THE ROLE OF SUBSURFACE MELTING IN THE GLOBAL CLIMATE CYCLES ON MARS. A. Kereszturi (Department of Physical and Historical Geology, H-1117, Budapest, Pázmány sétány 1/C., Hungary, E-mail: krub@freemail.hu).

Introduction: The cryosphere of Mars is made up of ice and carbon dioxide plus rock fragments and pore gases. If we would like to find liquid water on Mars it is more probable to find it below than on the surface because the low atmospheric pressure and temperature. In this work we would like to outline a possible process for the subsurface melting of ices [1,2,3]. Aside from the possible existence of deep subsurface water layer, the pressure driven melting is a possibility to get water near to the surface under present conditions. Episodic melting can take part in the following processes: 1. climate changes by water vapour and carbondioxide release into the atmosphere, 2. water outbreaks to the surface and sculps outflow structures, 3. chaos formation by the changes in the consistency of matters, 4. surface movements and crustal deformation by changes in the consistency of matters too. We had analised the possible ice content based on the poposity values. In the model only the pressure driven melting of ice was taken to account aside from the temperature, and the model was made only for water ice and not clathates. Because under special circumstances the lithostatic pressure can forse to the pore ices, increasing the pressure inside the pores this can cause subsurface melting.

The model: *Compaction and liquefaction* Below the surface of Mars it is probable that except at some places the geothermal heat flow is low for the melting of water ice. In this model we analyse only the pressure environment. We can have enough pressure for the melting in that case when lithostatic pressure is forced to the ice filled pores. For this process we need 1. pore compaction which is possible with: easily compactible matter like pelite, psammite, conglomerates, bereccias 2. high overburden pressure. For more than one liquefaction event we have to 3. put ice into the pores repeatedly 4. take away the liquid water 5. make new pores and new ice content inside them.

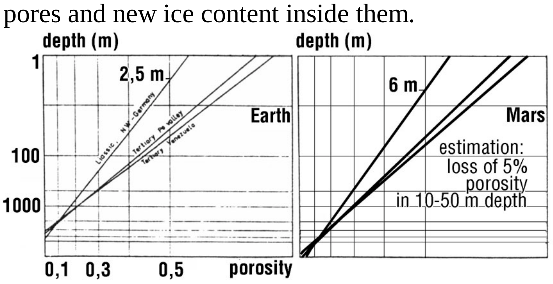

Fig. 1. Extrapolation of compaction curvers

Where are the best places? At the best places we have 1. periodic sediment accumulation, 2. easily compactible sediments, 3. periodic changes of the overburden pressure. All of this are present possibly below the polar caps, mostly below the northern polar cap.

Pressure driven compaction: From the Earth we know examples on the lithostattic pressure driven compaction of sediments. In the left part of Fig. 1. we can see example porosity vs. depth curves for pelitic sediment from the Earth. Taken into account the lower gravity and smaller lithostatic pressure on Mars, we can extarpolate the martian version of these compaction curves as it is visible on the right part of the Fig. 1. On Mars the same compaction happens around 40% of the depth on Earth.

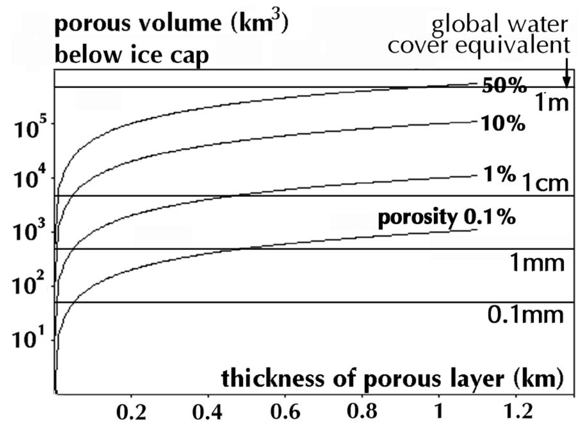

Fig. 2. Possible ice volumes below the ice cap

The mass of the stored ice and carbondioxide depends on the originally locked mass in the sediments, and the porosity. Taken various porosity values, we can assume the possible volatile mass inside the rocks. On the Fig. 2. we can see various porosity volumes according to the thickness of sediments below the northern ice cap for various porosity ratios. (The horizontal lines represent different globan water cover equivalents.)

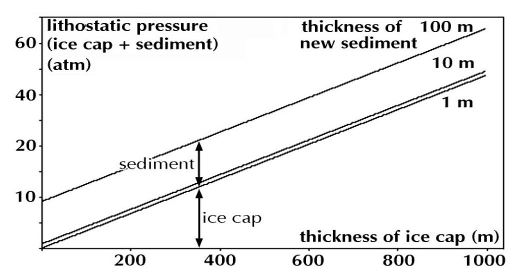

Fig. 3. Theoretical lito(cryo)static pressure values below the ice cap.

The pressure environment: In the case of the polar caps we can account on different pressure values accoring the density of the mixed matter polar caps. On Fig. 3. The pressure was estimated from the cap and the sediments as the cap would be made up of pure water ice with 1 g/cm^3 density and current area.

