Shallow ice extent further exposed by recent meteor impacts

Knowledge of the latitudinal extent and character of shallow buried water ice is important for constraining the budget of water on Mars and for possible future in-situ resource utilization (ISRU) purposes. One novel approach to defining the presence of shallow ice is to look at new impact craters which typically excavate 1-2 m or more into the surface, depending on the size of the impactor. Such sites are being found by the Mars Reconnaissance Orbiter (MRO) Context Camera (CTX), which identifies new low-reflectance features, and which the High Resolution Imaging Science Experiment (HiRISE), which confirms the existence of a new crater. Occasionally, HiRISE shows bright patches within the crater. Their high albedo (with lowering over time) suggests that shallow ground ice has been exposed and is followed by sublimation. This has been confirmed for some sites by near-infrared data from the Compact Reconnaissance Imaging Spectrometer for Mars (CRISM). Such observations have extended the shallow ice boundary from high to mid latitudes (as low as 39° N). This significantly extends the latitudinal occurrence of subsurface ice from the Odyssey Neutron and Gamma Ray Spectrometers, whose detections of ice within a meter of the surface was confirmed by the Phoenix lander at 68° N.

New craters are harder to see in the darker albedo expanses of the southern hemisphere, but a handful of detections there raises hope that the southern ice boundary can also be extended to lower latitudes. The ice uncovered by these impacts is observed to disappear over time, as expected from sublimation upon exposure to surface conditions or from renewed dust cover. This could be important for determining the severity of obliquity cycles in Mars recent past, as the ice boundary may be at different latitudes in the two hemispheres. The impacts and excavation depths are at the meter to sub-meter scale, and some appear to have penetrated the visible subsurface ice layer to bedrock beneath this unit. Significantly, the persistent high reflectance of the ice suggests it to be massive and relatively pure, rendering it potentially suitable for ISRU purposes outside the tropics.

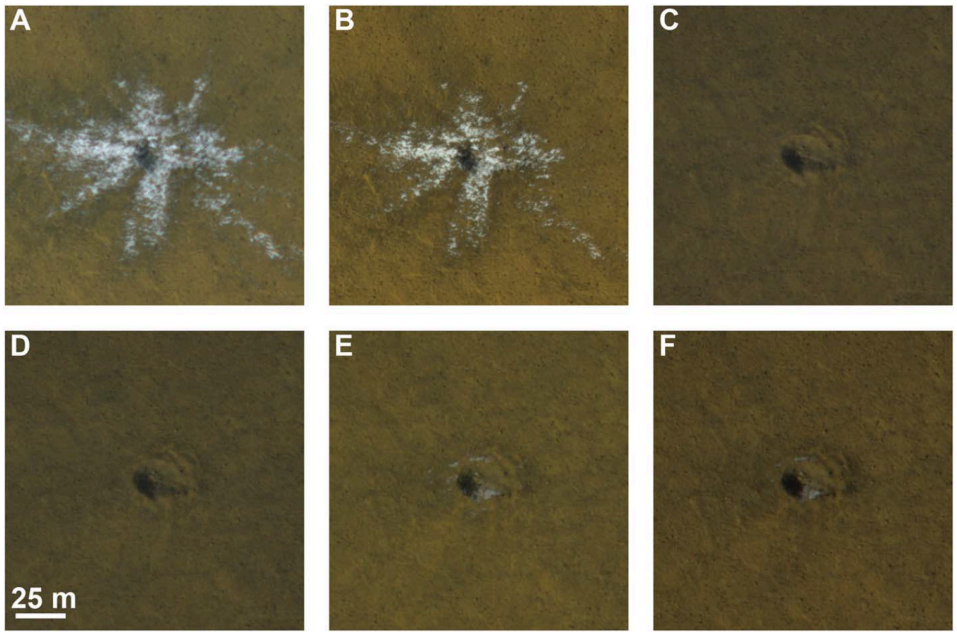

Figure 10. Changes at site 9 over time. Over the initial summer after impact, the ice (a) fades and (b) shrinks somewhat. It is then essentially invisible at the start of the following (c and d) spring before (e) rebrightening and (f) fading again. All images have been given an approximate correction for atmospheric haze by subtracting the I/F value of the darkest pixel in the scene and then given identical stretches over the same range of corrected I/F. This atmospheric correction is imperfect, which may account for some of the variation in the appearance of the ground around the crater. The rest is likely due to different lighting angles. (Figures 10a–10f: HiRISE images ESP_017868_2440, ESP_018646_2440, ESP_024949_2440, ESP_025516_2440, ESP_026505_2440, and ESP_027982_2440. North is up, and light is from the left in all images.)

Figure and caption from Dundas et al., (2014); see below.

Relevant references:

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