BRIGHT FEATURES SUGGEST POSSIBLE DARK DUNE MIGRATION ON MARS E. Gardin[1,2], M. Bourke[3,4], P. Allemand[1] and C. Quantin[1], [1] Laboratoire des Sciences de la Terre, Université de Lyon, Ecole Normale Supérieure de Lyon, Université Claude Bernard Lyon 1, CNRS UMR 5570, France, Bat Géode, 43 bd du 11 Novembre, 69622 Villeurbanne cedex, France, [2] Laboratoire de Planétologie et Géodynamique de Nantes, CNRS UMR 6112, 2 rue de la Houssinière, 44322 Nantes cedex 3, emilie.gardin@univ-nantes.fr, [3] Planetary Science Institute, Tucson, Arizona, [4] OUCE, University of Oxford, UK.

Introduction:

Interaction between the Martian dunes and the climate change is the topic of many studies [1, 2, 3, 4, 5] to understand the recent Martian history. Some authors, for example [6] have compared the images, which have been acquiring for the about fortieth years of data (e.g. Mariner to HiRiSE). Movement of dark dunes has never already been observed on Mars. A recent study of [7] shows that small dome shapes have disappeared between two MOC images with a timescale of nearly three Martian years. Then, they have explained that saltation might always be active on the current conditions of Mars. However, no migrations of dunes have been observed on Mars.

On Earth, some dune fields record the evolution of the climate. For example, the White Sand Desert National Monument (WSDNM) presents evidence of dune migration [8]. Dunes of WSNDM are composed of gypsum. Accumulation of humidity occurs at the base of the avalanche slipface and forms a crust of induration. Thus, migration of the dunes can be follow.

On Mars, new releases of HiRISE images, one Martian dune field has presented some bright features above the dark dunes and in the interdune. We will present in this work, a morphological survey at high resolution (HiRiSE images) of a dune field, which is inside a crater on the equatorial area of Mars (11.89°N and 185.87°E). Then, we will present our hypothesis about the origin of the bright features.

Context setting:

The dune field is located inside an impact crater of about 90 km of diameter [9] in the northern hemisphere, at 11.9°N latitude and 185.9°E longitude. The dune field is located at the south-western part of the crater. Barchans and barchanoid shapes have been observed on the field. Some TARS [10] and dark streaks appear on the crater's background. The morphological analysis of the dune field shows that the dark dunes (e.g. barchans and barchanoid shapes) are formed by trend wind direction toward the south-east (Figure 2).

Some bright features appear on the dune field and are located in the interdune and also near the foot of the windward side of the dunes. This study presents the morphometry and morphology of the bright features in order to propose an origin of the bright formation.

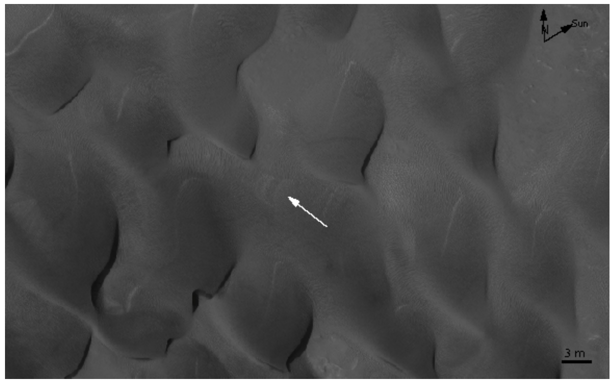

Figure 1: HiRiSE image: (PSP_001882_1920) at 25cm/pixel of resolution. The white arrow shows several bright features located in the interdune. This example presented here illustrates the crescent forms of bright features.

Photometry:

In our study, we have realized morphometry above this particular dune field (11.89°N; 185.87°E) to evaluate several distances. The measures have been taken based at high spatial resolution (25 cm per pixel) - with HiRiSE images. We have done the following measurements above 95 dark dunes and reported the mean values and the standard deviations in the Table 1.

The first reported values correspond to the distance between the bright feature and the foot of the windward side of the nearest dark dune.

The second series of reported values is the distance between the bright features and the brink of the nearest dark dune.

Sometime, some groups of several bright features are observed on a same dark dune. The third category of reported values is the distance between the bright features themselves inside a same group.

Moreover, we have also measured width and length for each bright feature.

Finally, the DN represents the brightness of each pixel and ranges between 0 and 255 values (0 for low albedo pixel and 255 for brighter pixel on the image). Therefore, we have reported the mean Digital Number (DN) for each bright feature, with the average of eight points.

