AN EVALUATION OF MODELS FOR MARTIAN GULLY FORMATION USING REMOTE SENSING AND IN SITU MEASUREMENTS OF SVALBARD ANALOGS. E. Carlsson[1,2], H. Johansson[3], A. Johnsson[4], J. L. Heldmann[5], C. P. McKay[5], M. Olvmo[4], S. Fredriksson[2], H. T. Schmidt[3], [1]Swedish Institute of Space Physics, Box 812, SE-981 28 Kiruna, Sweden (ella@irf.se), [2]Luleå University of Technology, Department of Physics, SE-971 87 Luleå, Sweden, [3]Department of Physics, Stockholm University, AlbaNova University Center, SE-10691 Stockholm, Sweden, [4]Earth Science Centre, Göteborg University, Box 460, SE-405 30 Göteborg, Sweden, [5]Space Science Division, MS 245-3 NASA Ames Research Center, Moffett Field, CA 94035-1000, USA.

Introduction: The newly discovered gully systems on Mars [1] have been found on rather young geological surfaces such as dunes and polygons [2]. This in combination with the general absence of superimposed impact craters suggests that the gullies are relatively young geological features. Their morphology indicates that they have been eroded by a liquid fluid, most probably water. A recent discovery [3] suggests that gully formation is an ongoing process, which appears to occur even today. This is a paradox since water in current Martian atmospheric conditions cannot be found in a stable form on the surface due to the low pressure and temperature during normal conditions.

Several formation mechanisms have been proposed for the Martian gullies such as liquid carbon dioxide reservoirs [4], shallow liquid water aquifer [5], melting ground ice [6], dry landslide [7], snow melt [8] and deep liquid water aquifer [9]. However, none of these models can alone explain all the gullies discovered on Mars. So far Martian gullies have only been studied from high orbit via satellites.

Gullies found in Arctic climates on Earth could be an equitable analog for the Martian gullies and a comparative analysis could help disclose the formation mechanisms of the Martian gullies as well as their eroding agent.

Svalbard as a Martian Analog: Analog sites for Mars are scarce on Earth. However, in the Polar Regions, locales can be found that resemble the surface morphology and climate on Mars. Svalbard, which is situated 74°-81°N and 10°-35°E, in the discontinuous zone of permafrost, is a fairly good analog for comparative Martian studies. On a scouting mission performed in July 2006, gullies similar to those previously studied on Mars [10], were discovered by our team in the valley of Longyearbyen and on costal slopes of Isfjorden. Longyearbyen has a typical periglacial environment and the braided river system in the valley originates from meltwater from the two glaciers, Larsbreen and Longyearbreen. The valley consists mainly of sandstone, shales and shists of cretaceous and tertiary age [11]. The valley slopes are covered with gullies and debris, and is underlain by permafrost. The depth to the top of the permafrost is approximately 1 meter, but differs with annual temperature changes and lithology.

Gullies on Svalbard exhibit the same kind of characteristic features as Martian gullies (figure 1), such as alcove, channel and debris apron. The theatre-shaped alcove tapers down-slope where the V-shaped channel commences. The gullies on Svalbard have consolidated strata layers in the alcove regions, which have been detected also for some of the Martian alcoves. Moreover, the channels of the gullies on Svalbard tend to streamline around obstacles in the same way as some of the Martian gullies do.

Project Description: The purpose of this project is to improve the understanding of the formation mechanisms of Martian gullies and to investigate whether water is the eroding agent. The study consists of three phases. In the first phase, annual variations of the Svalbard gullies will be studied by deploying temperature, RH and moist loggers in strategic places in and around the gullies. This equipment was deployed in the summer of 2007 and will collect data for a year. As a second phase, satellite data over these gully locales on Svalbard will also be analyzed. This will be done with the help of imaging and thermal emission data of Earth, by using a similar methodology previously used in a study of Martian gullies [2][10]. The third phase will be carried out *in situ* on Svalbard in July 2008, where additional measurements will be made such as: length, width, depth, slope angle, angle of repose, direction, sun/shadow exposure, temperature, grain size, surrounding terrain survey, RH, depth to possible aquifer (radar), volumetric water content, water flow velocity, photography, depth to permafrost, permeability, stratigraphy and snow/ice occurrence. The results will be compared with previous results from Mars in order to better understand the Martian gullies.

Aknowledgements: This project is financed by the Swedish National Space Board.

References: [1] Malin, M.C. and Edgett K. S. (2000), *Science*, 288, 2330-2335. [2] Heldmann, J.L. and Mellon, M.T. (2004), *Icarus*, 168, 285-304. [3] Malin, M. et al., (2006), *Science*, 314, 1573-1577. [4] Musselwhite, D.S. et al., (2001), *Geophys. Res. Lett.*, 28, 1283-1285. [5] Mellon, M.T. and Phillips, R.J.

