EVOLUTION OF WATER ICE MOUND DEPOSIT IN 'LOUTH' CRATER AS OBSERVED BY CRISM AND HIRISE.
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Introduction: The Mars Reconnaisance Orbiter (MRO) spacecraft has carried out coordinated observations of the northern polar region of Mars since the commencement of the primary science phase in November 2006. Two high resolution instruments – the Compact Reconnaissance Infrared Spectrometer for Mars (CRISM, [1]) and the High Resolution Imaging Science Experiment (HiRISE, [2]) have been used to observe features in a ~35km diameter crater containing perennial water ice [3,4].

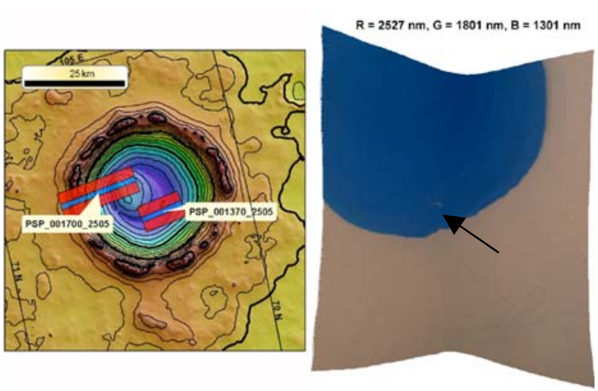

Figure 1. Left Panel: MOLA topography of crater in stereographic projection and HiRISE image coverage. Right Panel: CRISM False Color, full-resolution image FRT00002F70_07 of crater interior showing water ice in blue and the low visible, high IR albedo feature (arrowed). The image is ~12km wide.

CRISM: CRISM is a Visible to Near Infrared Spectrometer sensitive to photons with wavelengths from 0.4 to 4.0 µm [1]. It is well suited to observing water ice due to the strong H_2O water ice bands at 1.25, 1.5 and 2.0 µm. All observations discussed here were obtained while CRISM was in high resolution mode, with a pixel size of ~20m and a swath width of 12km.

HiRISE: HiRISE is a high resolution camera capable of providing detailed images of 0.25-1.3m/pixel [2]. It is capable of collecting color data (red, green and near-IR) and stereo pairs for topographic data.

'Louth' crater: A 35km diameter, 1.5km deep (Fig 1a) (officially unnamed) crater located at 70.5°N, 103.2°E has been observed to contain a circular, ~15km diameter interior deposit of smooth, high albedo material since Viking (Fig 1b). We have submitted the name 'Louth' for IAU consideration. The deposit was recently interpreted as water ice from temperature measurements taken by THEMIS and observations by HRSC [3,4].

Observations: As part of the MRO strategy of coordinated observations, CRISM and HiRISE both imaged 'Louth' crater during the northern summer. The following observations were made.

Arcuate features. Arcuate features, which appear smooth in CRISM observations parallel the edge of this deposit. These arcuate features display layering at HiRISE resolution.

Low visible, high IR, albedo feature. CRISM observations show an anomalous spectral signature from an elongated feature displaying low reflectance in the visible and high reflectance at wavelengths > 1.2 µm (Figure 2). The feature displays strong bands at 1.25, 1.5 and 2.0 µm, characteristic of H_2O ice. Inspection of HRSC images shows the feature present in February 2005 [4]. No MOC NA coverage of this anomalous feature is available. HiRISE data reveal what appears to be a small dune deposit (Fig 3A, 3C). Layering can again be seen (Fig 3B), erosion of these layers appears to be liberating the sand.

Patches of water ice outside the edge of the main deposit. HiRISE observations show small patches of high albedo material outside the edge of the main deposit (Fig 4). CRISM detects a much reduced 1.5 micron feature out to ~1.3km from the edge of the main deposit. This is consistent with sub-pixel mixing of bright material seen by HiRISE.

Water ice on the crater rim. CRISM observation FRT0000348E_07 shows exposed water ice signatures on the crater rim. This was also seen by HRSC [3].

Discussion: The arcuate features appear to be erosional products (as layers are exposed there). They appear to coincide with breaks in slope and perhaps indicate where the present ice deposit buries the edge of a previous mound. The layers could represent periodic growth of the deposit driven by climatic fluctuations, analogous to the Polar Layered Deposits.

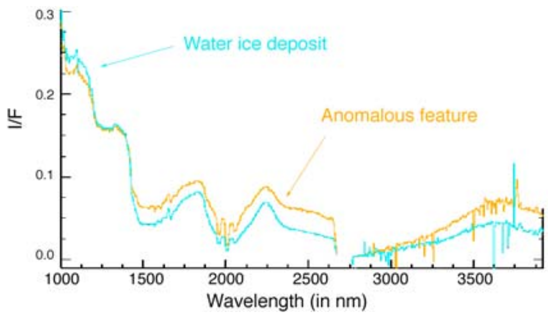

Figure 2. CRISM spectra of the arrowed feature in Fig. 1 (orange) and surrounding water ice (blue). Note lower I/F of the feature at 1000nm, but higher at 1500nm. Some residual atmospheric features are present, particularly near 2.0 µm.

