HYDRATED MINERALS IN CIRCUMPOLAR REGIONS

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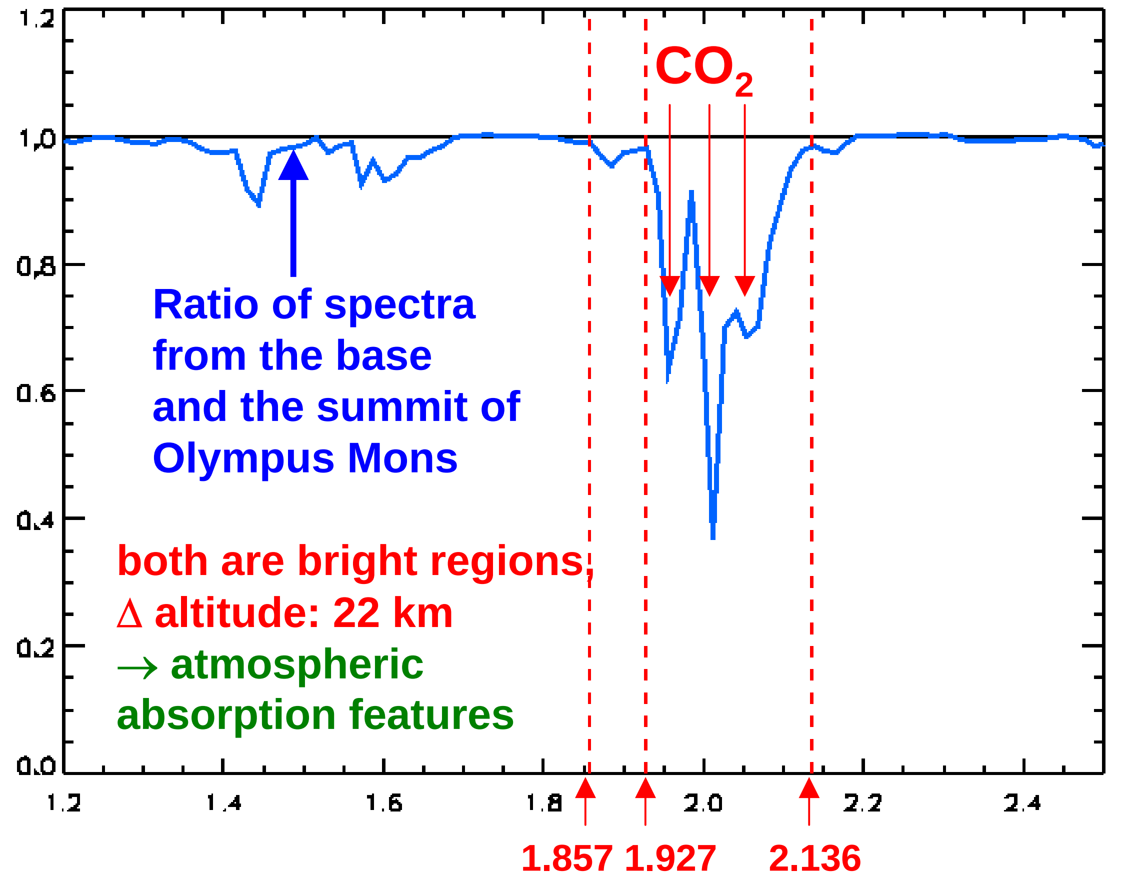
- Hydrated minerals (clays, sulfates, ..) present a specific absorption at 1.9 – 1.95 µm which can be readily observed by OMEGA

- there are strong CO_2 and weak H_2O features from 1.8 to 2.2 µm

- the 1.94 µm feature can be mapped by dividing the reflectance at 1.927 µm by a continuum defined at 1.857 and 2.136 µm

