Analog modelling for pit craters and its relation to extensional features on Mars. M. G. Spagnoulo, A. Pio Rossi[2],. [1]Laboratorio de Tectónica Andina. Facultad de Ciencias Exactas y Naturales. Ciudad Universitaria Pab. 2. (mauros@gl.fcen.uba.ar), [2]ISSI, Bern, CH. (arossi@issibern.ch)

Introduction:

Pit craters are conical collapse structures widely occurring on the surface of Mars. Main morphological differences with impact craters are the lack of the crater rim and impact ejecta [1,2].

Terrestrial counterparts for these structures are rather scarce. Recent studies associate these structures with dilatational fractures related to normal faults under tensional regimes and they would be related to the presence mechanical strong layers where a void is generated and unconsolidated material from above collapses [3,4]. Interestingly not all extensional features show these kinds of structures (Fig. 1). Following [5] in order to evaluate the hypothesis of pit crater formation we have performed analog modeling probing different arrays of internal layers, changing thickness and mechanical parameters. We consider those experiments could be useful to constrain Mars internal structure and subsurface mechanical parameters along different areas. Preliminary results show that pit craters in fact form in the presence of unconsolidated material over hard layers (e.g. possibly lava flows and piroclastic and/or non volcanic material in the case of Mars) but no faults are developed, so a mixed array should be tested in order to have both, grabens and associated pit craters. We also evaluated the depth of the structures to probe recently proposed rift models like Tempe Fossae, Tratcus Fossae and Thaumasia regions.

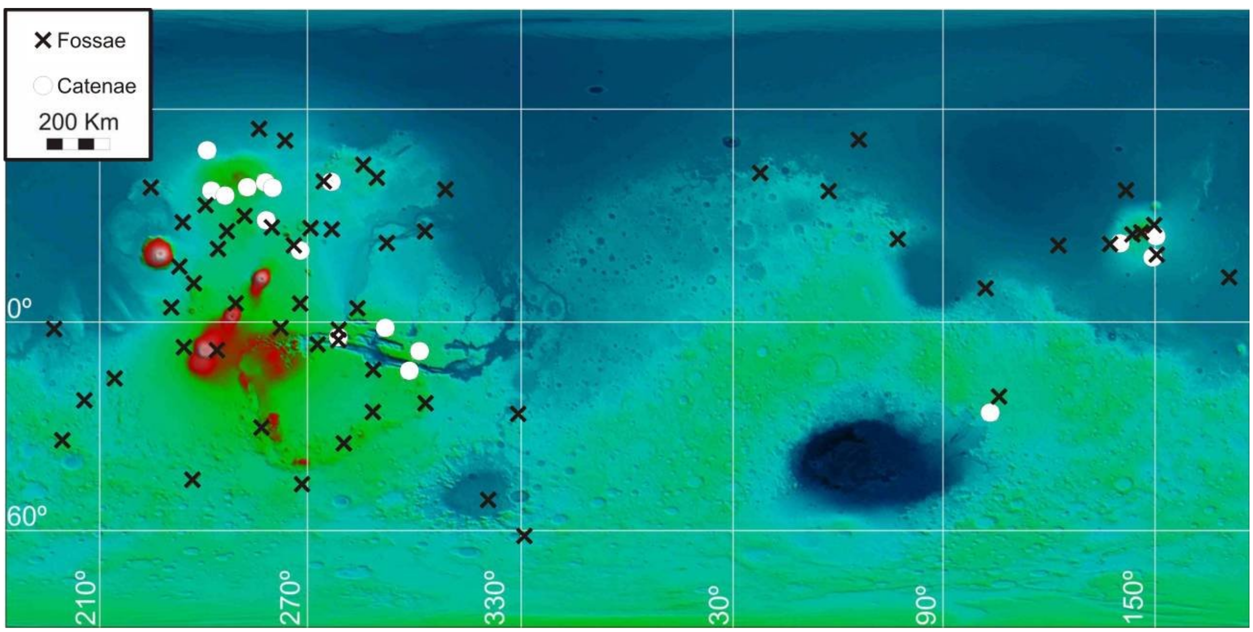

Figure 1. MOLA topographic map of Mars showing the association between pit crater chains and fossae regions. It can be seen that most of Catenae are associated with a fossae region while there are fossae regions that are not related to pit crater chains.

Analog modeling: For the modeling we used a step by step motor to stretch a latex which was covered with layer of sand (Fig 2). The stretching of the latex simulates an extensional process. We made two experiments in order to test different layers arrays and stretch velocities. The first one was made with a thick layer of wet sand, which was used to simulate a cohesive material below a thin layer of dry sand. In the second experiment we made two models in parallel, in order two be sure of being stretching at the same velocity and to have the same extension values for both. One of each was similar to the first experiment, while the other had a thin layer of wet sand and a thick layer of dry sand.