The spectral behavior of the anomalous region (Fig 2) could be explained by mixing ice with small amounts of spectrally neutral material, or by variations in optical path length due to grain size and particle shape. The appearance in the HiRISE image suggests a scenario of darker material eroding out of the icy mound and contaminating the spectra. The unusual spectrum of this feature is unlikely to be due to a shadow, which would show lower albedo across all wavelengths.

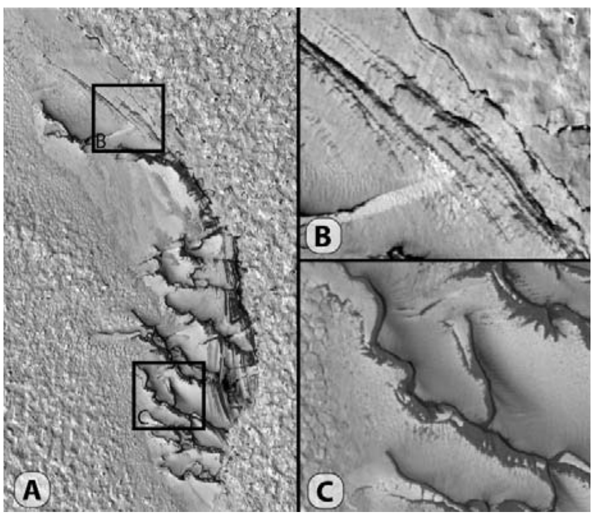

Figure 3. Context (A) and full-resolution views (B & C) of the feature arrowed in Figure 1 from HiRISE image PSP_001370_2505. North is up and illumination is from below in each frame. Scene in A is 350m across, scenes in B and C (positions marked in A) are 90m across.

Finally, the scattered icy outliers (Fig 4) may be remnants of a previously larger extent of the ice deposit, supporting the notion that it is currently losing mass. However, the sharpness of the boundary of this deposit indicates a stabilizing feedback is in operation. Ice is unstable on the dark terrain adjacent to the deposit, but the higher albedo and thermal inertia of the ice itself will reduce the maximum temperatures (which total sublimation is sensitive to) experienced.

Conclusion: 'Louth' crater is a conveniently small and self contained deposit that is suitable for testing models of volatile stability in the Martian north polar region. It may bear greater resemblance to the polar cap than previously expected. Its current dynamic state is likely in the early stages of sublimation, perhaps due to warmer global conditions on Mars [5]. We will report on modeling of this deposit's evolution constrained by the further coordinated observations.

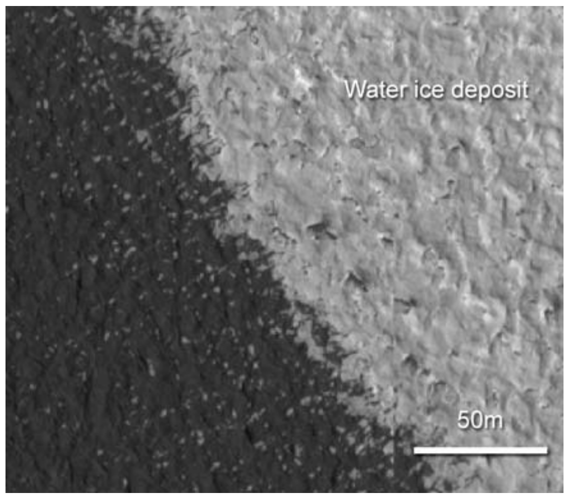

Figure 4. Part of HiRISE image PSP_001370_2505 showing the edge of the ice deposit. The presence of small patches of ice in the dark surrounding material suggests a formerly larger deposit.

Future work: We intend to obtain fall and winter observations of 'Louth' and other regions [6] in order to determine the onset of CO_2 frost cover and use the high resolution capabilities of CRISM and HiRISE to determine any fluctuations in texture or spatial extent of the emerging water ice deposit next Northern summer. In addition, we will observe the crater over time to test the theory that dust contamination decreases over the summer interval [7].

References: [1] Murchie S. L. et al. (2005) *Proceedings of SPIE, Volume 5660,* 66–77. [2] McEwen, A. et al. (2005) *Eos Trans. AGU 86(52), Fall Meet. Suppl., Abstract P23A-0171* [3] Xie, H. et al. (2006) *LPS XXXVII* Abstract #1764. [4] http://www.esa.int/SPECIALS/Mars_express/SEMGKA808BE_1.html [5] Malin, M.C. et al. (2001) *Science 294* 2146-2148 [6] Brown, A.J. et al. (2007) *this meeting* [7] Langevin, Y. et al (2005) *Science 307,* 1581.