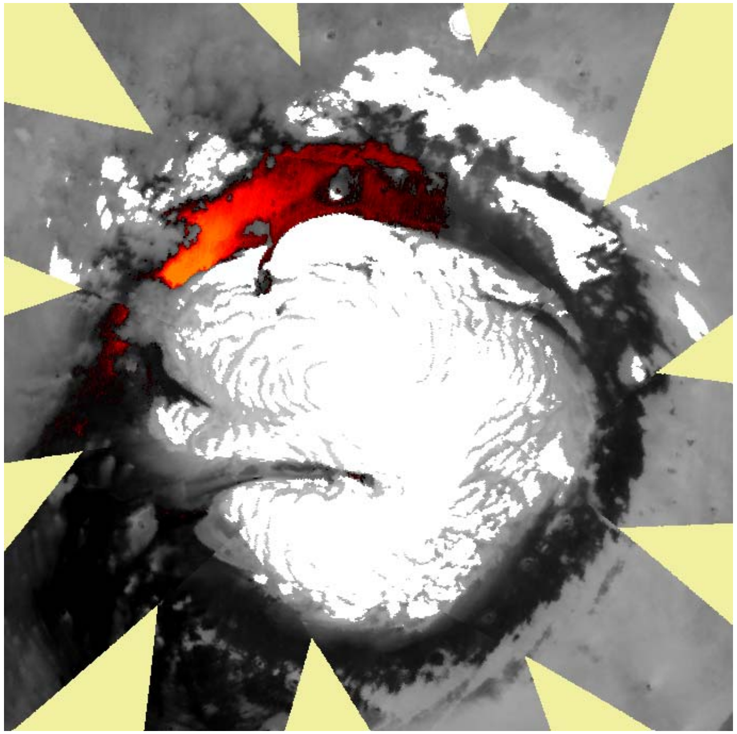
Influence of the atmosphere:
< 2% absolute, << 2% relative



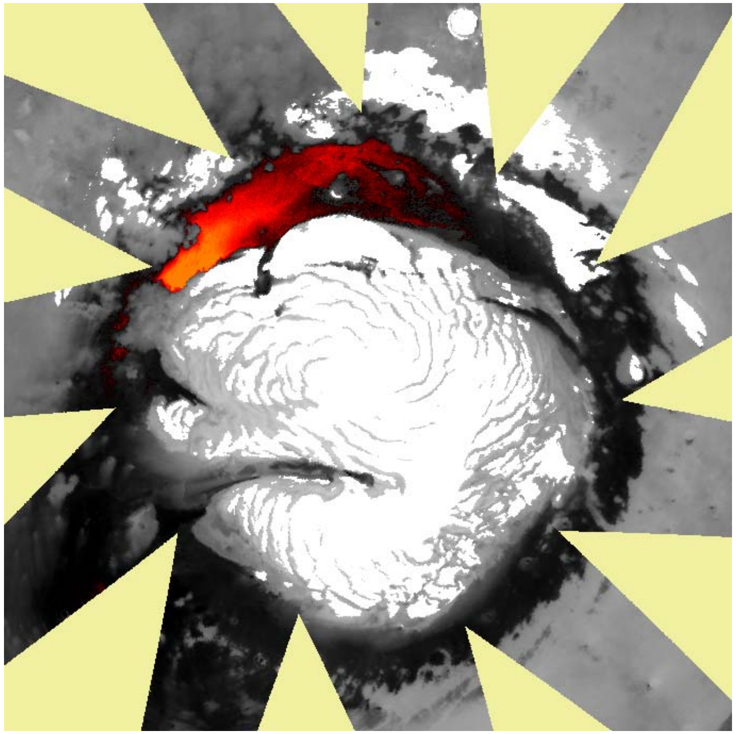
GLOBAL MAPS OF CIRCUMPOLAR REGIONS

- **Mars Express: 11 orbits in 3 sols, inclination 86.5°, precessing pericenter**
  In october/november 2004, comprehensive coverage with 11 OMEGA tracks
  they cannot be in succession due to data volume limitations

Orbits 886 to 923: Ls 93.3° to 98°



Orbits 941 to 980: Ls 100.2° to 105°



A strong absorption at 1.93 µm (> 20%) is consistently observed
on part of the dark terrains surrounding permanent surface ice (white)
and associated circumpolar dust deposits (light grey)

