Hydrated Minerals in the North Polar Chasmata and Circum-polar Erg B. H. N. Horgan[1], J. F. Bell III[1], P. C. Thomas[1], E. Z. Noe Dobrea[2]. [1]Cornell University Dept. of Astronomy (briony@astro.cornell.edu); [2]JPL/Caltech.

Background: The north polar region of Mars is situated at the lowest elevation of a basin that encompasses much of the northern hemisphere, making it an ideal place for the potential deposition of outflow channel fluids and sediments [1]. Results from the Mars Express OMEGA near-IR imaging spectrometer investigation have indicated the presence of extended deposits of hydrated calcium sulfates in the Olympia Planitia (OP) region, which have been identified as gypsum ($CaSO_4 \cdot 2H_2O$) [2]. Gypsum formation generally requires a source of sulfur and H_2O interacting with Ca-bearing minerals [3].

We are examining hydration in the entire north polar region to establish a regional context for the OP sulfates and to test the proposed OMEGA global mineralogic history [6]. If the sulfates are limited to OP, then they are most likely intimately related to the dunes and may be much younger than sulfate deposits elsewhere; alternately, hydrated minerals elsewhere in the region may suggest otherwise.

Methods: The OMEGA image cubes that we have used in this study have average resolutions between 1 and 4 km/pixel, lie between 75°N and 85°N, and are limited to L_S 90° to 115° (the summer season). To compensate for atmospheric absorption, we have employed an empirically-derived correction based on the ratio of OMEGA spectra of high and low elevation regions on Olympus Mons [8].

To map hydrated minerals, we first calculated the 1.94 μm band depth using the OMEGA parameters [8]; however, this algorithm is also sensitive to water ice, which has a large band around 2 μm. To determine if a spectrum contains hydrated minerals as opposed to water ice, we require the band minimum wavelength to be at 1.941 or 1.955 μm (see [9] for more details).

Because the hydration band is located inside the 2 μm ice band in ice-rich terrains, using the OMEGA parameters gives an artificially inflated band depth, offset by as much as 10% band depth. To evaluate the approximate 1.94 μm band depth inside ice bands, we instead have approximated the continuum value at 1.94 μm with the equivalent value on the opposite side of the ice band, at 2.12 μm. Because the ice band is symmetric around 2.03 μm, this has provided us with much improved band depth estimates.

The maps and spectral averages presented here have a minimum 1.94 μm band depth of 4%, compared to

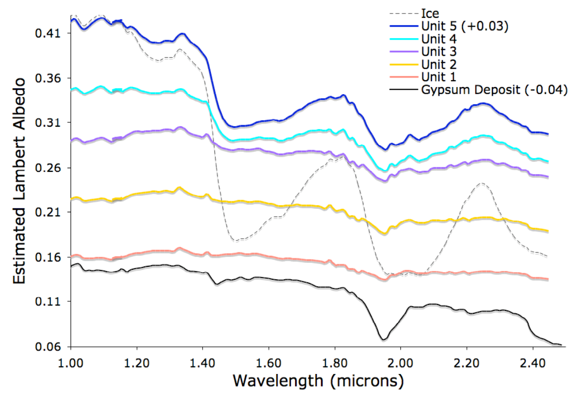

Figure 2: *Regionally averaged spectra of hydrated and ice-rich terrains in the north polar region. OP gypsum-rich deposit shown for comparison.*

