WHAT DOES CONTROL THE THERMAL BEHAVIOUR OF THE PITS NEAR ARSIA MONS? T.Lopez[1], D.Baratoux[1], M. Rabinowicz[1],R.Antoine[1], F.Ayoub[1,3] and L. D'Uston[2] , [1]Laboratoire de Dynamique Terrestre et Planétaire, UMR 5562 ,CNRS, Observatoire Midi-Pyrénées, 14 av. Edouard Belin, 31 400 Toulouse, France. [2]CESR, UMR5187, CNRS, 9 av du Colonel Roche, 31400 Toulouse Cedex 4, France. [3]Californian Institute of Technolofy, Division of Geology and Planetary Sciences, Pasadena, CA, USA. lopez.teodolina@gmail.com

Introduction: Seven deep pits had been recently discovered North of Arsia Mons (7°S, 240°E) or near the volcano [1]. The THEMIS instrument onboard Mars Odyssey imaged these pits in the visible and infrared channels with the THEMIS-VIS and THEMIS-IR subsystem. We first report on the finding of 45 new pits in the South of Arsia Mons, near of the volcano from THEMIS and HRSC images. These all pits seems to be distributed according to a line NE – SW *(Fig. 1).* These pits can be detected from nighttime THEMIS images from their thermal signal. They are systematically warmer than the surrounding at night [1].

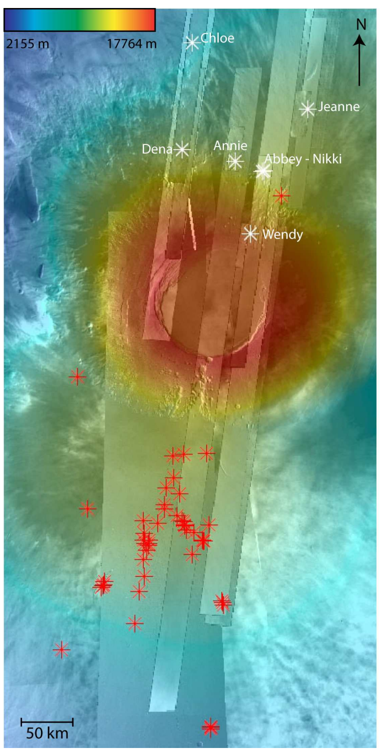

Figure 1*: Localisation of severals pits discovered near Arsia Mons (red cross) and the first seven pits discovered are labeled (white cross).*

We present a detailed thermal study of these pits to evaluate several hypotheses that could explain their thermal behavior. In particular, we propose that the heat detected at night results from the advection of the geothermal heat in a subsurface CO_2 circulation system in the porous media of the volcano flank. If true, these observations may constrain the present subsurface thermal heat flow of Mars.

Methodology: THEMIS visible (18 m/pix) and infrared images (100 m/pix) were used [2]. Localisation and morphological information are provided by high resolution images of various data set (THEMIS-VIS, MOC, HiRISE, HRSC). These images and the topographic information from MOLA have been integrated into a Geographic Information System (GIS) (*Fig. 1*). Diameters and depths were first documented. We improve the geometrical model developed by [3] for determining the pits' depth from shadows on HiRISE images. Infrared images have been processed with THMPROC and the brightness temperature has been retrieved from the band 9. In order to discuss pits temperatures, histogram of the brightness temperature of the pits and their surroundings have been achieved. These histograms were useful to delineate precisely the pixels affected by the hot surface in relation to the pits.

Observations: Diameters range from 160 to 300 m and depths range between 100 to 300 m.Graphics for each pits with the maximum temperature of each regions *(Fig. 2)* as a function of time were created. All pits are in average 9K warmer than the surroundings. We investigate the excess temperature in the pits in comparison with the surroundings as a function of the season. While the season has an influence for the pits temperature, the temperature difference between the pits and the surroundings is always observed.

Discussion : In summary, the pits are about 9K warmer during all the observation times by THEMIS. Which mechanisms could explain this phenomenon?

Topography. The first mechanism who can explain this behaviour is topography. Indeed, we now that these deep pits have a bottom and overhanging walls. With this geometry, the cooling of the surface within the pits is less efficient at night [4]. In order to evaluate this hypothesis, we also analysed the thermal signature of small impact craters of similar dimension. For each pits, an impact with appromatively the same diameter is selected. In this case, the temperature difference between the pixels associated to the impacts and the surroundings is quasi nonexistant. Even if the pits are about twice deeper than the corresponding impact of a similar diameter, we think that the topographic effect alone is not sufficient to explain the thermal observations.