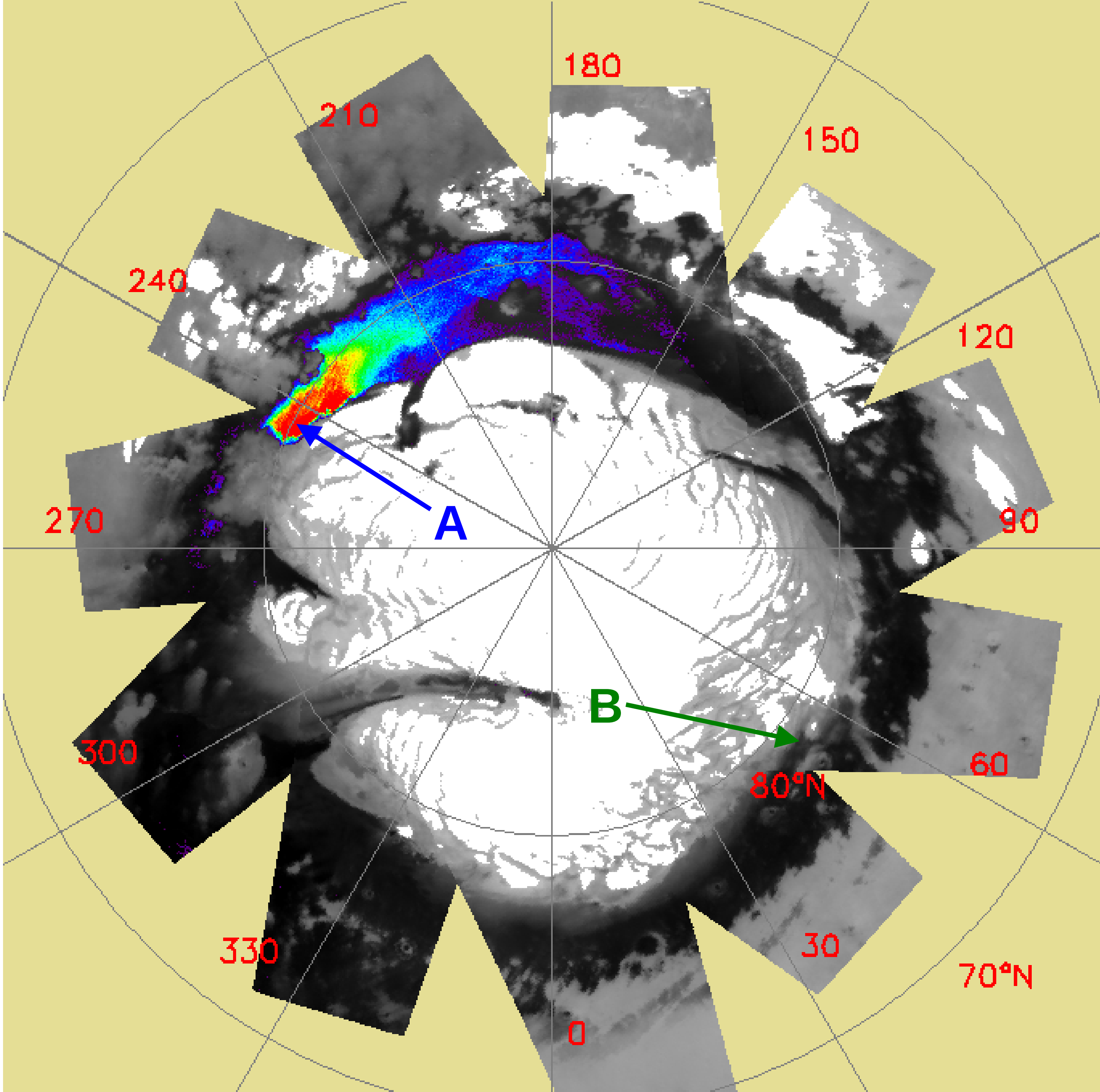
Ls 100 to 105°

Pixel size:
3 to 5 km

the spectral unit is located close to 80° N, max at 244° E (Region A)

it extends over more than 60 km x 300 km

a reference region at 55° E, 78.2° N has been selected with a similar albedo and altitude (region B)