	Distance + std deviation
Foot + std deviation	5.60 m + 0.54 m
Brink + std deviation	16.06 m - 0.17 m
Next + std deviation	4.37 m + 0.26 m
Width + std deviation	0.56 m + 0.02 m
Length + std deviation	9.27 m+ 0.23 m
Digital Number (DN)	70.71

Table 1: Reported average values and standard deviation of bright feature measurements. "foot": distance between the foot of the windward side of dune and the bright feature. "brink": distance between the brink of the dune and the bright feature. "next": distance between two consecutive bright features on a same dune. This table also presents the average of measurements for the width and length of bright features "DN": brightness of each pixel ranging between 0 and 255 values (0 for low albedo pixel and 255 for brighter pixel).

Morphology of bright features:

Many bright features appear clearly above dunes and in the interdune of the field. They are very thin, only 56 cm. They appear with several shapes: strength, curve or arcurate. Some dunes present groups of neighbouring bright features (Figure 1). All bright features are either parallel to the brink or parallel to the edge of the nearest dune. Theses observations suggest that the bright features are in relation with the dark dune shapes.

Material of bright features:

Bright features are composed of high albedo material given by the strong DN values (Table 1), in comparison with the background. At high resolution, it appears located between the TARS, which superimposed the barchans (Figure 1). The bright material is different than the material of the dark dunes. This implies that both dunes and bright features have not the same process of formation.

On Earth, similar footprints have been observed in the interdune of the WSNDM [8]. These particular dunes are composed of gypsum. As [8] has described, the dune sediment can be cemented in the vadose area of the dune. The humidity amount is mainly accumulated in the bottom of the avalanche slipface of the barchan dunes. The dune sediment is composed of evaporating material, which can be indurate with the small amount of water to form a crust at the foot of the avalanche slipface of the barchans. The shape of the terrestrial crusts is arcurate because of the crescent shapes of barchans.

If as we propose, the bright Martian features observed in this study, are formed in this way, this will be the first observations on dark dune, which can indicate the presence of moisture at the equatorial area. The bright features could suggest the following pathway of the dune migration.

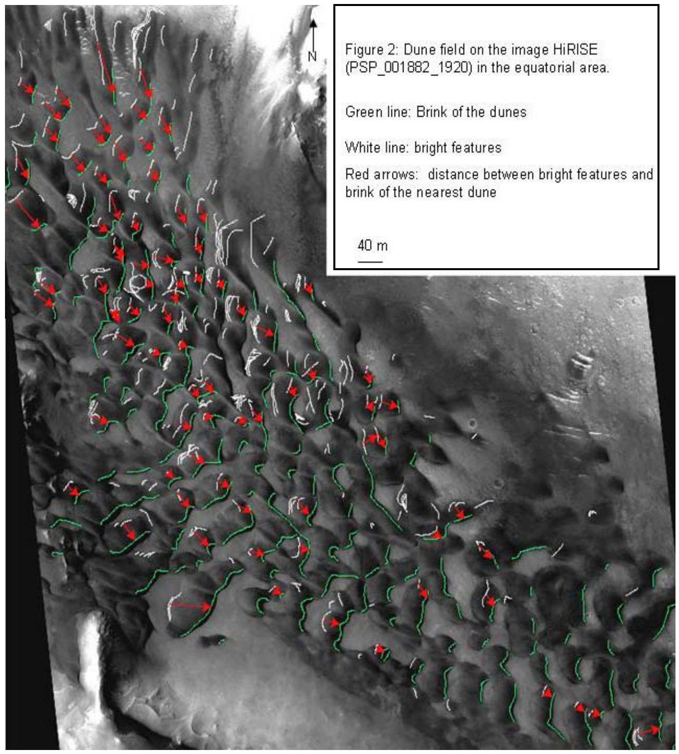

Figure 2: Dune field on the image HiRISE (PSP_001882_1920) in the equatorial area.

Green line: Brink of the dunes

White line: bright features

Red arrows: distance between bright features and brink of the nearest dune

Conclusions:

We have observed particular bright features in a dune field located in the equatorial crater. We have done morphometrical and morphological studies of bright features base of HiRISE images. The bright features show a similar range of shapes, dimensions and DN values, which indicate a same process of formation everywhere in the field. Terrestrial analogs are issue of the geochemical cementation. If as we propose, theses Martian bright features are formed as their terrestrial analogs -observed at WSNDM, this implies that small amount of water was stable at this equatorial location in the recent Martian time.

References: [1]: Gardin et al., 2008, *PWD*. [2]: Gardin et al., 2009, *LPSC XXXX*. [3]: Bourke et al., 2007, *Geomorphology*, 94. [4]: Fenton et al., 2003, *JGR*, 108. [5]: Tirsch, 2008. [6]: Williams, 2004, LPSC, XXXVII. [7]: Bourke, 2008, *Geomorphology*, 94. [8]: McKee, 1966, *Sedimentology*, 7. [9]: Barlow, 2000, *JGR*, 105. [10]: Balme, 2008, *Geomorphology*.

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