DEFROSTING SEQUENCE ON THE RUSSELL MEGADUNE, MARS. E. Gardin[1], C. Quantin[1] and P. Allemand[1] Laboratoire des Sciences de la Terre, Université de Lyon, Ecole Normale Supérieure de Lyon, Université Claude Bernard Lyon 1, CNRS, France, Bat Géode, 43 bd du 11 Novembre, 69622 Villeurbanne cedex, France (emilie.gardin@univ-lyon1.fr).

Introduction:

Uncommon features have been observed in the cryptic region near the south polar cap during the spring time retreat of the seasonal cap. The defrosting of the seasonal CO_2 cap leads to dalmatian spots named dark spots [1], spiders [2], fans [3] and polygonal crack patterns [4]. (Kieffer, 2007) proposed a semi-quantitative model to explain all these processes. The dark spots, fans and spiders would be formed by the venting of sub-ice CO_2 gas under pressure. This model implies a pure CO_2 ice slab responsible of heating and defrosting the basal part of the ice slab by translucency [5].

The high resolution pictures, MOC first, and now HiRiSE, display such uncommon features further north in the southern hemisphere. Indeed, some south facing scarps in middle latitudes are partly frosted during the local winter and recorded the defrosting sequence during the spring time retreat. It is the case of Russell Crater (54.6°S and 12.4°E), a large crater of the southern hemisphere, that exposes a large dune field in its center. The aim of this abstract is to describe the active features produced by the defrosting on the megadune of Russell Crater and to discuss the possible mechanisms that originated of these features.

Data set: MRO (Mars Reconnaissance Orbiter) did a large effort on survey defrosting sequence over Russell megadune with HiRiSE and CRISM data acquired at different times during the defrosting period. Some HiRiSE pictures are acquired only a few Martian days apart (table 1). We studied HiRiSE images from the solar longitude (Ls) 136° to 218° that covers a period from the middle winter to the end of spring. CRISM is the hyperspectral imager onboard MRO that measures the reflectance at the visible near-infrared wavelengths [6]. Targeted MRO/CRISM images collect 544 wavelengths from 0.36 to 3.9 µm in ~10-12 km wide swaths at 18-36 m/pixel resolution [6]. In the present study, we used only the near-infrared data between 1 and 2.6 µm that is the spectral range discriminating for CO_2 and water ice. The used data are processed for instrumental effects, converted to I/F and the atmosphere is removed using a ratio with a CRISM scene of Olympus Mons, scaled to the same column density of CO_2. All these processing were done with CAT. This software was released by the CRISM team for public to help the data exploitation. We processed the following images: FRT_39DF, HRS_4061, FRT_42AA, HRS_43BC and FRT_5339 that have been acquired from the solar longitude (Ls) 157° to 215°, covering a period from the middle winter to the end of spring (Table 1).

CRISM	HIRISE	Ls	Season
	PSP_1440_1255	136°	Winter
FRT39DF	PSP_1981_1255	158°	Winter
HRS4006	PSP_2337_1255	173°	Winter
FRT42AA	PSP_2482_1255	179°	Winter
HRS43BC	PSP_2548_1255	182°	Spring
	PSP_2904_1255	198°	Spring
FRT5339		215°	Spring
	PSP_3326_1255	218°	Spring

Table 1: List of processed CRISM data and HiRiSE images on the megadune of Russell Crater (54.6°S and 12.4°E) with their acquisition Solar Longitude (Ls) and the local season.

Regional context:

Russell is a 134 km diameter crater west of Hellas basin (figure 1). This crater hosts a 1704 km^2 dune field with an unusual megadune on its north-eastern boundary. This megadune, visible on MOLA data is around 500 m high. This megadune is highly studied because its south facing scarp displays gullies [7-8-9]. The gullies are here interpreted as flowing water during recent climate changes related to Martian obliquity variations [10]. This South facing slope of the asymmetric megadune is steep with an average slope of 30°. The slope is exposed to seasonal frost and we reported in the present study the defrosting sequence over this scarp (figure 1).

