DUNE FIELDS ON MARS: MARKERS OF CLIMATIC CHANGES? E. Gardin[1], C. Quantin[1] and P. Allemand[1], [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: On Earth, the shapes of dunes are controlled by wind regime and sediment supply. The geometry of each dune of a dune field is generally similar and reflects the present wind conditions. On Mars, dune fields are not homogeneous as on Earth [1, 2, 3]. Several types of dunes can coexist in the same Martian area [4].

For some authors, dunes are current. In some example of [5], dunes fit well with present wind azimuths obtained by atmospheric Global Circulation Models (GCM). However, physical formation of Martian dunes develop by [3] show a turn-over time of a dune formation estimated at 100,000 years. If dunes are formed at this timescale, dune fields should have recorded last climatic variations. In such scenario, dune field should expose aeolian morphology overlaps.

The aim of this work is to describe five examples of dune fields which record several aeolian events.

Method: A global digital Martian dune database is available to the scientist community which contains informations on more than 550 dune fields stored in a Geographic Information System (GIS) [5]. From this database, we constructed individual GIS for each dune fields. For that, we have geo-processed all available high resolution images covering dune fields: MOC-NA images, THEMIS VIS images, and HIRISE images. That allows us to obtain image mosaics at optimal resolution for each dune fields until 25cm per pixel. The individual dune fields GIS are named by the ID Barlow's method [6]. The first number corresponds to longitude coordinates and the second to latitude coordinates of the field. In this abstract we present a selection of five dune fields.

Dune_field ID	0104-584	0126-545	0386-448	0326-500	0168-589
Lat (°S)	58.44	54.51	44.84	50.07	58.98
Lon (°E)	10.47	12.66	38.69	32.61	16.88
Dune types	B,Bd,T,L	B,Bd,T,L	B,Bd,T	B,Bd	B,Bd,T,L
Fields area (km^2)	30	1704	116	117	264
∅ of host crater (km)	68	134	no crater	103	70
chronology	yes	yes	no	no	yes

Table 1: Characteristics for each studied dune field. Their name employed the Barlow_ID method [6], Latitude and longitude are added. Dunes types found on dune fields are listed (B: Barchan dune, Bd: Barchanoïd form, T: transversal dunes, L: Longitudinal dune). Diameter of host crater provided and surface of fields are mentioned up to global GIS [5] measurements. Aeolian chronology or not is indicated.

Morphological Observations: The five dune fields are all located in the Southern hemisphere between 45° and 60° of latitude (Table 1). The surface of each field is from 30 and 1704 km^2 calculated by [5]. Four of them are localized in craters. Only one of them is located outside a crater.

0104-584: Three types of dunes can be observed in this field (Figure 1A). Barchans and transversal dunes, located in the eastern part of the field, reflect the existence of a unidirectional wind regime coming from the ESE. Longitudinal dunes, well-recognized by their symmetric geometries and frontal progress forms [1, 7], reflect the existence of a bidirectional wind regime from both SW and SSE directions. Some pre-existing barchans are clearly reshaped in longitudinal dunes.

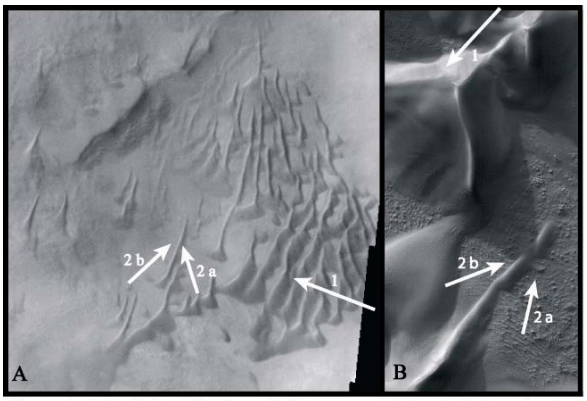

Figure 1: [A]: 0104-584 dune field shows a ESE wind direction in the eastern part of the field (arrow 1); and two contemporary aeolian directions:SW and SSE (respectively arrows: 2-a and 2-b) on a visible THEMIS image (V09849007). [B]: Russell Crater dune field (0126-545) shows a pre-existant barchan formed by a NE wind (arrow 1) and two comtemporary wind directions: SSE and WSW (respectively: arrows 2-a and 2-b) on a MOC image (E2100396).

0126-545: the dune field of Russell crater presents two types of dunes (Figure 1B): barchans formed by a NE wind direction and reshaped by both SSE and WSW wind to create longitudinal dunes. This observation of two aeolian regimes can be generalized to the whole dune field of the Russell crater. Material of pre-existent barchans seems to be recycled with the bidirectional aeolian regime. History of aeolian activities can be done on this field.