(2001), *J. Geophys. Res*., 106, 23165- 23179. [6] Costard, F. et al., (2002), *Science*, 295, 110-113. [7] Treiman, A.H. (2003), *J. Geophys. Res*., 108. [8] Christensen, P.R. (2003), *Nature*, 422, 45-48. [9] Gaidos, E.J. (2001), *Icarus*, 153, 218-223. [10] Heldmann, J.L. et al. (2007), *Icarus*, 188, 324-344. [11] Larsson, S. (1982), *Geografiska annaler series A-Physical Geography*, 64, 105-125.

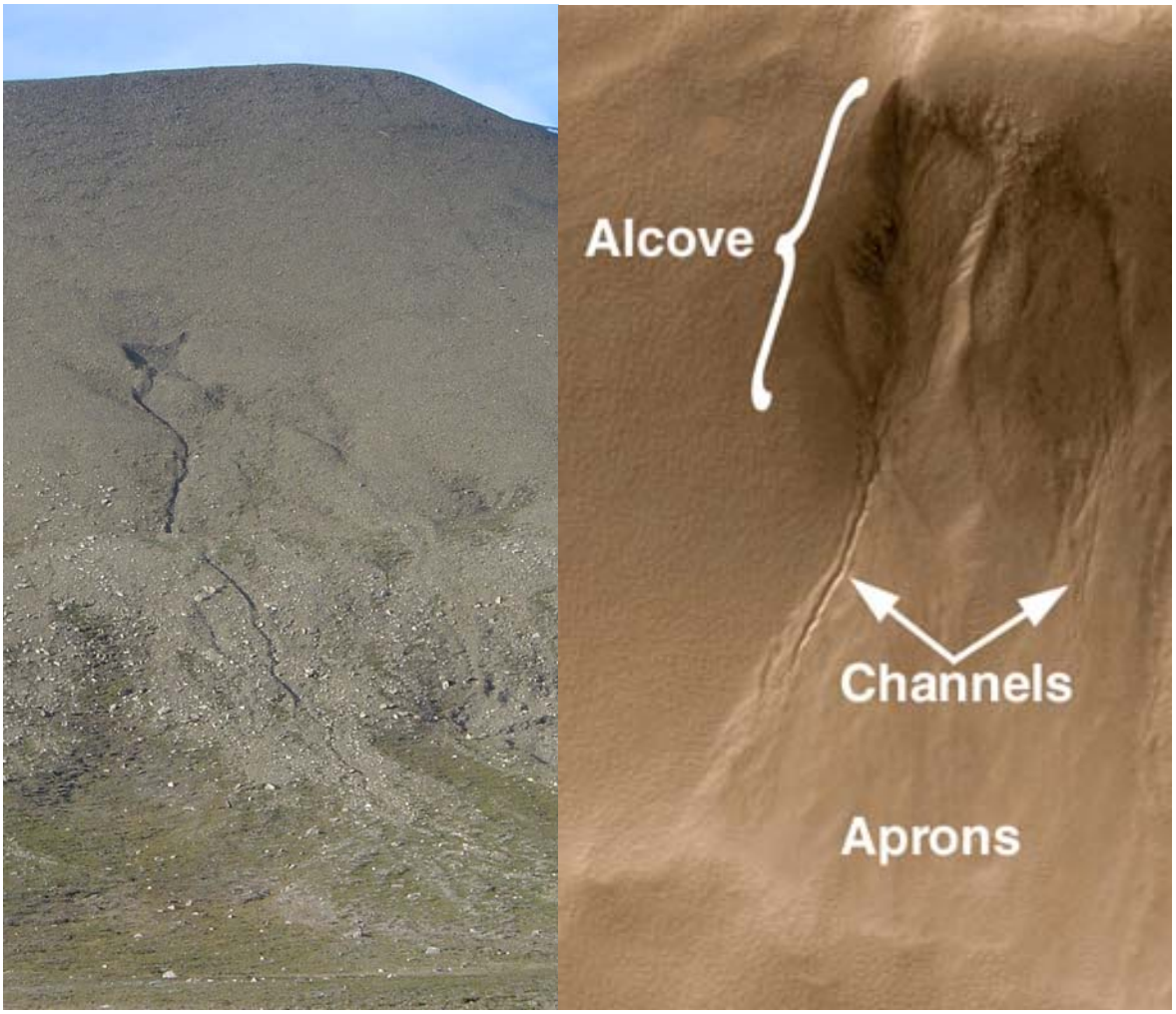

Figure 1: The left side of the figure shows a terrestrial gully on Svalbard (Adventfjorden) and the right side show a Martian gully. Left figure credit: NASA/MSSS.