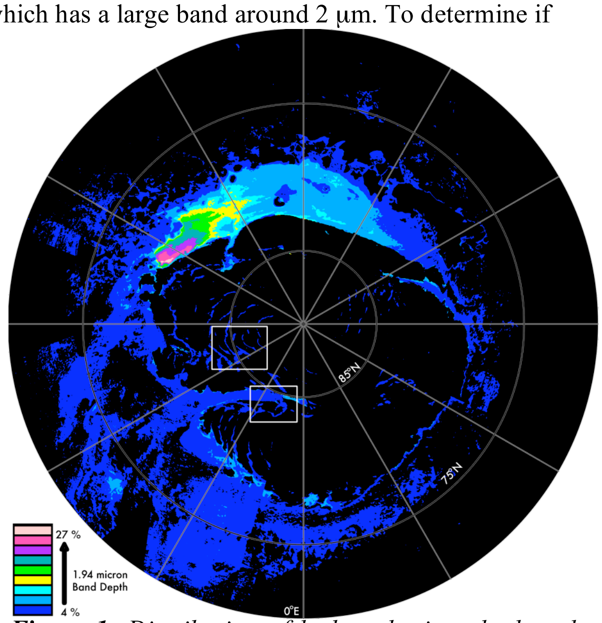

Figure 1: *Distribution of hydrated minerals, based on 1.94 μm band depth. Band depths range from 4 to more than 27% below the continuum.*

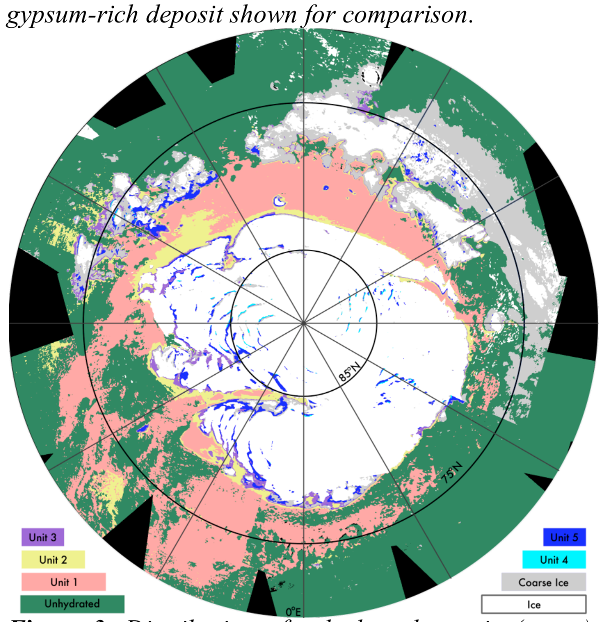

Figure 3: *Distribution of unhydrated terrain (green), fine and/or solid water ice (white), coarse grained water ice (grey), and hydrated units identified above.*

the OMEGA noise level of ~2% [8]. All maps have been orthographically projected at 1 km/pixel resolution.

Results: Figure 1 shows our 1.94 μm band depth map, created using the combination of band depth algorithms described above. Hydration is detected in Olympia Planitia, as expected [2,4], but also in much of the remaining circumpolar erg, on the floor of reentrants, and in scarps exposed by troughs troughout Planum Boreum. In the plains around Planum Boreum, the hydration signature correlates geographically with the Olympia Undae geologic unit [10]. The band depth values appear to be bimodaly distributed, with the majority of Olympia Planitia exhibiting band depths between 7 and 25%, and the rest of the deposits exhibiting band depths between 4 and 7%.

The spectral character of the hydrated units is remarkably consistent. Figure 2a shows regional averages for 4 hydrated spectral types, representing a continuum parametertized by increasing ice content and/or decreasing ice grain sizes. The distribution of the spectral types is shown in Figure 3. In Planum Boreum, hydration is found along with coarse ice in the chasmata, while the resdual ice cap appears to be devoid of hydration.

To search for correlations of hydration with geologic features or units, we have directly compared our hydration maps with THEMIS images and MOLA topography, as shown in Figure 4. Our initial investigations have suggested that in Planum Boreum, hydration is associated with troughs that expose dark PLD on slopes and scarps large enough to be resolved by OMEGA. Although OMEGA does not have the resolution to link hydration with specific layers, such correlations may be revealed in future investigations with CRISM.

Implications: Our finding that sulfates are present in nearly all dune fields in the north polar region as well as in the polar layered deposits suggests that the sulfates were formed prior to the emplacement of most of Planum Boreum; however, the vast range of hydration band depths in the region implies that hydrated minerals are not homogeneously distributed throughout a single set of sediments. The order of magnitude higher hydration band depths observed by CRISM in eastern OP [11] may be due to aeolian mining of a locally enriched gypsum deposit [12]. This deposit may be separate in composition and origin to the hydrated minerals in the other dune fields and in Planum Boreum, or may have been the source for these hydrated minerals in an earlier epoch.

