DUST DEPOSITS WITHIN AND AROUND THE NORTH POLAR ICE CAP OF MARS: WHAT ARE THEIR MINERALOGICAL COMPOSITIONS, THEIR SOURCES AND THEIR ACCUMULATION PROCESSES? M. Massé[1], O. Bourgeois[1], S. Le Mouélic[1], C. Verpoorter[1], L. Le Deit[1], J.-Ph. Combe[2]. [1]Laboratoire de Planétologie et Géodynamique, UMR 6112, CNRS, Université de Nantes, 2 chemin de la Houssinière, 44322 Nantes Cedex 3, France (marion.masse@univ-nantes.fr), [2]Bear Fight Center, Box 667, Winthrop WA 98862, USA.

Introduction: The North Polar Cap of Mars (Fig. 1) is an accumulation of H_2O ice layers with various amounts of interstratified dust particles and different ice grain sizes [1, 2]. In Olympia Planum, the lowest part of the cap has been exhumed by erosional retreat of its upper part [1]. It is now extensively covered by dust deposits and dune fields. On these superficial deposits, spectral signatures of gypsum (hydrated calcium sulfate) have been detected by the OMEGA spectrometer [3]. At other locations around the North Polar Cap, spectral signatures of gypsum or other hydrated minerals (possibly ferrihydrite or jarosite) have been recognized also [4]. As for Olympia Planum, these signatures systematically correspond to superficial dust deposits and dune fields located at the feet of erosional escarpments bordering the ice cap.

This proximity suggests a genetic link between the hydrated minerals and the ice cap. It has been proposed, that the lowest part of the polar cap is a source for the gypsum of Olympia Planum [5] and more generally for the North Polar Sand Sea [6]. However circum-polar dune fields are not systematically composed of hydrated minerals: most of them are generally interpreted as composed of mafic minerals [2].

This raises several questions: (1) What are the mineralogical compositions of the various superficial circum-polar sediments (dust cover, sand sheets, dunes)? (2) What are the sources of these sediments? (3) How have they been transported? (4) How did they accumulate? (5) What is the link (if any) between these sediments and the ice cap?

To answer these questions, we are currently performing integrated morphological, structural and compositional analyses at several sites along the contact between the North Polar Ice Cap and the surrounding superficial sediments. We show here the first results obtained in one region of Gemini Scopuli (Fig. 1).

Methods and data: The mineralogical composition is investigated from data acquired by the OMEGA and CRISM hyperspectral imaging spectrometers. OMEGA collects 352 spectral channels from 0.38 to 5.2 µm at a spatial resolution ranging from 300 m to 4 km [7]. CRISM collects 544 spectral channels from 0.36 to 3.9 µm at a spatial resolution ranging from 15 to 19 m/pixel [8]. After removal of the atmospheric spectral contribution, we compute maps of mineralogically significant spectral parameters. The geological interpretation of these spectral maps is constrained by morphological, textural, structural and sedimentological analyses based on altimetry data and high-resolution images from MOLA, MOC, THEMIS, CTX and HiRISE.

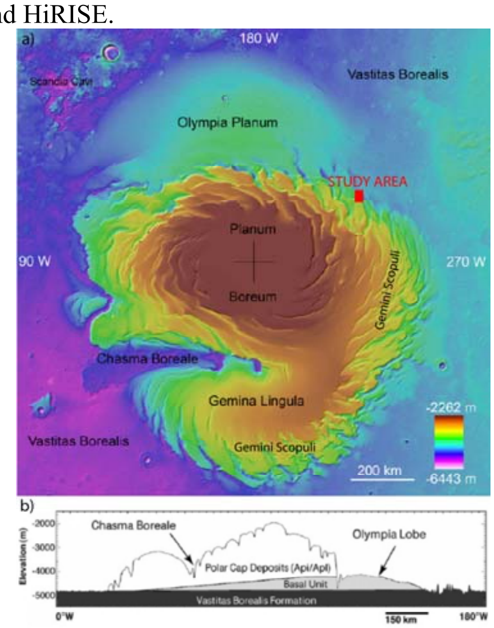

Figure 1: *The North Polar Ice Cap: a) Mola topographic map [2], b) Interpretative cross-section [1].*

Accumulation processes: CRISM image hrl0000330c was acquired in summer in Gemini Scopuli (Fig. 2b). The surface of the ice cap, gently dipping southwards, occupies the NW half of the image. In the central part of the image, a subhorizontal terrace is covered by superficial sediments (light greenish brown) and dunes (dark brown). North and south of this terrace, two steep cliff provide vertical sections where the internal structure of the ice cap above and below the sediment-covered terrace can be analyzed. Further south, superficial sediments (light greenish brown) cover another subhorizontal terrace lying at lower elevation. At the southern border of the image, the surface of the lower terrace is clean of sediments and ice is visible.

The ice cap is distinctively layered and the map of the 1.5µm band depth reveals that this layering corresponds to different amounts of water ice (Fig. 2-d).

On these CRISM and OMEGA images, dust rich layers display a characteristic narrow absorption band at 2.14 µm, superimposed on the wide absorption band of water ice centered around 2.0 µm (Fig. 2-a and e). We attribute the 2.14 µm band to dust because the map of the 2.14 band depth (Fig. 2e) is anti-correlated with the map of the 1.5 µm band depth (2d). This 2.14 µm band is also present, and even deeper, in spectra of superficial sediments and dunes covering the upper and lower terraces.

Synthetic spectra computed by a linear mixing of a spectrum representative of dunes with a spectrum typical of ice-rich layers fit the spectra of dust-rich ice layers (Fig. 3). This suggests that dunes and superficial sediments covering the terraces have a composition similar to that of dust interstratified in the ice cap. On the basis of this similarity in composition and of the location of the dunes and superficial sediments at the foot of a cliff formed by erosional regression of the ice cap, we infer that these superficial deposits are a sublimation till covering the ice cap.