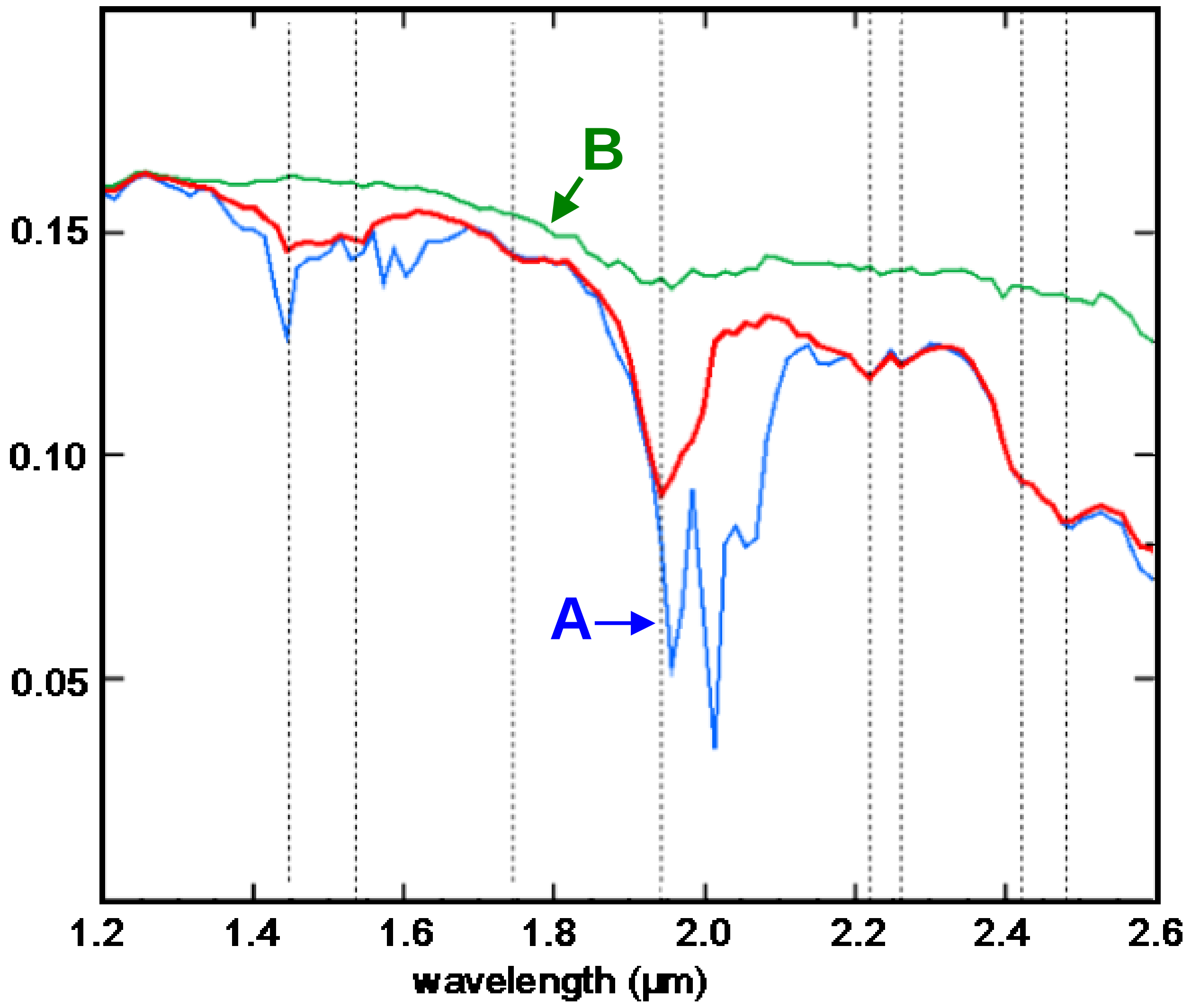


IDENTIFICATION OF THE HYDRATED MINERAL (1)

