IDENTIFICATION OF A NEW OUTFLOW IN THE SYRTIS MAJOR REGION, MARS. N. Mangold[1], V. Ansan[1], D. Baratoux[2], P. Masson[1], G. Neukum[3], and the HRSC team. [1] IDES, CNRS and Université Paris 11, Orsay, France, mangold@geol.u-psud.fr [2] IAS, Université Paris 11, 91405 Orsay Cedex, France. [2] LDP, OMP-Toulouse, France, [3]FU, Berlin.

Introduction: Outflow channels on Mars are formed by very energetic floods suggesting catastrophic episodes of concentrated water flows [1]. These floods comes from a gigantic release of water such as in terrestrial glacial surge, but their exact origin is debated. Outflow channels of the Xanthe Terra region east of the Tharsis area are all of the Late Hesperian epoch and their source regions are formed by chaotic terrains of unknown origin. Most models suggest a formation by groundwater release either by aquifers, permafrost melting from increasing geothermal flux or magmatic activity, or eventually impact crater effect [1,2,3]. Nevertheless, outflows such as Mangala valles or the recently discovered Athabasca Valles have similar channels characteristics but a source area consisting of a single fracture likely due to tectonic-volcanic activity [4,5]. The identification of new area of similar floods is important to complete the different types of outflow formation and understand better the relationships with magmatic activity.

Observational evidence for floods: HRSC images of NE Syrtis Major provides high resolution (12 to 22 m/pixel) images of the lava plains. Close up shows surface features different than usual lava flows. The first feature consists of elongated striations (Fig. 2). The striations, or grooves, are oriented in the NS direction and present narrow width compared to their length of several kilometers. These grooves typical are of erosion into resistant bedrock. They may be created by glacier abrasion, wind erosion or water flows. Wind erosion forms features such as yardangs and is unlikely to explain grooves here. Indeed, many grooves are curved while yardangs are usually very straight. Glaciers abrasion forms grooves at different scales with other features associated such as drumlins and moraines. In contrast, a water flood could create grooves similar to those observed in outflow channels such as Kasei Valles. Such flood would not affect the Noachian hill if the flow is thin and slow (given the slope) and surrounds the hill. The second feature observed is a tear-dropped island (Fig. 2). This feature is very similar in shape to the islands observed in classical outflow channels such as Ares Valles [1]. These features are due to the erosion by energetic water flows stopped by an obstacle such as an impact crater. This forms a zone of non erosion, or at least of less erosion than in the middle of the flood, in the "shadow" behind the crater. This feature is thus a main argument in favor of liquid water flows over the smooth plains. The orientation of the island also gives a North to South direction of flow, which is consistent with the orientation of erosional grooves.

Southeast of the erosional grooves, we can observe the presence of a deep valley about 100 km long. At low resolution, this valley resembles to a lava tube as often seen over Martian lava flows. Nevertheless, close-up over this valley shows clear characteristics of fluvial valleys. The main valley is connected to a few tributaries and are also frequently sinuous. Both characteristics are consistent with water flows better than with lava tubes. Thus, the valleys might be due to a higher incision of the flow at this location while no incision occurred in the western part. This hypothesis is consistent with local slopes. At the beginning of the valley, there is a gentle step in the topography corresponding to the change of the slope from a North-South direction. The slope is here of 0.8° where the valley occurs, thus more than in the figure 2 area where it is lower than 0.1°. This may explain that the flood was not canalized in the flattest part of the plain, and that it is canalized after this step. East of the figure, the valley disappears progressively. Here the topography becomes more flat again, suggesting a widening of the flow without any valley at that place. Unfortunately, we miss data at the eastern end of the flood, thus making impossible the detection of possible terminal deposits.

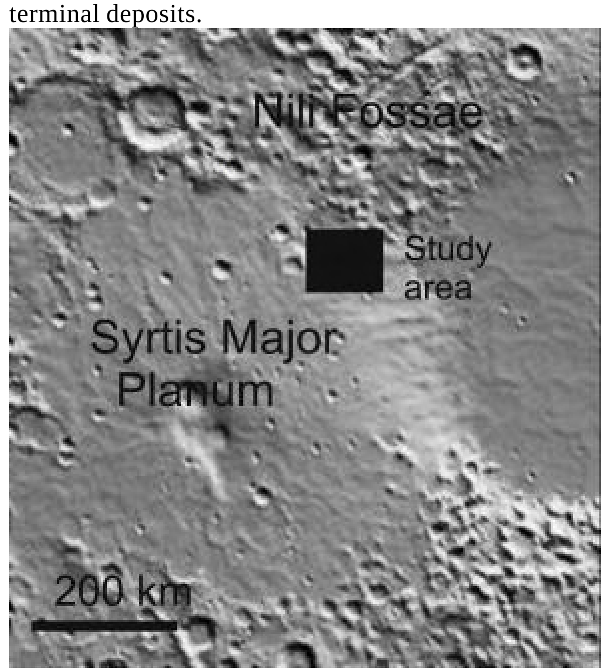

Fig. 1: Context map. Outflows are identified in the NE corner of Syrtis Major lava flows, close to Nili Fossae.

