HiRISE IMAGES OF SPRING ON MARS. C. J. Hansen[1], G. Portyankina[2], N. Thomas[2], S. Byrne[3], and A. McEwen[3], [1]Jet Propulsion Laboratory / California Institute of Technology (4800 Oak Grove Dr., Pasadena, CA 91109, candice.j.hansen@jpl.nasa.gov), [2]University of Bern, Sidlerstr. 5, Bern, Switzerland, [3]University of Arizona, Lunar and Planetary Laboratory, Tucson, AZ.

Introduction: Spring on Mars is a time of active change at latitudes covered by seasonal CO_2 ice. The volatile nature of the CO_2 sublimation leads to erosion and local redistribution of loose material on the surface [1, 2, 3]. The High Resolution Imaging Science Experiment (HiRISE) on the Mars Reconnaissance Orbiter (MRO) has imaged two southern spring seasons and one northern spring. This temporal coverage allows us to compare processes extant in one spring to the next in the south, and to compare phenomena in the south to the north.

Spring at high northern latitudes: The working hypothesis in the north polar region is that, like in the south, seasonal CO_2 ice is at times translucent, allowing sunlight to penetrate and warm the ground below. The ice layer then sublimates from the bottom, trapping gas, which escapes from the nearest opening, entraining fine material. In south polar regions fans of fine material are transported by the escaping gas to the top of, then deposited on, the ice layer. In the north we have looked at regions suggested in [3] as likely sites of translucent ice, to search for fans and channels carved in the surface, similar to the araneiform terrain observed in the southern hemisphere [2, 4].

Figure 1 shows an example of a fan in the north. Fans in this region tend to be bright at blue wavelengths, indicative of frost condensing from gas rather than transport of fine surface material. As described in [5] it is likely that decompression and adiabatic cooling of pressurized gas being released from below the ice causes condensation of frost, which shows up as a fresh bright streak.

Figure 1. Sub-image of PSP_007181_2655, acquired at latitude / longitude = 85.4 / 180.5 E, L_s = 28.4.

We have not imaged (in the small sample of the surface imaged by HiRISE) any araneiform terrain. Frost-filled troughs in patterned ground and polygons have been imaged.

The degree of mobilization depends substantially on the nature of the surface material. Where the material is cemented only bright frost streaks are detected. On the dunes, where the surface material is loose, a host of sublimation-driven features are apparent. In regions with dunes on cemented substrate the contrast between the level of activity on the dunes vs. the substrate is dramatic, illustrated in Figure 2.

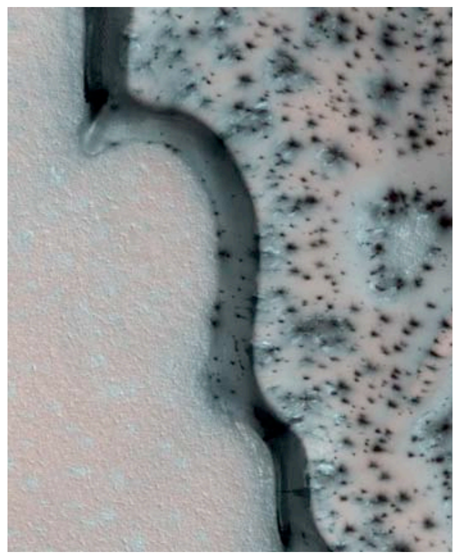

Figure 2. Dune on cemented substrate in sub-image of PSP_007725_2600, acquired at latitude / longitude = 80.0 / 122.56 E, L_s = 47.5.

Dunes and seasonal phenomena. In the image shown in Figure 2 many small relatively dark fans of fine material are seen deposited on top of the seasonal layer of ice. When the ice is gone the fans are no longer visible. This material is being transported from below the seasonal ice layer to the top, in a process that is likely analogous to the well-modeled process that occurs in the southern hemisphere [1, 6]. The fine material appears to be sprayed out in numerous directions, compared to the predominantly uni-directional fans in the south. Although this could be indicative of a more expolosive release of gas and fines exiting with a speed far greater than the prevailing winds, the similar directions of the numerous fans argue for a different explanation, namely that the release of gas and dust is determined by winds that change direction over the duration of the release. This implies that most of the vents open at the same time, possibly multiple times, when the conditions are just right.

Slope streaks on dunes also appear to be mobilized by the vigorous activity associated with the sublimation of CO_2. Streaks are observed to appear and lengthen as the season progresses, guided by existing dune morphology, and mass wasting from the crests of the dunes is implicated. Figure 3 shows an example of these streaks and may also show a dust cloud being raised by falling material, similar, although on a much smaller scale, to the cascade of ice and dust detected along the scarp of the north residual cap [7].

