# COMBINED OMEGA AND CRISM OBSERVATIONS OF THE CRYPTIC REGION OF THE SOUTH SEASONAL CAP CLOSE TO EQUINOX

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**Introduction:** From equinox to mid spring, a region of the South seasonal cap, the “cryptic region” exhibits low albedo values as well as cold temperatures compatible with $CO_2$ ice [1]. This unusual behavior was interpreted as a clear slab of $CO_2$ ice, the underlying dark surface absorbing photons in the continuum of $CO_2$ ice bands [2]. The specific patterns such as fans, spots and patterns observed at high sublimation latitude have been attributed to a venting process [2,3]: $CO_2$ ice sublimates at the interface between the surface and the $CO_2$ ice slab due to solar heating. The pressure builds up until a vent forms in the $CO_2$ slab. Observations in the near IR by OMEGA from March to May 2005 (Martian year 27, $L_s$ 184° to $L_s$ 250°) demonstrated that the CO2 ice signatures are weaker in the cryptic region than in other regions of the South seasonal cap [4]. The low albedo of the cryptic region in mid spring is attributed to extensive contamination of a $CO_2$ ice layer by dust. A widespread contamination of the surface is also observed in mid-southern spring by TES / THEMIS [5]. These observations raise major questions on the complex relationship between surface contamination and $CO_2$ sublimation under the slab: the fraction of photons reaching the underlying surface decreases with surface contamination by dust, hence the process should be self-quenching. A critical issue is whether there are regions covered with a clear slab of $CO_2$ ice, what is their location, their spatial scale and the evolution with time.

**Observations:** When slab ice is present, the solar photons travel several tens of cm in $CO_2$ ice, hence major and minor $CO_2$ ice bands are saturated. A map of the strength of the 1.435 µm $CO_2$ ice band at $L_s$ 195.5° obtained by OMEGA in April 2005 is presented in Fig. 1. Slab ice spectral signatures (Fig. 2) were observed at very high latitudes corresponding to the permanent cap, after correcting for the contribution of aerosols [6, 7]. This contribution is large due to the high incidence (85°). The resulting albedo of 72% in the continuum is consistent with that observed in the same region later in spring at lower incidences. At this stage, the spectral bands of $CO_2$ ice are much weaker in the cryptic region (Fig. 3), corresponding to average penetration depths of solar photons in $CO_2$ ice in the range of a few mm.

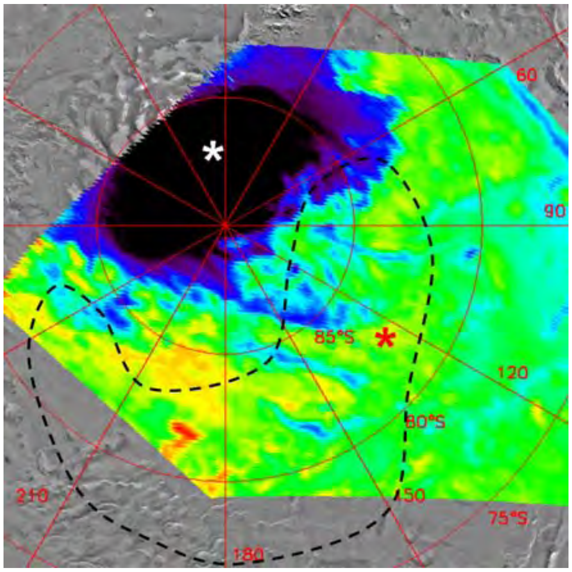

Fig. 1: map of the strength of the 1.435 µm band of $CO_2$ ice at $L_s$ 195.5°. The rainbow scale extends from 0% (red) to 60% (black). The black dashed outline corresponds to regions with high densities of “spiders”, “fans” and “spots” [3], associated with venting. The white star is the location of the spectrum of Fig. 2, the red star is the location of the spectrum of Fig. 3