- **The raw spectrum of region A (blue) can be corrected from atmospheric features (red curve)**

  It then exhibits a strong absorption centered at 1.94 µm and several weaker features

- **The corrected spectrum for the reference region (green curve) exhibits a broad and shallow absorption from 1.8 µm to 2.1 µm**

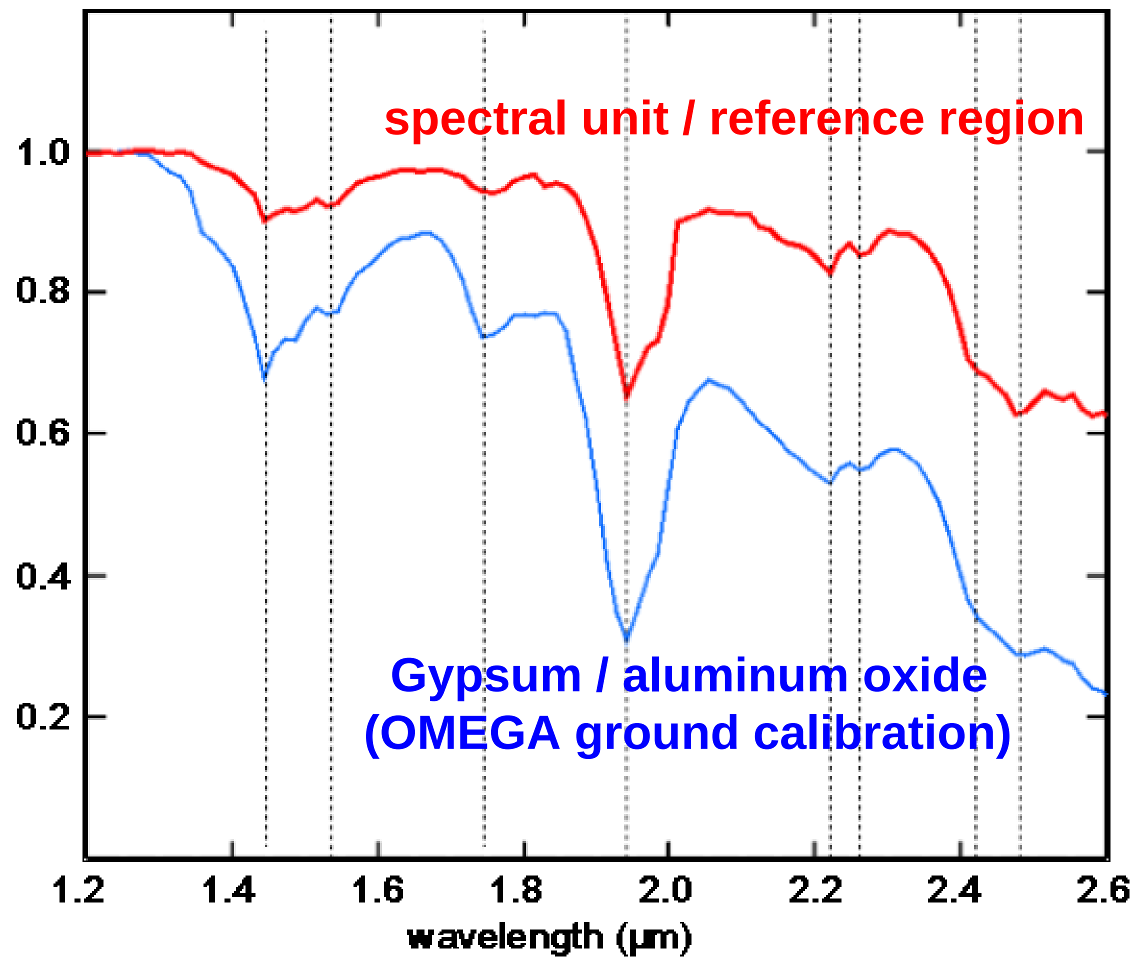


IDENTIFICATION OF THE HYDRATED MINERAL: GYPSUM

- artefacts could result from the photometric function of OMEGA or from the atmosphere correction procedure