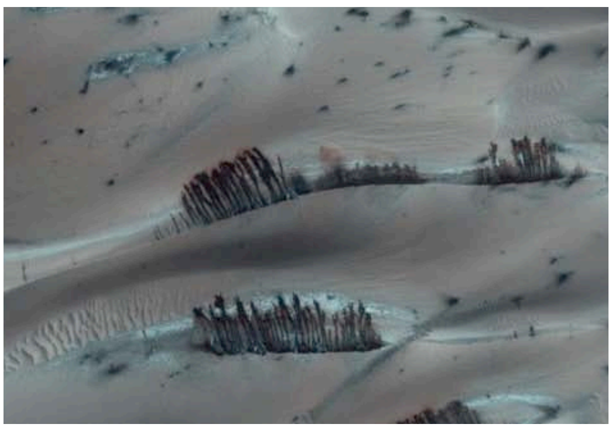

Figure 3. Slope streaks and a small cloud of dust kicked up by falling material are captured in this sub-image of PSP_007962_2635, acquired at latitude / longitude = 83.5 / 118.6, L_s = 55.7.

Polygonal cracks are observed in the ice on the dunes in the same locale as shown in Figure 3, and others. Cracking of the seasonal ice layer is predicted by models [3, 8], also lending support to the hypothesis of gas trapped under partially translucent ice in the north as well as the south.

It may be that the ice is only translucent at some times during the season. In the region shown in Figure 2 dark dunes cross a relatively bright substrate. The time series of images at this site show this contrast at L_s = 35, while the contrast between the two surfaces disappears from L_s 47 to 60.

Another puzzling sublimation feature appears at the crests of dunes and at the interfaces of the dune with the substrate, illustrated in Figure 4. Bright-dark-bright rings appear very early in spring and fade slowly as the season progresses. These do not appear to be caused by the morphology of the underlying surface although patterned ground and ripples on dunes can be seen.

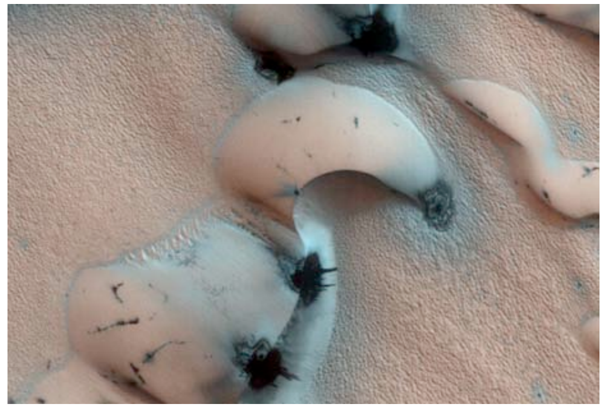

Figure 4. Bright-dark-bright sublimation patterns are illustrated in this sub-image of PSP_007043_2650, acquired at latitude / longitude = 84.7 / 0.7 E, L_s = 23.4.

Interannual Variability: In the first spring season observed by HiRISE in the south it was clear that the surface is worked and re-worked by the sublimation process. Fans of loose surface material mantle channels carved by escaping gas [4]. Surface material is in part ice-cemented (araneiform channels with sides steeper than angle of repose) and in part very loose, redistributed locally every spring.

Does this material affect gas flow? We have compared one particular location between the two martian years. In this location in the first Mars spring it appeared that a substantial amount of fine material had been blown out and across the channels. In the second year we looked to see where fans originated at a particular set of channels. Many of the fan origins are at the same place, implying some partiality for a rupture in the overlying ice to occur in that spot, but it is possible that there are some changes that might be attributed to material affecting gas flow. This is a tentative conclusion at best and must be verified by more observations.

References: [1] Kieffer H. H. (2000) *LPI Contribution* #1057. [2] Piqueux S. et al (2003) *JGR* 108(E8):3-1. [3] Piqueux S. and Christensen P. (2008) *JGR, 113,* doi:10.1029/2007JE003009. [4] Hansen, C. J. et al (2010) *Icarus*, in press. [5] Titus T. et al (2007) *AGU FM* Abstract #P24A-05. [6] Thomas N. et al (2010) *Icarus*, in press. [7] Russell, P. et al (2008) *GRL 35* CiteID L23204. [8] Portyankina G. et al (2010) *Icarus*, in press.

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