show that such a dune can only be formed when it is covered by vegetation. If vegetation is removed the bare linear dune disintegrates into small barchans. Simulation also shows that linear dune is unstable and deforms until it takes the shape of a string of barchans, which are the stable shape under unidirectional winds.