CLIMATIC PLANETOMORPHOLOGY: HYPOTHETICAL SYNTHESIS FROM AVAILABLE DATA.

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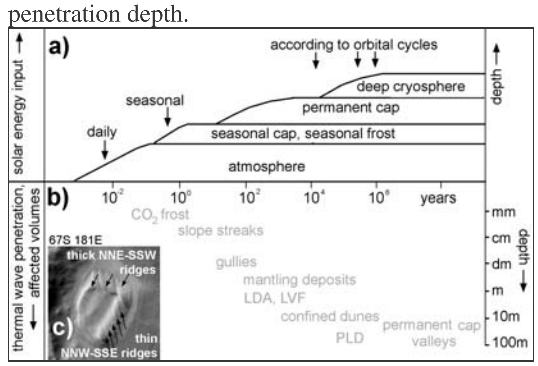
This work reviews related fields of Mars research, where analysis is going on by our group, to point to connections that may give better knowledge of the red planet. These methods are relatively new in planetary, but not in Earth sciences [1]. They can be applied to Mars, where surface structures are strongly connected to climate, partly because surface conditions are close to the phase transitions of both important volatiles.

The possible ***methods*** in climatic planetomorphology (or climatic planetary geomorphology) for Mars have already been used in Earth sciences in climatic geomorphology. Several authors have already published articles on connections between orbital elements forced climate changes and surface structures [2,3,4] on Mars. Based on models [5,6,7,8] quasi-periodic climate changes take place on Mars, during these periods variously sized and located volatiles could have been released, accumulated and produced surface changes. This approach may help in climate reconstruction, and to understand what are possible planetary evolutionary tracks like.

Theoretical steps could be: 1. identify climate related surface structures, 2. estimate their morphometric properties, frozen volatiles cementing them, 3. analyze models of climate change induced thermal wave penetration into subsurface, 6. estimate mobilized volume of volatiles/regolith, and possible loss/accumulation with various transport processes (mechanical, sublimation etc.). The available datasets completed with climate models can be used for this and could give us suggestions for future research. The results of changes (location, rate, length of higher/lower insolation, and cumulative energy input) are not to impossible but hard to estimate, because the zone of changes could migrate both meridionally and vertically. For example based on models [9] during high obliquity 0 °C isotherm may allow shallow subsurface melting in Polar Regions, but we still lack clear image of the changes.

Some ***connections*** in climatic planetomorphology are visible in the Figure: a) various time-scaled climatic effects (horizontal), cumulative energy input (vertical), affected spheres of volatiles; b) various structures and thermal wave penetration depth.



In subset c) the dunes of Suess crater are visible as ***example*** for climatic planetomorphologycal analysis: three units with different sizes (whole complex, thick NNE-SSW ridges, thin NNW-SSE ridges) were formed probably under different conditions. The following estimations may help reconstruct them: total dune volume → cementing ice volume + periods with suitable conditions (GCM) → different thermal wave penetration + transport rates → differently sized dunes. In the table other important fields are indicated that can be also useful in climatic planetomorphology.

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Table*: some structures that could be used as climatic planetomorphological indicators*

name	composition	location	volume (km^3)	possible preferred environmental conditions for formation	signs of potential cyclicity in formation
ILD (Valles Marineris)	sulphates, ferric oxides, dust [10]	Valles Marineris	10^2-10^4	volcanic ash falls, deposition from water during wet period	layering and compositional differences
PLD	ice + dust, only dust	high latitude	10^6 [11]	enhanced ice-dust circulation/deposition	layering
LDA [13]	rock + interstitial ice [12]	various latitudes	10^2-10^6	enhanced creep of ice-rock mixture [14]	terraces, slope angle changes
LVF	rock + interstitial ice [15]	various latitudes	10^2-10^6	enhanced creep of ice-rock mixture	spatial density, morphology
H_2O-rich mantling deposits	dust + ice [16]	30-60° latitude	10^5	enhanced H_2O and dust transport, deposition during recent Martian ice ages	latitude, thickness variation, degradational structures
polygonal ground	ice + regolith	above 55° latitude	10^5-10^6	temperature changes, phase transition point	different sizes of polygons
dunes [17]	basaltic grains + cement	N: circumpolar, S: intracrater	10^4-10^5	uncemented periods: movement, cementation periods: accumulation	dune and ripple size distribution
channels/valleys	eroded volumes + sediments	mostly southern hemisphere	10^4-10^5	water drainage during warm climate and/or enhanced ice melting	size distribution, eroded volumes + network structure
gullies [18]	Eroded/accumulated debris, buried ice	medium and high latitude	10^1-10^3	accumulation/insolation+melting/ pressure driven water outbreak	differently sized, situated and volumed groups gullies
slope streaks	dust, mobilized by avalanches	low latitude	10^1	seasonal deposition, and erosion probably by mechanical instability	stratigraphy of differently sized overlapping streaks