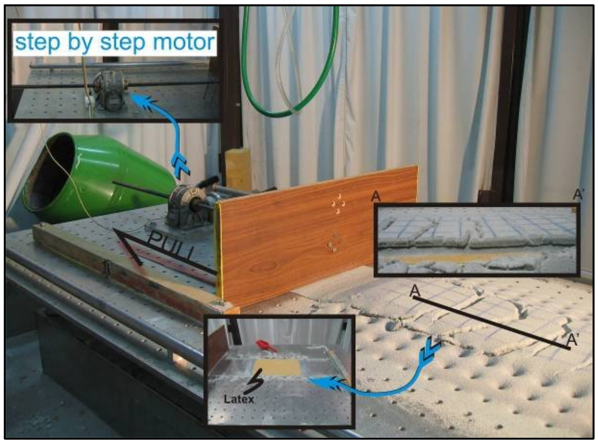

Figure 2.Example of the experimentshowing the layers of sand above the latex and the motor that pull it to simulate the extendion.

Results: Figure 3 shows the result of the second experiment, where two models were made in parallel. While faults were formed in both models, only one of them shows pit craters. Distinc pits were formed in the model with the presence of a the thick cohesive wet sand layer

Discussion: In previous analog modeling from [5] and [6] pit craters were formed under a same configuration of layers. A thin dry unconsolidated material above a cohesive material which instead of faulting, fracture apart. In resent papers [7] and [8], shows that many faults in basalt layers start growing as a fracture at surface and propagate downward until a critical depth were the structure continues as a fault. This fractures near the surface seems to be a necessary condition in order to generate a void for the collapse of unconsolidated material above. From previous works and the experiments performed we can conclude that:

a) Pit craters are form under special layer assemblages. This means that pit craters forms in heterogeneous layer arraignments, with interbedding of cohesive and unconsolidated layers.

b) Need for a thick cohesive layer. The cohesive layers below the unconsolidated material must have a critical thickness which has to be grater than the unconsolidated material that lays above.

c) Pit crater formation seems to be controlled by velocities of extension and the thickness of the cohesive layers Between experiment one and two the extension velocity changed. Therefore low velocities appear to favor pit crater formation.

d) Pit craters may be related to depth of the faults. As fractures and faults propagates downward they resolve as listric faults. Deeper structures would favor the formation of the space necessary to develop pit craters.

Future work: We plan to perform detail topographic maps of the model so that real extension will be compared with the extension measured by topographic displacement and measurements of pit crater cavity volume. Preliminary results shows that only in certain areas of Mars were thin layer of sediments deposited above cohesive strata like basalts in active fault zones, should form. The relation between rift mechanic and pit craters formation is more difficult to understand, but there seems to be a relation between extensional velocities and depth of the structures.

References: [1] Gibbons H.L. et al. (2001) LPS XXXII, #1154. [2] Mege, D. et al. (2000) LPS XXXI, #1854.[3] Wyrick D. et al. (2004) *JGR.*, 109 E06005 [4] Wyrick D. Y. et al. (2003) *LPS XXXIV*, #2025 [5] Wyrick, D.Y et al. (2004) GSA Today, 14, 10, 4-12. [6] Sims D.W.et al. (2003) *LPS XXXIV*, #2099. [7] Acocella V. et al.. (2003) J. Struct. Geol, 25, 503–513 [8] Holland M et al. (2006) E&PSL, 248, 301–315

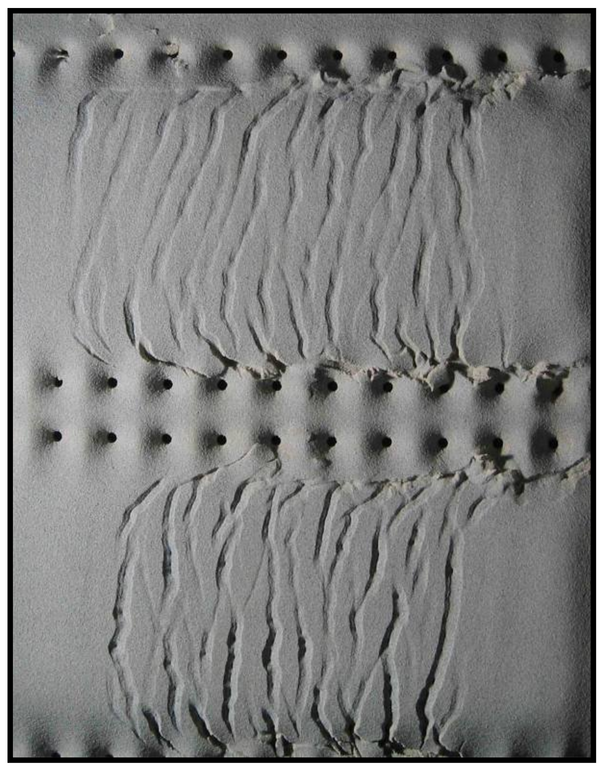

Figure 3. Parallel models showing diference in structures. While in the bottom model some pit craters formed they are absent in the top modell. It can also be seen that more faults are formed when no cohesive layer are present (top model)