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ANALOGY BETWEEN GULLIES ON MARS AND ON EARTH: WHAT SIMILARITIES? WHAT DIFFERENCES?

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Introduction and goal: Recent gullies on Mars are observed on the wallslopes of the mid-latitude regions. They may sign the presence of fluid flows, likely involving liquid water, in a recent past [1]. However, several authors have shown that dry flows might be an alternative to the formation of Martian gullies [e.g. 2]. By analogy with Earth, we show that two characteristics, levees and sinusosities, plead in favor of the involvment of liquid water, but we also identify specific patterns not recognized in terrestrial gullies.

Terrestrial-like characteristics: Levees are frequently present together Martian gullies independently of their location (dunes, crater wallslopes, isolated hillslopes) [1,3,4]. On Earth, when observed in association with debris flows, levees are characteristics of viscous flows involving a large solid fraction and liquid water in content <50%. Despite levees are not present for all gullies at HiRISE scale, many leveed channels have been identified on several images of gullies. The high resolution images HiRISE allow us to look in detail to levees characteristics and measure their size using photoclinometry, and retrieve physical properties. This is especially true for sinuous gullies. Indeed, granular flows can present changes of direction when the slope changes downward and, in some conditions of grains angular texture and diversity, they can show changes of directions [5]. However, they never show cyclic sinuous changes of direction resembling to meanders in simulations of granular flows or observations on Earth. On the other hand, sinuosities can be used to measure the velocity and viscosity of the debris flows. Calculations made on several HiRISE examples using photoclinometry show that values of about 100 to 1000 Pa.S are required to simulate the flow. These values are typical of debris flows involving around 20 to 40% of liquid water mixed in rocks.

Non-terrestrial-like characteristics: Gullies channels have locally terminal patterns different from terrestrial ones. They show small pits suggesting that some specific processes also concur at these locations, such as sublimation or infiltration of volatiles. In addition, many gullies hillslopes are submitted to CO_2 deposition in winter and their later sublimation in springtime. The role of these two processes is largely unknown and needs to be taken in account for a better understanding of gullies formation. However, processes involving CO2 flows or sublimation may not contradict the previous conclusion that sinuous flows require liquid water.

Conclusion: Most characteristics of gullies plead in favor of debris flows formed by a mixture of liquid water and solid rocks in proportion 20/80 to 50/50. HiRISE images continue to acquire images that will help to confirm this result and identify other processes unique to Mars surface.

Fig. 1: Close-up of HiRISE 3464_1380 showing a sinuous channel.

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