- the ratio of the raw spectrum from region A divided by that from the reference region (red curve) confirms that the observed features are real

- the blue curve corresponds to the ratio of a spectrum of gypsum powder divided by that of aluminum oxide (spectrally featureless in the IR) obtained by OMEGA in the lab



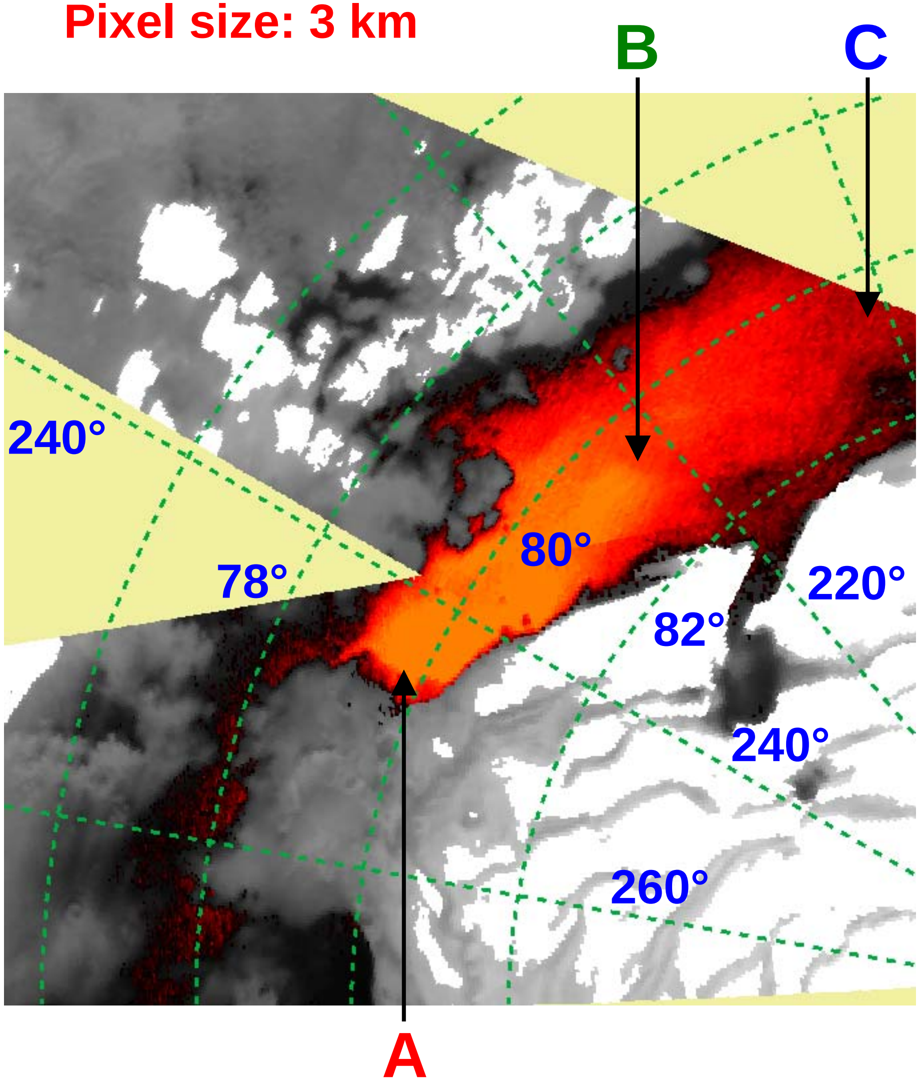
- The match in position and relative strength of features at 1.445, 1.535, 1.755, 1.94, 2.22, 2.27, 2.42 and 2.48 µm (dashed lines) with the lab spectral ratio is excellent

