EPSC Abstracts,
Vol. 4, EPSC2009-742, 2009
European Planetary Science Congress,

The dirty ice flow and elastic deformations on Martian moons

Pedram Aftabi *

Introduction: Mars has two very small satellites called Phobos and Deimos(Hall 1887 reviewed in[7]) with 22.2 and 12.6 km across respectively[15]which surfaced by deposits[5]as a thick regolith or dust and with a significant interior ice or ice and rock mixture[8,4&6].

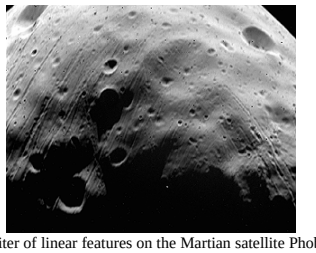

Fig1-Viking 1 Orbiter of linear features on the Martian satellite Phobos. The features are probably the result of impacts on Phobos surface. The North Pole is just off the top of the image to the left. The image is about 13 km from top to bottom. The Mars facing point on Phobos is just in the terminator at the lower left corner. (Viking Orbiter249A03-seewww.Nasa.Gov).

The Protype models: The mixture of the ice and rock in the deeper part and mixture with high amount of ice in the upper parts modeled by author in the experiments with different amount of water and sand in fridge. This type of experiments with the material same to proto type is novel and designed by author not only for the Martian moons but also for the Martian brines [In prep.].The water is special material with high conductivity which show deformations in very short time and produce similar structures but in small scales by temperature changes. In these experiments sand fragments cemented by ice and produced a sandstone with ice cement(Fig2 a to c).Very thin ice layer about 0.5 mm formed on top of free surface of the experiment box, but with increasing temp from -25 to 0 after 2 minutes a very thin cover of wet sand generated on top of the experiment. The soil (layer A in Fig1c)therefore generated only by water cycling in small scale model(5×5×3cm).The soil layer increased in thickness after 72 and 120 hours to B and c layers. The cover soil increased in thickness after every 24 hours in the small protype model (Fig2).The experiment suggest that the ice act as cement for the primary rock mixture but very rapidly after few hours in -23 degrees the cover soil formed by the evaporation of ice matrix to vapor just by change in the temperature of the fridge from -23 to less or more degrees. The ice matrix then evaporated very fast and the wet soil change to dry soils after few minutes.

Experiments by author showed that change in temperature results in the generation of rivers in the prototype modeling , but the rivers soon after decreasing temperature disappeared and the final morphological features are the dry rivers(in prep.).In nature the dry rivers are covered by dust or residual deposits.

Analogue modeling: The PDMS 36[10] suggested for modeling viscous materials like salt or ice [9, 1, 2&3].The author's other analogue models with using PDMS 36 and mixture of PDMS and sand for the simulation of ice and mixture of ice and rocks suggest that the density contrast between the PDMS layers with different amount of sand content generated different separated layers when the dense particles fall down and the less dense material like ice migrate to the top. After 336 hours the basal layer is the layer with very low amount of PDMS(less than 20%) and large amount of sand(<80%) but the top layer is a pure PDMS(ice).The scaling models suggest that the

Sand and PDMS mixture is good material for the simulations of the Ice and basalt articles in the Martian moons. The experiments showed that the ice and rock mixture flow but slowly in compare to pure ice(Fig2 d to I).However the ice rock mix sheets are surrounded by other sheets suggest forming of upright folds in the upper part of the suture fronts of viscous sheets(Figs 2 k,l ,5&6).

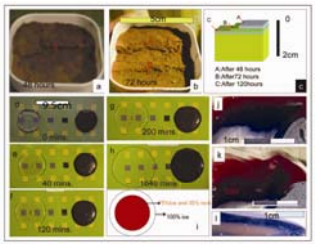

Fig2-a, b, c) the protype modeling for the ice and rock mixture. This type of experiments with the material same to proto type is novel and designed by author. The soil therefore generated only by water cycling in small scale model (5×5×3cm).The soil layer increased in thickness after 72 and 120 hours to B and c layers. **d,e,f,g,h,i)**Analogue modeling by author show the evolution of a spreading pure ice in the left and ice rock mixture (right). **J, k, l)** show the spreading of ice with a barrier in front. **l)** Spreading of ice and rock mixture which generated tank track folds in terminations.

The flow folds in ice: The modeling method by the PDMS 36 (Fig3)and field studies on viscous sheets(Fig4,5,6) on Earth(Iranian salt glaciers) and also photo geology of the Martian moons(subscribed by author) suggest that the flow folds change from top to lower part of the flowing sheet(Figs 5,6).The flowing ice and rock mixture sheets with different contents of ice cement beneath the thin skinned crust of the residual deposits formed overturned to upright folds similar to salt flowing sheets(Figs 4,5,6).The antiforms later upraised but the flowing lines of the water content covered more rapidly with advantage of the flowing crust in the through of antiform depressions(Figs2k,l5a).

*Geological Survey of Iran, PO Box 13185-1494, Ped_Aftabi@yahoo.com

EPSC Abstracts,
Vol. 4, EPSC2009-742, 2009
European Planetary Science Congress,

The folds may linked with the joint sets on phobos(Fig5e)and formed by elastic movements(Fig5). Experiments with PDMS 36 suggest that any channel in the flowing material can be hidden after a short time by the deep. Curtain folds developed in the source layer extrude from the viscous diapirs and are refolded by major recumbent folds with circumferential axes that simulate nappes in the uprising viscous materials [9].

