CURRENT GULLIES ACTIVITY: DRY AVALANCHES OBSERVED OVER SEASONAL FROST AS SEEN ON HIRISE IMAGES N. Mangold[1], D. Baratoux[2], F. Costard[1], and F. Forget[3]. [1]Lab. IDES-CNRS, bât. 509, CNRS and Université Paris-Sud, 91405 ORSAY, France, [2]OMP, Toulouse, France [3]LMD, Jussieu, Paris, France Contact: nicolas.mangold@u-psud.fr

Introduction: Recent gullies on Mars are observed on the wallslopes of the mid latitude regions with a preferential orientations on poleward facing slopes. They might sign the presence of fluid flows, likely involving liquid water, in a recent past, or even currently as shown by the recent gullies activity [1]. The high resolution images HiRise improve by ten times the MOC resolution allowing us to look in detail to the characteristics of these landforms. Here, we report the observation of streaks, formed over seasonal frost, that might sign a current activity of mass wasting inside gullies alcove. The streaks shapes appear as typical of granular flows, different from viscous or liquid flows involving liquid water. The role of CO_2 defrosting is likely important to trigger the observed mass wasting.

Observations: *Current activity from streaks over seasonal frost:* This study is based on the HiRise image number PSP1684_1410. This image was obtained at Ls=145° and it is located 38.9°S, 196E. The image shows some recent gullies that erode inside the wallslopes of a fresh impact crater. A close-up on the alcoves is possible thanks to the very good spatial resolution of the instrument (Fig. 1). Alcoves are mainly in shadows due to the late afternoon insolation, but the scattered light is sufficient to improve the contrast. Frost, visible by the very bright tone, is locally present on the image, especially inside the gullied alcoves and on the steepest part of the wallslopes. Some eolian ripples, visible from their partial frost cover are present on the hillslopes outside gullies alcove. Our key observation consists of the presence of new streaks formed over the frost blanket. These streaks are visible from their lower albedo in a strong contrast with the surrounding frost layers (arrows on figure 1 and figure 2). Streaks could be highlighted because of frost properties: Frost can be locally transparent inducing specific landforms. In our case, the albedo contrast is very strong, making unlikely that the frost is transparent only over the streaks, being opaque in the surrounding.

Defrosting at different rate can occur depending on the underlying material as it is visible for sand dunes on MOC images. In that case, the streaks would be visible from their difference of grain size or induration compared to the surrounding material. However, if streaks were visible from a difference of sublimation we would see streaks partially defrosted, with patches along the slope not defrosted. Yet we observe only streaks well defined from their begin to their end without any indications of a possible effect of differential sublimation with the surroundings.

In previous observations at MOC scale, we can observe that high latitude landforms are sometimes visible from the relative presence of frost due to difference of insolation angle as a frost trap or differential sublimation, as in the case of polygonal cracks. Differential sublimation effects exists on the studied image by highlighting the eolian ripples around alcoves. However, at the difference of ripples, the streaks inside alcove occurs in locations where the frost is still continuous whatever the local insolation angle. There is no indication that the streaks present a strong topography that could explain a relative frost sublimation here. If formed by a frost trap effect, we would expect variations of frost inside streaks depending on their position in the alcove.

In summary, these observations are much easier to explain if these streaks are superimposed on the frost, or removed the frost. This interpretation is important because it demonstrates that these streaks formed as recently as the frost cover, thus within the last two martian months before the image was taken.

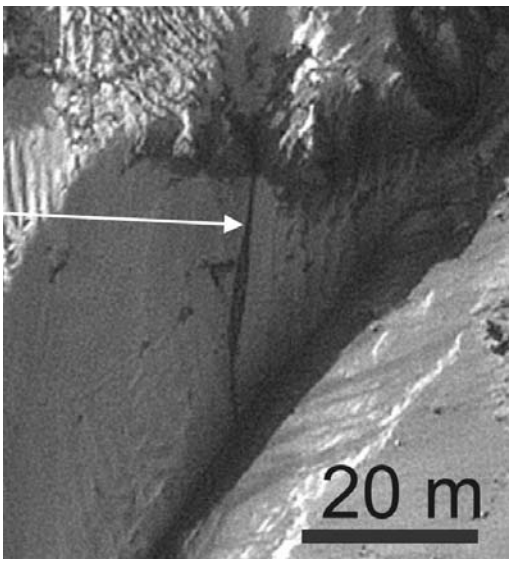

Fig. 1: Close-up on HiRise image PSP1684_1410. Dark streaks are observed over the frost blanket. Notice other streaks visible by a slight albedo difference are visible on the defrosted side of the gully, represent similar type of landforms less visible after the terrain is defrosted.