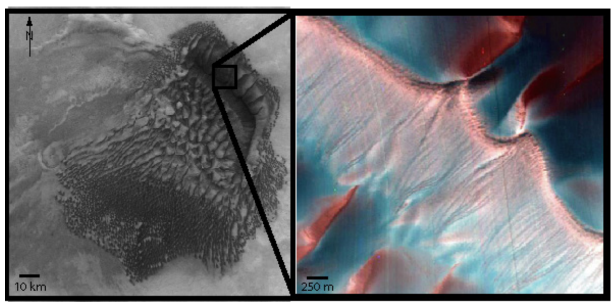

Figure 1: In grey scale, HRSC image from the dune field of Russell crater (54.6°S; 12.4°E). The enlargement is a false colour composite of CRISM FRT_39DF data cube (R: 2.5µm, G: 1.5 µm, B: 1.25 µm). The frosted part appears in bright.

Defrosting sequence observation:

Ls 136°: At this time, in the middle winter, the south facing slope of the megadune has to be frosted. The HiRiSE picture reveals a few 5 to 10 m diameter dark spots. They are located on the upper part of the slope and on the flat top of the megadune (Figure 2). The dark spot distribution is not random. On the upper part of the slope, the dark spots follow lines parallel to the crest whereas those on the top of the dune follow lines perpendicular to the brink.

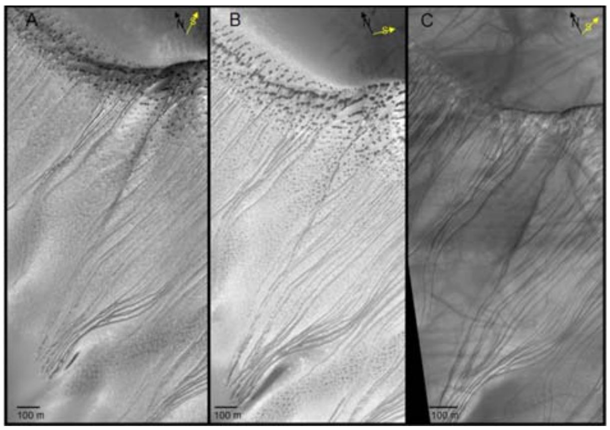

Figure 2: HiRiSE pictures of the south facing slope of Russell megadune at different solar longitudes (A: 158°, B: 182° and C: 215°) during the defrosting season.

Ls 158°: At this time, a CRISM data cube is available confirming that the megadune scarp is completely covered by CO_2 frost. The HiRiSE image shows that the number and the size of the dark spots have increased. Their average diameter is now around 10 m. The dark spots are still not randomly distributed and follow the same distribution as for the previous Ls. The area that exposed dark spots appears on CRISM scene with the weaker CO_2 ice signatures.

Ls173°: The presence of the dark spots is extended downward whereas the pre-existing dark spots are enlarged. They appear at full spatial resolution as diffuse patches. On CRISM data, CO_2 ice is still present with large heterogeneity in the depth of CO_2 ice signature. The dark spots region have still weaker CO_2 ice signature.

Ls 179-182°: New dark spots keep appearing further down the slope and the pre-existing dark spots are still growing (Figure 2). At some locations, dark streaks originated from the diffuse and large dark spots. Some of them spread down the slope. On CRISM data, CO_2 ice is still present. The deepest CO_2 ice signatures are located in the upper part of the megadune where the dark spots are very large and dense. The dark spots themselves have the weakeest CO_2 ice signatures.

Ls198°: The HiRiSE picture shows very large and diffuse dark spots as well as very large dark streaks. Both dark features display albedo variations. This picture shows the paroxysm of the defrosting features.

Ls215-218°: HiRiSE picture shows dust devil tracks, evidence that the frost is no more present (Figure 2). It is confirmed by CRISM data with flat spectra without any ice signature.

Discussion:

The frost retreat is not sudden and not spatially homogeneous over Russell megadune. From HiRiSE and CRISM data analysis it seems that lots of processes of sublimation and refrosting appear during the sequence, what is supported by albedo variation of the dark spot on HiRiSE, and by the variation in CO_2 ice signature on CRISM data. Weaker CO_2 ice signatures are usually interpreted by dust contamination [i.e.11]. The scenario proposed by [5] is not perfectly fitting our results especially in term of pure CO_2 ice slab. The dark spots are still appearing while the CO_2 ice signature seems to be highly contaminated by dust. The non-random distribution of the dark spots may be related to the interne dune structure.

Conclusions: We have observed the complete defrosting sequence over the Russell megadune. We observed features evolution from small size dark spots to large dark spots spreading down the slope. We were also able to monitor the CO_2 ice composition trough the process with CRISM data. The results may question the defrosting model proposed by [5].

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