- Gypsum ($CaSO_4 \cdot 2\ H_2O$) provide a better fit compared to bassanite ($2\ CaSO_4 \cdot H_2O$)

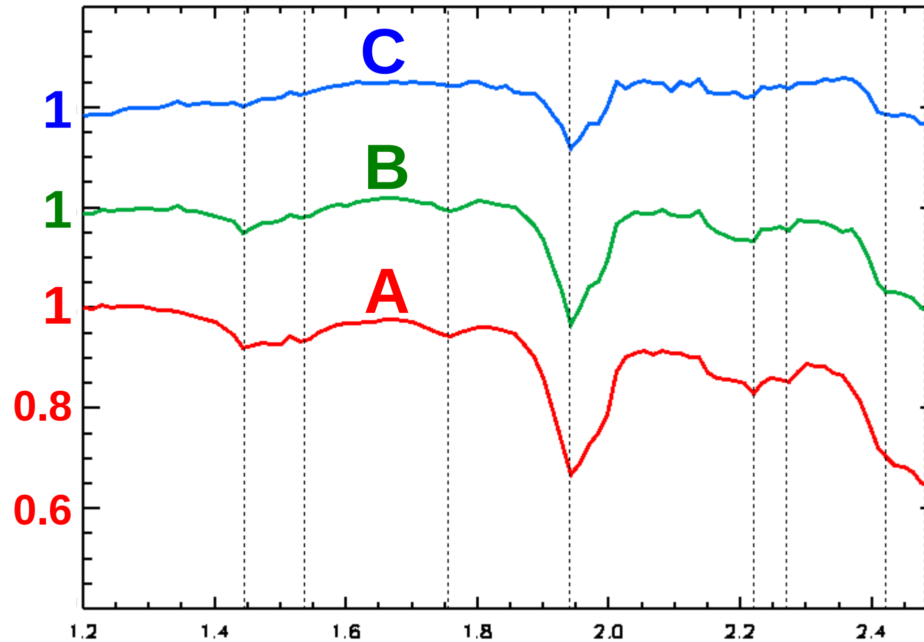
- the high Gypsum content and low albedo requires an admixture of a dark component

MINERALOGICAL HOMOGENEITY OF THE OBSERVED UNIT

Two track mosaic (Ls: 109.1°, 110.2°)
Pixel size: 3 km



A: 245.6° E, 79.8° N
B: 225.2° E, 80.7° N
C: 202.2° E, 80.5° N



the gypsum signature is observed with different intensities at distances of 430 km on Olympia Planitia

GYPSUM IN DARK DUNE DEPOSITS

- The observation of an extended high latitude region with Gypsum as a major constituent is an important constraint for understanding the geological history of these regions

- The Gypsum-rich unit is spatially correlated to the dark longitudinal dune unit of Olympia Planitia. The low thermal inertia suggests that this unit consists in aggregated µm-sized dust (e.g. Paige et al., 1994)

- A local origin is supported by the observation of a unit underlying layered deposits, which is correlated with the dune unit (Byrne and Murray, 2002). Alternately, fine-grained material could be transported by winds or as sediments.

- The gypsum-rich unit requires a specific formation process, possibly predating the emplacement of the present-day polar cap

POSSIBLE FORMATION PROCESSES

- The formation of Gypsum requires:
  - calcium rich minerals (pyroxenes, feldspars)
  - a sulfur-rich environment
  - water

  volcanic processes provide the most likely source of sulfur, as H_2S, SO_2 or pyroclastic ashes

- several scenarios can be considered for the water alteration process:
  - atmospheric weathering (requires high water vapor content)
  - groundwater from hydrothermal sources
  - interaction of basalt with acidic snows
  - outflows from the ice cap during a warm climatic excursion

The observation by OMEGA of an extended gypsum-rich unit at high northern latitudes provides strong evidence for a significant role of water alteration processes in the geological history of Mars.