Shape of the streaks: Dry or wet flows?: The shape of these streaks can be analysed to evaluate the origin of these streaks from liquid, viscous or dry flows. The overall shape is typical of mass wasting activity due to gravity effects on steep slopes (>15°). They are typically 1-2 m large for a few tens of meters long. In general, the streaks are elongated and go straight downslope. They are often narrow close to the source area and sometimes become wider during the flow. Most of these characteristics are typical of small dry avalanches. Viscous flows involving liquid water mixed with rocks have usually larger size (5-20 m) and visible levees at this scale. Liquid flows are also different from what we observe. Streaks sometimes join together but they are not ramified as we would expect for fluvial processes. Thus, we favor a formation by dry avalanche for most flows present.

Fig. 2: Close-up on same HiRise image over other alcoves showing other streaks.

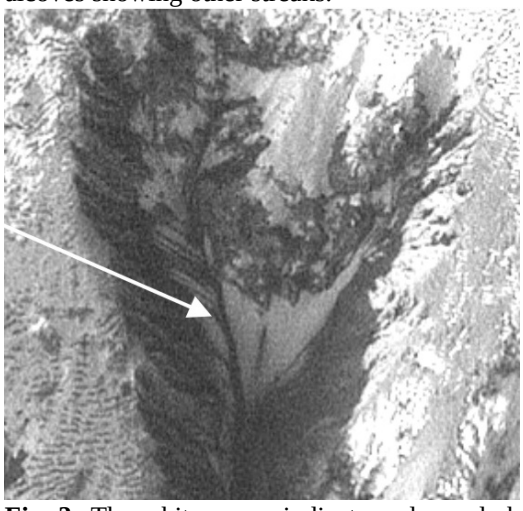

Fig. 3: The white arrow indicates a large dark strek with several smaller streaks branching on it.

Many source areas are observed in locations where the frost is still homogeneously present. Close to source areas, dark dots with surrounding gray aureola are observed inside the frost area (Fig. 2). These features are typical of defrosting areas as observed on MOC images taken at springtime: The sublimation of the frost begins at one point and then diffuses around this point. This observation suggests that the defrosting might help to create the initiation of the flow, which then is a consequence of the defrosting effects.

Discussion : Our study then questions if the overall gullies activity is related to this unique current process, or if another process involving liquid water is still required. Indeed, dry processes have been proposed to explain the formation of gullies [2], especially because the presence of levees, alcoves, debris fans are features that can form under pure dry sliding and not only after viscous flows involving a volatile. However, the newly formed streaks are very small, with about 1 meter large and a few tens of meters long, compared to the main channels observed with few tens of meters large and hundreds of meters long. The dry debris flows do not display any levees and they are restricted to the alcove: none of them seems to continue on the apron. Their seems to be more limited and of a different overall shape than the large channelized flows observed

In conclusion, the observed debris flows are likely small avalanches that are dry. They form currently as a consequence of the defrosting by destabilization of the debris aprons material. They contribute to the backward erosion of the gullies alcove and to the accumulation of large amount of debris that might help any further mass wasting process. We exclude liquid water as being responsible of the current gullies activity due to lack of adequate thermodynamic conditions. Nevertheless, liquid water is not excluded for a past activity that created the large channelled flows. The role of CO_2 and the possibility of CO_2 driven flows should be re-emphasized to better understand the relation between the triggering process and the flow itself to know if viscous flows can be generated by CO_2 vapor only as previously proposed [3]. These observations also reinforce the role of insolation and atmospheric conditions in the formation of gullies as mass wasting process rather than process related to subsurface activity.

References: [1] Malin et al., Science, 2006 [2] Treiman et al., JGR, 2003. [2] Schorghofer and Edgett, JGR, 2006 [3] Ishii, T. and S. Sasaki, LPSC abstract 1556, 2004.