The process of compaction: We used the following circumstances for the compaction as it is visible on Fig. 4. We took easily compactible matter as pelite and psammite with porosity values observed on the Earth. Because of the uncertanties of the diagenic process on Mars we account only on mechanical compaction.

COMPACTION MODEL FOR MARS

- only mechanical compaction (chemistry unkonown)
- examples from Earth
- lower gravity on Mars
- possibly lower geothermal heat

Conservative estimations:

	Original porosity	porosity by depth 10 m	100 m	1000m	porosity under ice cap 10m	100m	1000m
pelite	55%	50%	45%	30%	53%	51%	45%
psammite	40%	39%	36%	32%	39.6%	38.4%	32.8%

Fig. 4. Parameters of the simplified compaction

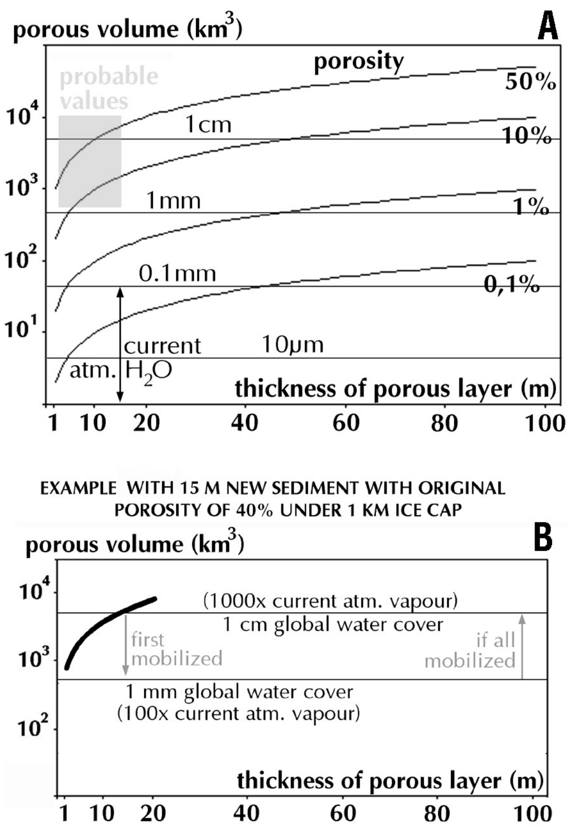

Fig. 5. Probable released water mass at various values (A) and at 15 m of new sediment with 40% of original porosity (B)

The melting: Melting takes place under enough overburden pressure which is able to compact the pores and because the compaction the lithostatic process forces onto the ices. Under optimal temperature melting occur and after great enough ice had melteed because of the instability in the sediment the water (and carbon-dioxide) breaks to the surface.

Conclusion: Based on the upper mentioned it is possible theoretically to construct a cycle with the following stops (Fig. 6.): 1. The temperature decreases and freezing occurs. 2. During the thickening of the polar cap and cryosphere (under optimal temperature) compaction driven melting takes place below the northern ice cap. 3. After a time water and carbon-dioxide break up through the unstable subsurface layers the climate become warmer. 4. Under the watmer climate because of the stronger weathering possibly new sediment layers form on the northern palins below liquid water. 5. Global cooling begins and the whole cycle starts again. The upper outlined cycle probably was not present on Mars as a dominant process but could take part in the global climate and surface evolution. As a possibly important process in the future we would like to improve our model to clathrate melting and to including the temperature factor into it.

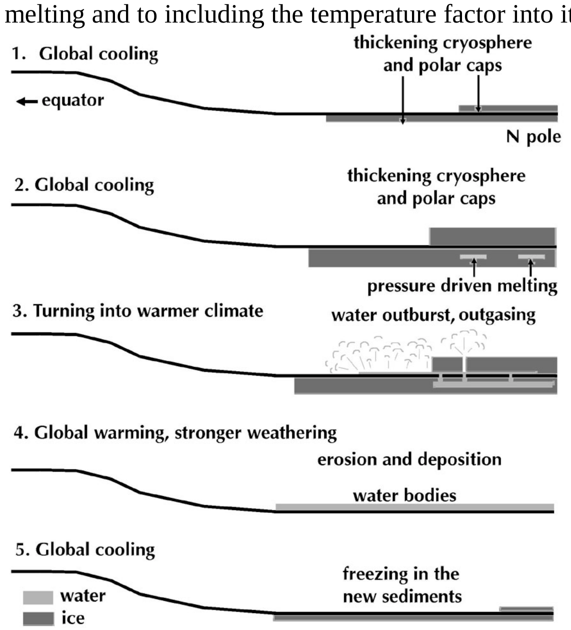

Fig. 6. Phases of the proposed cycle

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References: [1] T. Yokohata et al. (2002) LPSC 33th #1546, [2] L.S. Crumpler (2001) LPSC 32th #2007, [3] L. Csontos (1998) Sótektonika, Szerkezeti földtan, ELTE Eötvös Kiadó, Budapest.