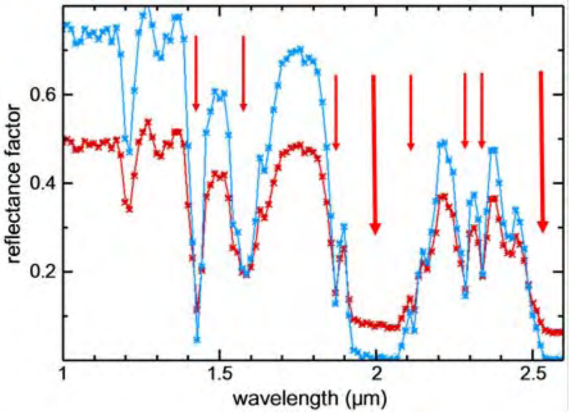

Fig. 2: OMEGA spectrum (red) of a region at 354° E, 87° S (over the permanent cap) obtained in April 2005 at Ls 191°. The strongest CO2 ice bands (thick red arrows) are saturated after correcting for the contribution of aerosols (blue spectrum).

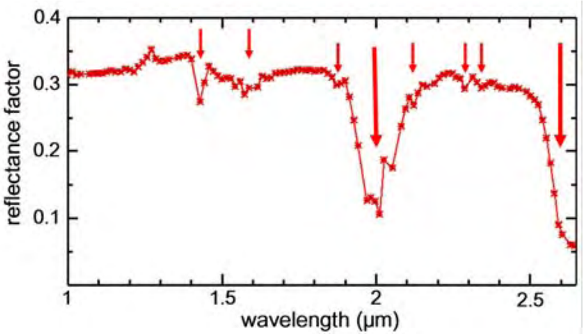

Fig. 3: OMEGA spectrum of a region at 125° E, 82.5° S obtained in April 2005 at Ls 195.5°. Most $CO_2$ ice band (red arrows) are not saturated, and that at 2.65 µm is only partly saturated. The solar photons are therefore scattered back to the instrument with a path length of at most a few mm in $CO_2$ ice. The small peak at 1.28 µm corresponds to $O_2$ fluorescence in the atmosphere.

**Planned observations:** Three sets of OMEGA observations have been planned in February 2007, so as to check for the presence of slab ice over the cryptic region immediately after sunrise at high southern latitudes ($L_s$ 175° - 185°). During Febuary 2007, the pericenter of Mars Express moves from 20° N to 6° N, so that altitudes over the South Pole decrease from 4000 km to 3000 km. The IFOV will progressively decrease from 5 km to 3.5 km, with a swath width of 64 pixels. This will make it possible to test whether the venting process can be initiated immediately after sunrise if the surface of the $CO_2$ ice layer is not yet contaminated by dust at that stage.

The increasing extinction by dust contamination of the surface of the slab by venting processes can be in part compensated by the higher flux as the Sun rises over the horizon so as to maintain gas fluxes below the surface. If contamination is first localized, as suggested by the observation of spots and fans [5], sublimation can proceed under areas which are still clear. This could explain the formation of channels (“spiders”) as dust is carried to the first punctures in the slab from increasingly larger distances. This model can be tested by searching for slab $CO_2$ ice signatures in small scale regions which have not yet be covered by dust emitted by vents.

Dedicated observations by CRISM/MRO are now planned for high southern latitudes in February 2007, together with OMEGA observations. From modeling of OMEGA spectra [4,8], it is already possible to discriminate between major dust contamination of the $CO_2$ ice over a small fraction of a pixel and widespread dust contamination over the whole pixel. Using both the survey mode (200 m IFOV) and the high resolution mode (18 m IFOV), CRISM will provide spectra at high spatial resolution on the cryptic region. These observations will be embedded in the OMEGA observations which cover much larger areas with its 200 to 300 km wide swaths. The CRISM data will provide essential information for assessing small scale spatial structures in the signatures of $CO_2$ ice and their relationship with albedo features, such as a widespread occurrence of black dots.

**References:**

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