In addition, we suspected that the dimensions of the hot regions exceed by several pixels in the THEMIS images the actual dimension of the entrance of the pits. In order to evaluate accurately this possibility, a forward thermal modeling taking into account sub-pixel temperature heterogeneities of 100 m/pixel THEMIS images has been achieved. This model addresses the effects of the temperature contrast at the rims of the pits (*Fig.3*)

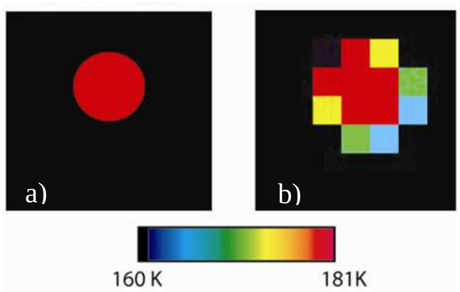

Figure 3 : *a) represents the pit with a grid at 1m/pixel, b) example of the same pit viewing with a grid at the THEMIS resolution. In the THEMIS image of this pit, 21 pixels are hot or with this model and for the same pit, we observe only 13 pixels hot.*

From this analysis, it appears that the immediate surroundings of the pits are also warm, which can not be explained by the cooling effect of sloped surfaces. In conclusion, we believe that an additional process is required to explain the observations.

Convection of fluids. We know, on Earth, that convection of air could explain the thermal patterns at some volcanic surfaces [5]. Following this example, we can suppose that the floor of Arsia Mons is composed of brecchias of basalts with a variable permeability.

First, we estimate the heat flow in excess at the exit of these pits. Considering an average temperature for the surroundings, the pits represent an excess of 440 kW (*Table 1)*.

Annie	12.82K	869 kW	29 km²
Chloe	6.58K	589 kW	20 km²
Dena	7.05K	233 kW	8 km²
Jeanne	10.66K	274 kW	9 km²
Nikki	12.33K	553 kW	18 km²
Wendy	5.53K	141 kW	5 km²

Table 1 *: Values of the heat flow in excess at the exit of the pits and the surface necessary to collect the heat The second column is the temperature difference*

The possible air convection would correspond to the advection of the geothermal heat in a region surrounding the cave, and released at the exit of the pit. The value given above is thus related to the geothermal heat flow of Mars and to the area affected by air convection. Assuming a heat flow of 30 mW/m2, and considering an 1-D model first, it is found that the advection occur over a reasonable distance of about 20 km of the cave. Characterizing the convection cells in the flank of Arsia Mons may thus help to constrain the geothermal heat flow of Mars. Hydrological models developped for the Earth [6] will be applied to the possible air circulation in the martian caves. We will also search for additional evidences in CRISM data from the presence of phases characteristic of the alteration associated with this air circulation.

References:[1] Cushing *et al.* (1997) *JGR, 90,* 1151–1154;[2] Fergason *et al*. (2006) *JGR, 111* ;[3] Wyrick *et al.* (2004) *JGR, 109* ;[4] Baratoux *et al.* (2005) *JGR, 110* ;[5] Antoine *et al.* (2008) *JVGR, in press* ;[6] Genthon *et al.* (1999) *JGR, 104,* 29275-29292.

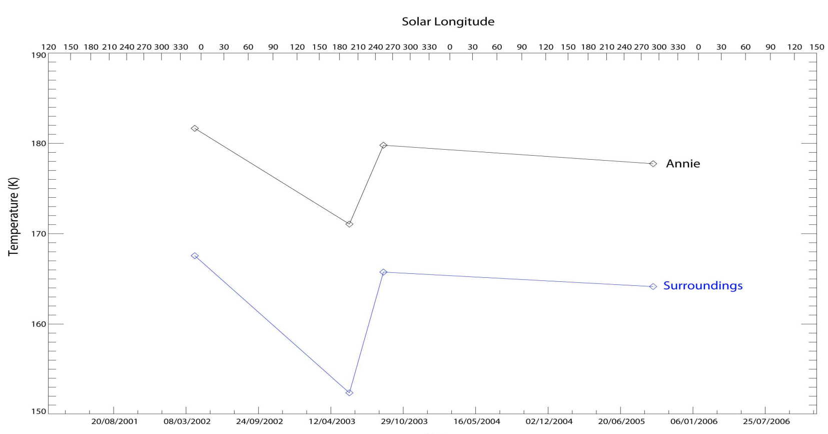

Figure 2*: Evolution of the brightness temperature versus acquisition date of the images. The upper abscissa represents the solar longitude. Curves represents the mean temperature of the hot pixels associated to Annie and the mean temperature of the surrounding.*