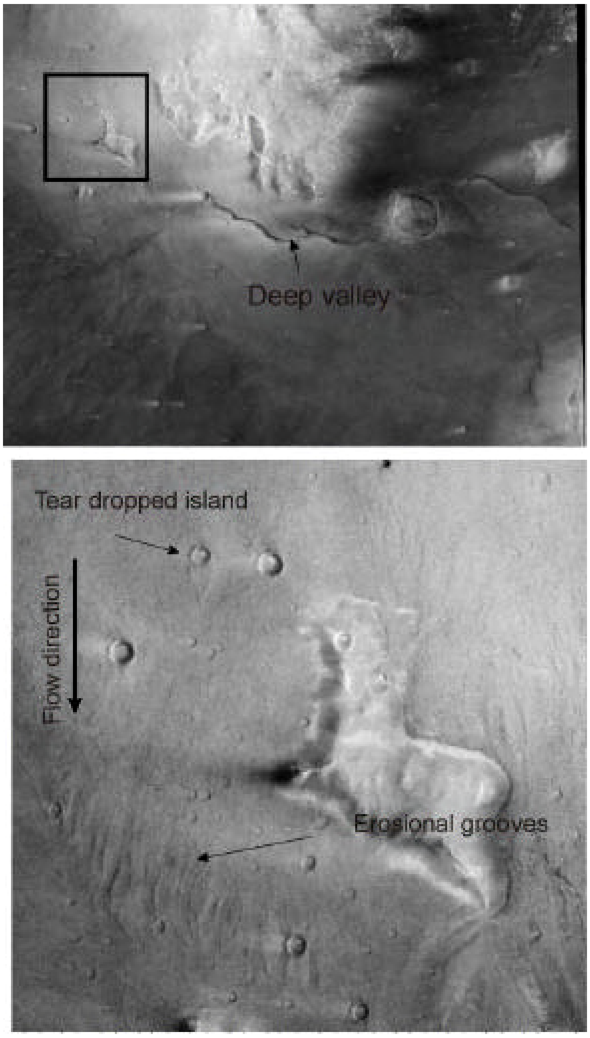

Fig. 2: (top) Syrtis lavas unit showing a deep valley with sinuous shape. Image 80 km wide. (bottom) Close-up showing erosional grooves and a tear-dropped island indicating erosion by north-south flows.

Flood discharge rate: These valleys are fluvial valleys incising inside the lava flows. They collected the water flows coming from the west. The main valley is about 50 meters deep for 500 m large. Because features such as grooves and the tear dropped island suggest flows typical of floods and not persistent flows, it is highly possible that this valley was formed quickly and corresponded more or less to a channel; i.e. water was filling the whole valley. Under this assumption, we can try to measure the channel discharge from the well known Manning relations. We use the relation modified for Mars by Komar [6]:

$$Q=A(g_m S R^{4/3}/g_e n^2)^{1/2}$$

where A is the flow cross-sectional area, g_m and g_e are gravity on Mars and Earth, S is the local slope of 0.8°, n is the Manning roughness coefficient and R is the hydraulic radius, defined as the ratio of flow cross-sectional area to wetted perimeter. Use of this equation to determine flow discharge has been used extensively for Martian outflow channels. A and R are calculated using the approximate depth of 50 m and width of 500 m of the channel that seems to collect most of the flood. Taking n=0.04 the result gives a value of Q=10.4 10^6 m^3/s. Taking extreme values of n of 0.01 and 0.07 would change the result by a factor of 5 approximately. The value of Q=10 10^6 m^3/s should thus be taken as a rough value giving the order of magnitude of the maximum discharge rate. This discharge rate is 100 to 1000 times lower than those calculated for the large outflow of Kasei or Ares Valles with values of 10^9 to 10^{10} m^3/s [6], but it is similar to the values found for late episodes of floods in Kasei Valles [7]. The calculated discharge rate is also on the order of calculated discharges associated with large terrestrial floods, such as the Lake Missoula Flood in the Scabland region with 20 10^6 m^3/s [8] or the Lake Bonneville Flood with 1 10^6 m^3/s [9].

Conclusion: We identified landforms typical of erosion by water or hyperconcentrated flows (water+rocks) usually observed in the case of outflow channels on Mars. The region of Syrtis Major is usually considered as very dry but Hiesinger and Head [10] suggested the possible interactions of volcanism with water in that region from the Isidis-Syrtis relationships. The source area and the process at the origin of the flow are not well identified yet and are currently under study.

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