

MAPPING EXPOSED DUSTY WATER ICE IN MARTIAN GULLIES. E. J. Orlando¹, C. H. Blaske¹, A. R. Khuller¹, P. R. Christensen¹, ¹School of Earth and Space Exploration, Arizona State University, Tempe, AZ, 85281 USA.

Introduction: The detection of near-surface, mid-latitude water ice on Mars is key to the exploration of the planet's surface and the potential presence of liquid water. Geomorphic evidence for ice-rich materials has been documented through much of the mid-latitudes, and numerous examples of “pasted-on,” smooth mantles are observed on pole-facing, mid-latitude slopes [1-3]. These mantles are thought to have originated as dusty snow that was subsequently buried [2]. Recently, using High Resolution Imaging Science Experiment (HiRISE; [4]) images, [5] documented the presence of dusty (<~1%) water ice being exposed within these mantles by slumping in gullies. These exposures confirmed that the mantle is indeed composed of buried, dusty water ice. Although only 15 such locations were documented in the southern hemisphere [5], to date, no global survey of water ice exposures within gullies has been conducted.

Methods: In this work, we map similar exposures of dusty water ice within gullies formed within the mantle and the underlying wall rock using HiRISE images of gullies mapped [6] in the northern and southern mid-latitudes (29 - 65°N and 30 - 60°S). We distinguish between exposed subsurface water ice and potential surface frosts by only looking at mid-afternoon (~3 pm local time) images between L_S 70 - 200 for the north and L_S 250 - 20 for the south, when surface temperatures are too warm for frosts to form.

While it is easier to identify water ice in HiRISE color images, most locations only have single-band data. Thus, water ice was identified as isolated,

light-toned patches exposed within the mantle, unlike frosts that drape the surface. When available, images from different Mars Years were also examined to look for potential changes, especially because [5] noted decameter-scale topographic retreat within similar ice-exposing gullies.

Results:

Northern hemisphere mapping: In the northern hemisphere, out of 500 gully sites, 238 (47.6%) sites had images that met our search criteria. We found water ice exposures in 15 out of these 238 (6.3%) northern gully sites (green dots in Fig. 1). The lowest latitude water ice detection we made was at 46.4°N. We also found 7 other potential ice locations that are more difficult to characterize, and might appear lighter toned because of local lighting conditions rather than the presence of water ice (yellow dots in Fig. 1). Overall, these sites fall between 35 - 61°N latitude.

Southern hemisphere mapping: A similar southern hemisphere gully survey is currently ongoing. We have examined 717 of the 5000 (~15%) gully sites in the southern mid-latitudes. Of these 717, 128 (17.9%) locations had HiRISE images that met our criteria. Thus far, we have detected exposed water ice in 24 locations in addition to 6 sites that potentially contain ice.

HiRISE spectral analysis: We are in the process of analyzing the three-point HiRISE spectra of locations where color data is available in order to qualitatively assess the ice's dust content [5, 7]. In Figure 2, the Lambertian albedo was calculated