Fig3-Strain markers in termination of separated ice sheets with caterpillar tank track folds (experiment by author).

The structure between salt and ice(and ice rock mixture) is very similar[2], because they are viscous material(Fig3).The author's experiments show that the PDMS with 50% sand flow as a viscous material similar to a PDMS sheet with no sand content but the rate is1/5 rate of that(Fig2). Means that the ice and rock mixtures flow in similar manner with the models and field studies (Figs,4, 5).

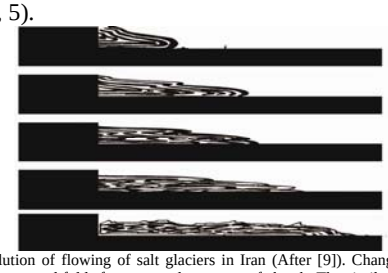

Fig4-Revolution of flowing of salt glaciers in Iran (After [9]). Changes in rate of spreading generated folds from top to lower part of sketch. The similarities between ice and salt suggest similar structures in ice tectonics.

The flowing sheets also flow in same manner and different rates as a conclusion of humidity changes. The measurements suggest that the rate of flow in the surface salt of the Mars planet(and any related moon) is much slower than Earth because of temperature fall[2].If the planet is cold and covered by deposits the channel very soon can be cover by the new deposits. The experiments with simple rectangular sheets of PDMS showed that the flow rate have a positive relationship with temperature [2, 3]. The daily measurements suggest that the high activity area and related faults are mainly affected by climatic changes [1].The new consideration of temperature in the analogue model sheets of viscous fluid by the author suggest that rate of flow not only is very less than the pure ice in the Martian moons, but also it is slow because of the low temperature in the Martian moons.

Discussion: The thermal conductivity in the Martian moons should penetrate in 1 km depth and not more. This suggest probably an ice and rock mixture layer on depth which not penetrated by the atmospheric changes and a more dense core in the Centers of moons which the think skinned deformations are similar on those on Earth. Both the physical analogue modeling and novel protype modeling suggest that the ice and ice rock mixture layers formed in the Martian moons which are the subject to the different rates of spreading of the different icy plates. The temperature is an important factor for this novel method (by author) both in the prototype models and for analogue models.

Conclusion: The structural analysis by photo geology investigated traces on the Martian moons(subscribed). The analogue and protype models confirm the finding and suggest that the linear structures on the pictures by NASA[7] probably are related to the flowing material in depth. The ice and water cycling may exist on the Martian moons(Phobos and Deimos) and the possible dirt ice is below the 1 km thick deposits. However the thermal conductivity may decrease the volume of ice, but the experiments and field studies in earth glaciers suggest that thin skin deformation is as a cap for the ice in depth because it is thickened by deformations with probable upright folds(Fig5,6).

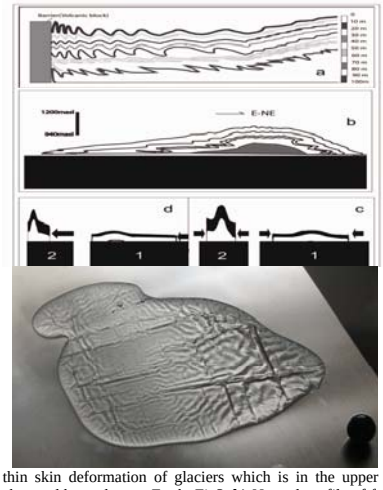

Fig5-a) The thin skin deformation of glaciers which is in the upper 30 m of the glaciers see observed by author on Earth. Fig3. **b)** Natural profile of folds in glacier on Earth consist thin skin folds and deeper folds. **c,d)**Mechanism of possible thin skin deformation on Martian moons.e)Upright folds formed in the plastic realistic modeling water which are mainly related to the elasticity of the lower sheet and the joints in the plastic sheet(ball in the right is two cm).

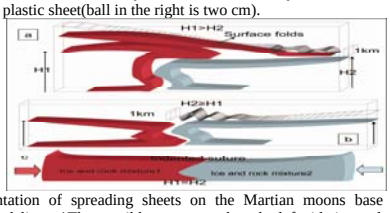

Fig6- indentation of spreading sheets on the Martian moons base on author's analogue modeling. **a)**The possible structure when the left side ice and rock mixture is higher than the right**. b,c**) when the heights of the two spreading sheets are similar. **c)**Show the indentation of the sheets. However the thin skin deformation of 1 km on top is possible like Earth's glaciers.

References:
[1]Aftabi,P., et al.,2005,Radar,Houston,Texas,LPI ,p.6012.
[2]Aftabi,P.,2006(1),Polar,Davos,Switzerland.LPI,No.1323,p.8059.[3]Aftabi,P.,2006(2),EGU,Vol.8, P.7962.[4]Avanesov G, et al.,1991,Planet Space Sci. 1991;39(1-2):281-95.[5]Clark, R. N. et al.,1986,UniversityofArizonaPress,p.437491.[6]Fujiwara, A.,1991,Icarus,vol.89,1991,p.384391.[7]http://WWW.NASA.Gov.[8]Smith, D. E.etal.,1995,Geophysical Research Letters, Volume 22, Issue 16, p. 2171-2174. [9]Talbot,C,J; Aftabi,P.,2004,Journal of the Geological Society, Volume 161, Number 2, 2004 , pp. 321-334(14).[10]Weijermars,R.,1986,Naturwissenschaften,73,33pp.