Dust composition: The mineralogical species responsible for the 2.14 µm absorption band is still to be determined. Horgan et al. [4] have defined a spectral parameter allowing to map the 1.9 µm mineral hydration band distinctly from the 2 µm water ice band. The computation of this parameter on CRISM image hrl0000330c reveals that some hydrated minerals are probably present on the superficial dunes. This signature can be attributed to gypsum [4] but no other absorption bands of this mineral are detected. The mineralogical significance of these two signatures (and other spectral signatures representative of polar dust) will be investigated in further studies.

References: [1] Fishbaugh K. and Head J. (2005) *Icarus*, 174, 444-474. [2] Fishbaugh et al. (2008) *Icarus*, 196, 305-317. [3] Langevin Y. et al. (2005) *Science*, 307, 1584-1586. [4] Horgan B. et al. (2009) *JGR*, in press. [5] Roach L. (2008) *LPSC XXXVIII*, Abst#1970. [6] Byrne S. and Murray B. (2002) *JGR*, 107, doi:10.1029/2001JE001615. [7] Bibring J.-P. et al. (2004) *Eur. Space Agency Spec. Publ.* 1240, 37. [8] Murchie S. et al. (2007), *JGR, 112*, E05S03, doi:10.1029/2006JE002682.

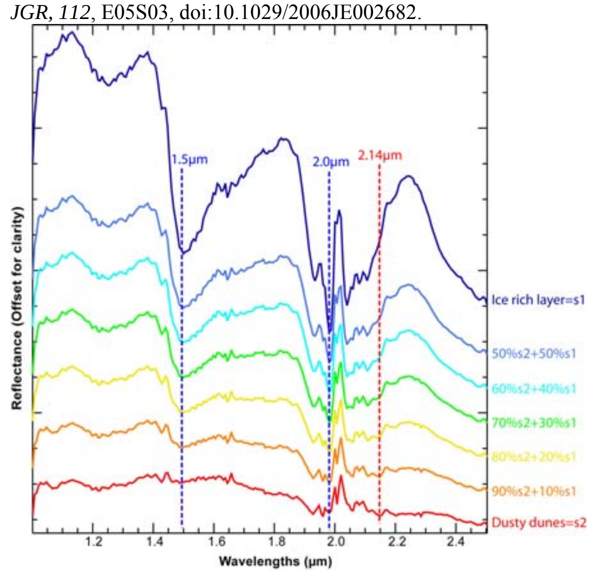

Figure 3: *Spectra computed by a synthetic linear mixing of two spectra typical of ice rich layer and dune (Fig.2).*

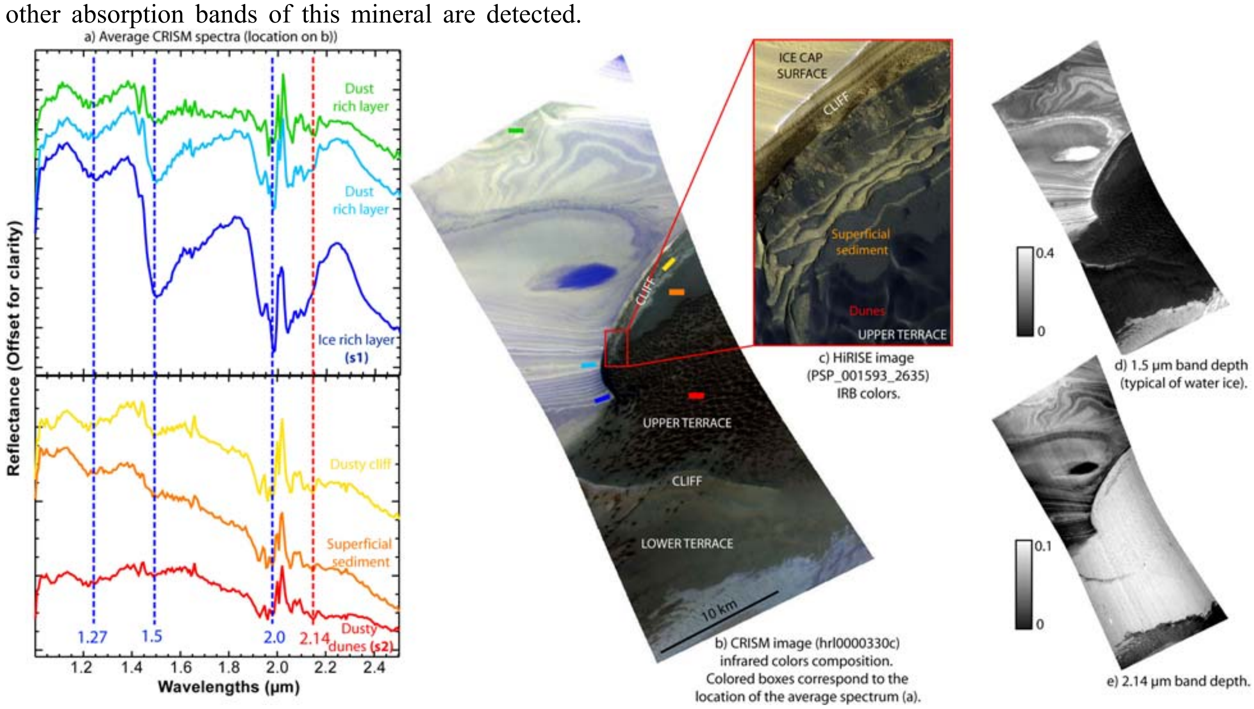

Figure 2: *Spectral and morphological properties of the study area.*