References: [1] Zuber *et al*. (1998) *Science*, *282*, 2053. [2] Langevin *et al.* (2005) *Science*, *307*, 1584. [3] Deer *et al*. (1992) *The Rock-Forming Minerals*, Pearson, 612. [4] Fishbaugh *et al.* (2007) *JGR*, doi: 10.1029/2006JE002862. [5] Feldman *et al*. (2007) *Icarus*, doi: 10.1016/j.icarus. 2007.08.044. [6] Bibring *et al*. (2006) *Science*, *312*, 400. [7] Cloutis *et al.* (2006) *Icarus*, *184*, 121. [8] Poulet *et al.* (2007) *JGR*, doi: 10.1029/2006JE002840. [9] Horgan *et al*. (2008) *39th LPSC*, #2122. [10] Tanaka *et al*. (2007) *7th Mars*, #3276. [11] Roach *et al*. (2007) *38th LPSC*, #1970. [12] Tanaka (2006) *4th Mars Polar Sci. Conf.*, #8024.

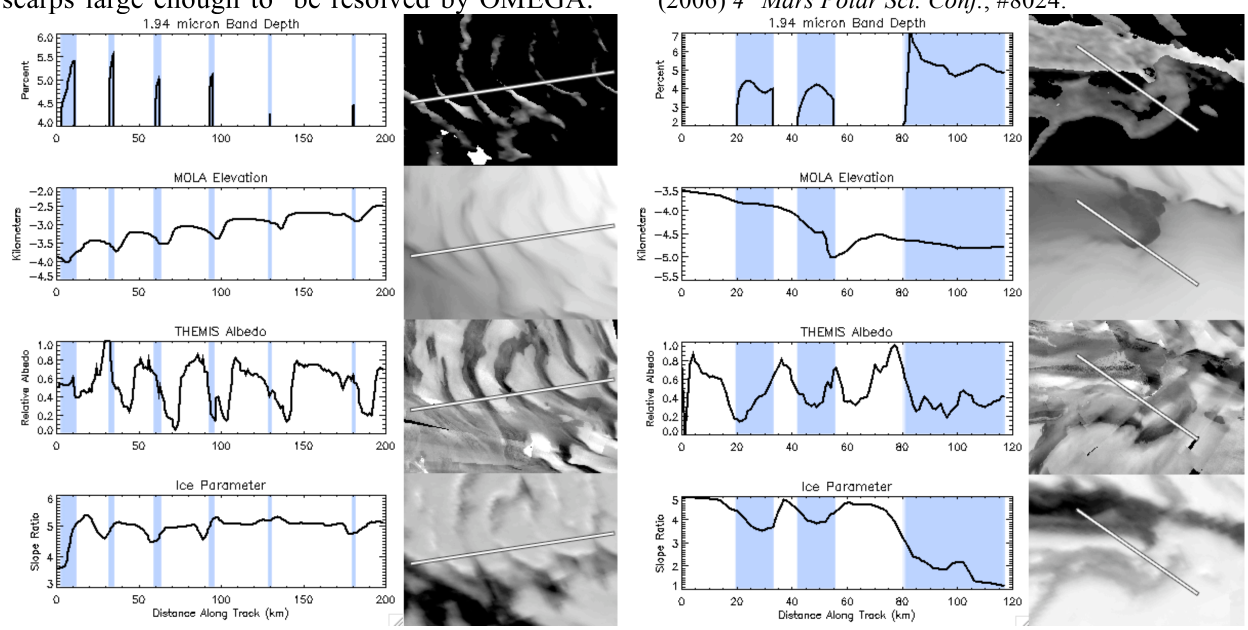

Figure 4: *From top: Hydration band depth compared to elevation, albedo, and relative ice content, as defined by a ice spectral parameter (see [9]). Blue bars indicate hydration. Left: Profiles taken on Planum Boreum show preferential hydration on poleward slopes. Right: Profiles taken at Chasma Boreale head scarp show preferential hydration on equatorward slopes. Context shown in Fig. 1 – upper box is left image, lower box is right image.*