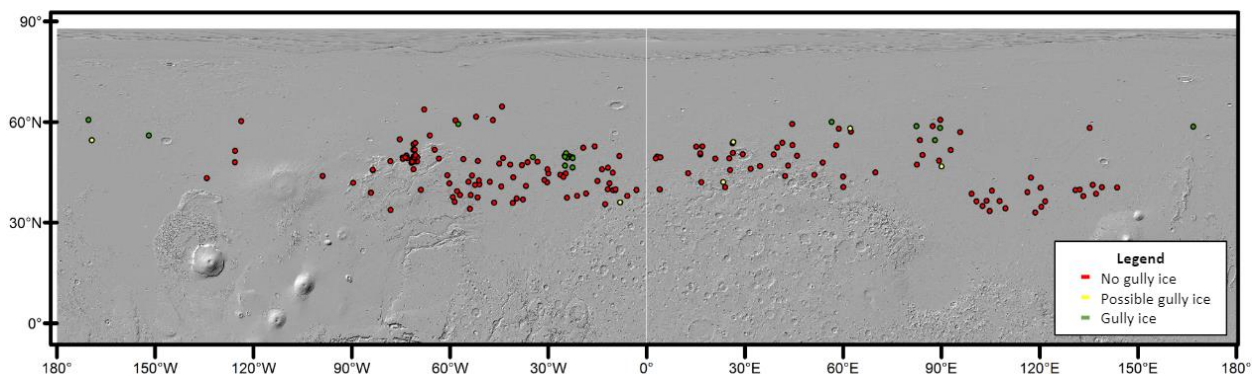


Figure 1. Map of northern mid-latitude gullies that meet our HiRISE search criteria with exposed ice (green), potential ice (yellow) and no ice (red).

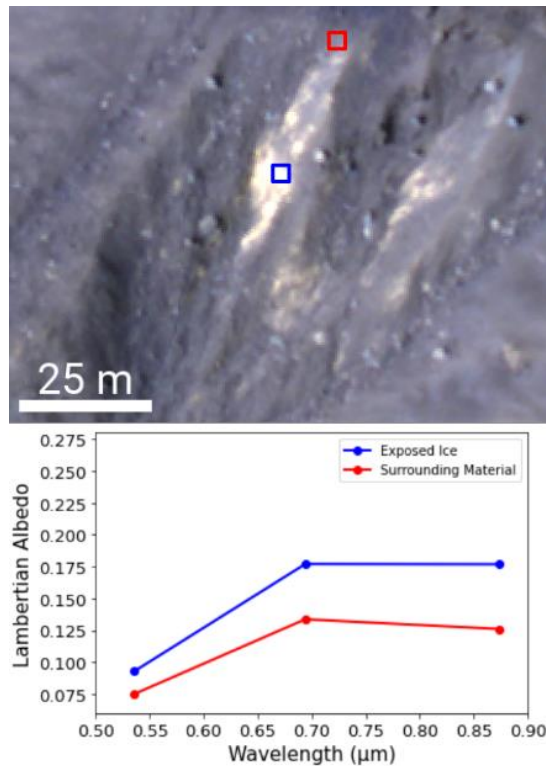


Figure 2. Exposed dusty water ice found in a crater at 49.3°N, 335.8°E. The blue plot measures the Lambertian albedo across HiRISE's 3 bands (RGB = 874, 536 and 694 nm) of the exposed water ice selected in the box of the same color, and the red plot measures the same for the nearby material in the red box. Each box represents a 5x5 pixel average. HiRISE image ESP_054476_2295.

for one example of exposed ice (blue box and line in Fig. 2) found in a northern crater located at 49.3°N, 335.8°E and compared with the albedo of nearby material with similar topography (red box and line in Fig. 2). By comparing the spectral shape of the exposed ice albedo and qualitatively comparing it with the modeling results from [5, 7], the gully ice appears to have between 0.1 and < 1% dust in it, similar to previously documented mantle-gully ice exposures [5] and ice within steep scarps [4].

Discussion: The newly discovered water ice exposures from the northern hemisphere survey do not fall within a similar longitudinal range as the scarps and icy craters found in [8-10], and appear to be “fill in” longitudinal gaps (between 0-60°W, for example) where no previous ice exposures have been found previously in the northern mid-latitudes. These observations are consistent with broad mapping of the mantle and other subsurface ice indicators that are present relatively uniformly with longitude [10, 11].

The slope of each gully location may also play a role in where ice is exposed within gullies. We are currently analyzing the local slopes of each ice exposure to assess any potential correlations.

While all the detections of dusty ice have less than 1% dust because ice with greater amounts of dust is indistinguishable from dust alone at these wavelengths [5], our initial qualitative analyses of the HiRISE spectra indicates that there are subtle differences in dust content between ice exposures. These differences in dust content could be due to: (1) different amounts of dust present within the snow that originally formed these mantles, (2) the formation of dust lags, (3) local slope. While it is difficult to ascertain the precise cause for these differences in dust content, we will present an analysis of dust content within each ice exposure that has HiRISE color data available.

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