0386-448: presents barchanoïd forms and barchan dunes (Figure 2A). Their slipfaces show clearly two opposite azimuths implying two opposite wind directions: (i) a west origin on the western part and (ii) an east origin on the eastern part. Both directions are observed all over the field however there are no

evidence of coexistence of both aeolian orientations at dune scale. It is so challenging to determine a chronology.

0326-500: presents transversal and barchan dunes (Figure 2B1). Like the precedent dune field, barchans slipfaces show two opposite orientations. Some barchan structures like in Figure 2B2 have two coexisting slipfaces. Such geometries have no equivalent on Earth. Singular dunes recorded two wind directions. Our geomorphologic survey on this field didn't allow us to determine an event succession.

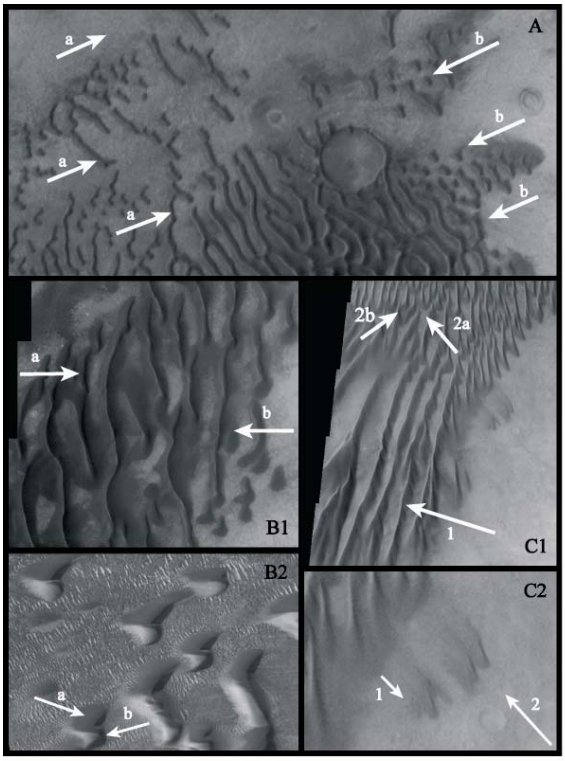

Figure 2:[A]: 0386-448 dune field presents two aeolian directions on the visible THEMIS image (V17598008). A first one from the WSW (arrow a) and a second one from the ENE (arrow b). No chronology is visible. [B1]: 0326-500 dune field has some evidence of two opposite aeolian directions: one from the west (arrows a) and one from the east (arrrows b) on the visible THEMIS image (V16475005). A zoom of the field is shown on the MOC image (E0300618) [B2]. It presents unusual barchan forms that seem to be created by two directions (a and b) of winds.[C1]: 0168-589 dune field shows that 3 wind directions occured on the field, on visible THEMIS image (V10011001) [C2]: Records of pluri-aeolian directions are shown on a zoom of visible THEMIS image (V10011001). A pre-existent barchan formed by a NW wind (arrow 1) and a second SE wind (arrow 2) re-uses the material to create dark streaks.

0168-589: presents a barchan dune created by a NW direction wind and dark streaks [8] formed by a SE wind, on Figure 2C2. Material of the pre-existent barchan is re-used to form dark streaks. Two consecutive winds have been acting on the dune. This field is the best example for dunes to be recorders of several aeolian events.

Discussion: The morphological observations presented in this paper reveal that dunes record different wind orientations. Theses variations are observed at different scales: (i) at dune-scale: pre-existent material is re-employed by two successive winds. (ii) At dune field-scale, two aeolian directions coexist but there are no chronological evidence at dune-scale. Only coexistence of aeolian directions at dune-scale allows us to propose a chronology.

The 0386-448 and 0326-500 dune fields present barchans created by two opposite wind azimuths. Taking into account the timescale dune formation, one wind direction might have succeeded to the other one. However, there are no evidence for dune overlaps. Thus a chronology can not be proposed.

0104-584, 0126-545 show evidence of a recycling of barchans by longitudinal dunes and allow us to foresee a chronology of wind directions. A first regime creates barchans with a NE wind and a second regime alternating both SSE and WSW winds forms longitudinal dunes. Thus longitudinal dunes are younger than barchans.

0168-589 show a barchan created by a NW wind direction which is reworked by dark streaks supporting a SE wind. Dark streaks refresh the barchan and thus are younger.

The third last dune fields show clearly evidence that dune fields recorded different consecutive wind regimes. However, it is challenging to correlate which climatic changes induced theses wind regime variations.

Conclusions: We conclude that some dune fields are formed by several aeolian regimes.

In some cases, when there is no overlapping between different kinds of dunes, it is impossible to establish a chronology. In other cases, aeolian chronology is possible and shows destabilization of the previous type of dunes, what indicates a variation of the wind azimuth over the last 100,000 years at least. Dunes are so pertinent markers of climatic change.

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