MARTIAN GULLIES: MORPHOLOGIES AND POSSIBLE PROCESSES IN THEIR FORMATION. Y. Cedillo[1] , and R. A. Craddock [2], [1]Posgrado de Geografía, Facultad de Filosofía y Letras, Universidad Nacional Autonoma de Mexico. Circuito Interior. Ciudad Universitaria s/n. C.P 04510. D.F. Mexico . (yolandac@comunidad.unam.mx), [2]Smithsonian Institution. National Air and Space Museum. Room 3762. 6 th Street and Independence Avenue SW. Washington D.C. 20560-0315 (craddockb@si.edu) .

Introduction: Martian gullies are often morphologically similar to terrestrial gullies that were formed by liquid water. The gullies also appear young, and because the current environment on Mars does not support liquid water, explaining the origin of these features is complicated. Here we present evidence that the Martian gullies have a variety of morphologies, suggesting that a several processes may have been involved in their formation. In particular, analyses of HiRISE images indicate that at least some gullies were formed by dry mass wasting, although rapid sublimation of H_2O and CO_2 ice that may have been incorporated in the talus slope cannot be ruled out.

Malin and Edgett [1] first described Martian gullies as containing three distinct physical attributes, including an upper alcove, main channel, and a fan or cone of debris based on Mars Orbiter Camera (MOC) images. The paucity of craters and superposed relationships with other geologic materials and features, such as patterned ground or dunes, indicates that the gullies formed recently (Malin and Edgett [1], Hartmann [2].

The hypotheses that have been presented to explain the formation of Martian gullies basically fall into 2 categories: fluid flow (mainly water) and dry mass wasting.

Unfortunately, no single hypothesis adequately explains the formation of Martian gullies

Study area: We analyzed more than 200 images from the High Resolution Imaging Science Experiment (HiRISE) on board NASA's Mars Reconnaissance Orbiter (MRO) spacecraft. The Martian gullies included in our study were located in both the northern and southern hemispheres, at different latitudes both near the equator (ESP_14396_1415) and at the poles (PSP 010343_1750) to -68.8º (ESP 011 396_1115) and -72.1º (ESP_012873_1075), and a range of elevations (-4 km to 8 km). The gullies were found associated with a variety of features, including impact craters, mesas and isolated features such as central peaks, scarps, and dunes. From these analyses, we classified Martian gullies into three broad categories based on the type of feature where they are found:

Gullies on the interior slopes of impact craters
Gullies on isolated slopes (hills, plateaus)
Gullies on dunes

The gullies in our study exhibited a range of morphology and morphmetric characteristics, including variations in the length of the channel, the size of the alcoves, or lack of these.

Methodology. Using High Resolution Imaging Science Experiment (HiRise) images and data, we identified gullies with varied morphologic features.

10 images were selected. We measured the width of the alcoves and lengths of the channels in order to differentiate the diversity of morphologies and discuss the possible mechanisms involved in these morphologies as there are channels of different lengths and shapes very almost straight or sinuous. The forms show very elongated alcoves or very wide. And in some cases hardly exhibit alcoves.

Proposed mechanisms. Mechanism 1-*Fracturing mechanism of the inner slopes of impact craters.* Most gullies are located on slopes inside impact craters of different diameters (10, 20 km). These diameters correspond to geologically recent craters. Apparently these gullies may be relatively young. However it should be taken into account where the material is located on impact crater.

The gullies could be formed later in the fracturing caused by the impacting object to create the crater.

The large craters of diameters> 200 km or more, usually very old ones (on the stage of frequent impacts), but the gullies could be formed during later stages to the creation of craters.

Mechanism 2 - *The wind accumulates dried material.* Rock material by alternating temperature changes, daily and annual emerges from the top of the inner slopes and rocks forming slide grooves. In areas with rock formations, rock fragments due to extreme weathering. Are also produced dust accumulations which may be mixed with snow of H_2O and CO_2. In this case the sublimation of snow can cause destabilization of grain dust and sand material setting in motion a mechanism to occur suddenly. Perhaps it would be a momentary event by type of material involved, rock, debris, dust. The slippage of material would occur if the layer of material moves on solid material. In this scenario would produce the fall events, landslide and flows of material in various sequences.

Mechanism 3 - *wind dry fine material accumulates on dunes*. Another agent that could trigger the sliding movement of the material is the wind, primarily for gullies formed on the dunes. On Mars winds reach speeds of 200 km / h to produce material transport in

much of the surface. Aeolian erosion dig gullies through several stages, but will depend on the type of material accumulated on the slopes and the underlying layer. In rock layers the material will behave differently from the material accumulated in a layer of fine material and in areas of dunes. In this case the fine material would slide quickly, perhaps in a few short duration events.

Discussion: It is possible to observe sinuous channels that appear to have formed from liquid but in many cases these are on dunes and near-polar latitudes where it is even more difficult the existence of liquid water. Besides recent changes have been detected in some gullies on dunes, which also indicate that some exogenous process rather than endogenous role in the formation of these gullies.

Conclusions. We conclude that exogenous processes are involved in the recent formation of Martian gullies. We also considered feasible mechanisms here could explain the existence of gullies in diverse geologic settings and different latitude and altitude.

It is still necessary to undertake research to see if any recent changes in the gullies that were selected in this work.

References: [1] Malin, M.C. and Edgett, K.S. (2000). *Science*, ***288***, 2330-2335. [2] Hartmann KW, (2003) A traveler's guide to Mars Workman Publishing 468 pp.