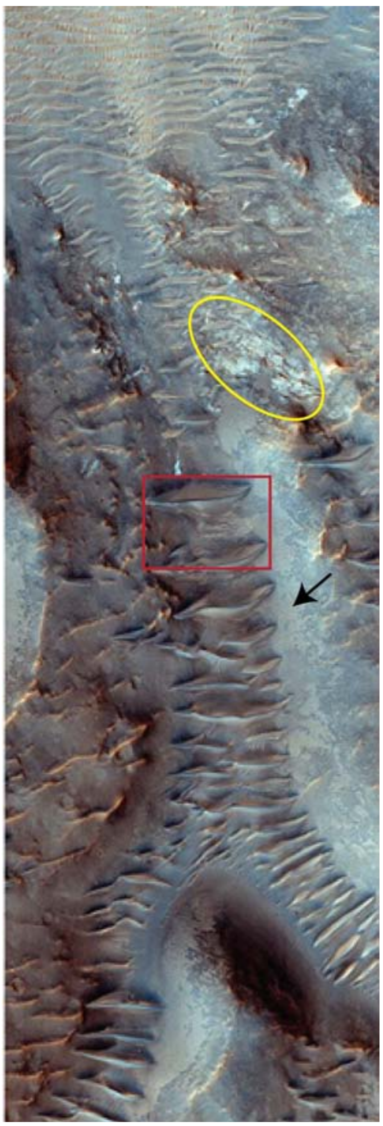
INTERDUNE DEPOSITS SUGGEST HIGH GROUNDWATER IN AN EQUATORIAL CRATER ON MARS.

M.C. Bourke[1,], and J. J. Wray[2] [1] Planetary Science Institute, Tucson, Arizona,[2]Department of Astronomy, Cornell University, Ithaca, NY 14853, USA. mbourke@psi.edu

Introduction: There is a rich history emerging of the interaction of aeolian dunes and volatiles on Mars. Dunes may be enriched with ice during and/or after their formation e.g., the Polar dunes in the northern and southern hemispheres (*1, 2*); dunes may also be composed of sediment wholly or partly sourced from strata rich in hydrated minerals (e.g., the aeolianite in Meridiani (*3*) or the dunes in Candor Chasma (*4*)). Here we describe features that suggest a past phase of high groundwater in an equatorial crater that coincided with active dune migration.



Location of study site: The dunefield is located in a crater, situated on the rim of the larger Huygens basin (11.6°S, 51.9°E). The crater has a central pit with a small channel draining into it. Dunes are widespread across the pit floor and also align along the channel. The features we describe are visible in the interdune close to where the channel enters the central pit (Fig.2).

HiRISE stereo DTM data show that the bedforms are <5 m high, 300-400m wide and are spaced approximately 200 m apart. The occurrence of small impact craters on the bedforms and the erosion of strata on the windward slope suggest that the bedforms are immobile at present.

The dunes overlie a higher albedo surface (arrow in Fig. 1) that has alternating high and low albedo lineations where exposed in three of the 100m long interdune areas (Fig. 2). The features are curvilinear in planform and display crosscutting relationships, but overall parallel the dunes.

Lineations can form in the interdune area on Earth in four ways. First, they may be arcuate ridges of remnant stoss slope sands stabilized by vegetation. A well documented location for this type is along the NE Brazilian Coast (*5, 6*). Second, they may be frozen dune strata found in cold climate deserts such as Antarctica (*7, 8*). Third, they may be the exposure of an older aeolianite underlying the modern dune system. One example is located in the Wahiba Sand Sea (*9*). Fourth, they are formed in wet aeolian systems where the availability of pore water through high or fluctuating groundwater leads to cementation of aeolian cross strata by soluble minerals. An example of one such system is the White Sands National Park dunefield (*10, 11*). As vegetation is not a binding agent on Mars, and ice is not stable at the surface at these latitudes, we suggest that the features reported here are either aeoliantite exposures or cemented cross beds. We prefer the fourth mechanism as the organization of the lineations and

Figure 2: Crossbeds exposed in the interdune. See Figure 1 for location.

their scale bears more resemblance to known examples of cemented cross strata (Fig. 3). Exposures of aeolianite tend to have multiple strata orientations and are often well-indurated, so can display significant relief.

A local source of cement? CRISM data show that both phyllosilicates and carbonates are exposed in the crater's central pit wall (*12*). These carbonates are inferred to be more Fe- and/or Ca-rich than the Mg-carbonates observed elsewhere by CRISM (*13*). However, spectra at the precise location of the cross-strata are ambiguous. The closest carbonate exposure lies 400m to the NE (Fig. 1). Elevations measured from HiRISE Stereo image DTM range from 1396m to 1473m for that exposure. These are similar to the elevations of the interdune strata, which lie at 1459 and 1478m. This suggests that the incision of the valley floor had the potential to access carbonate strata if present in the subsurface. This carbonate could be the cementing agent.

Figure 3: Oblique photo of crossbeds exposed in the interdune at White Sands.

A local source of water ?The Fe/Ca-carbonates in the crater central pit are inferred to predate crater formation (*12*). They may have reached the interdune site via enriched groundwater or have been transported as a carbonate-rich dust from the adjacent source. Both scenarios require carbonates to have been dissolved and re-precipitated to form the cement to indurate the crossbeds. Fe- and Ca-carbonates are relatively insoluble when compared to Mg-carbonates detected elsewhere on Mars [e.g., (*14*)]. Therefore significant groundwater may have been required. The valley emptying into the central pit indicates liquid water was available after crater formation. The channel long profile is convex suggesting that groundwater or short-lived precipitation-sources may have been responsible.

Liquid water may have been generated by the impact event. While the formation of central pit craters is still under discussion the leading hypotheses suggest the release of volatiles from an ice-rich impact target (*15*). For such targets, the extreme temperatures underlying the transient cavity are sufficient to vaporize the volatiles which are released once pressure thresholds are reached (*16*). Whether these volatiles can stabilize as liquids during or after the impact is not certain. Another source of fluids may be the interaction of impact melt and shallow ice. These potential sources require further investigation.

Conclusions: Strata exposed in the interdune of an equatorial dunefield suggest that a phase of high groundwater along a valley coincided with active aeolian dune migration. The avalanche face strata may have been cemented with sediment sourced from a locally exposed carbonate.

Acknowledgements: Funding from NASA MDAP grant NNX10AQ35G.

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