CONVERGENCE IN PLANETARY SURFACE MORPHOLOGY – SAME FEATURES AND FORCES PRODUCED ON VARIOUS OBJECTS OF DIFFERENT MATERIALS. A. Kereszturi[1] ([1]Research Centre for Astronomy and Earth Sciences, e-mail: kereszturi.akos@csfk.mta.hu.

Introduction: Some basic aspects of a general "rule" in planetary surface morphology [1,2,3] is outlined here that we call "convergence" for such processes, which act at different bodies, and produce similar landforms occasionally of different materials. The phenomenon is partly similar to how convergence is used in biology: for the phenomenon during the evolution when different species could converge toward the same morphology, and resemble appearance.

Methods: We collected the morphological and morphometrical data of many published surface landforms during the last 5 years, used for the compilarion of an encyclopaedia on planetary surface features [4]. With already published data, altogether 600 items/landforms were analyzed (observable by their topographical, morphological, compositional, albedo etc. characteristics), to describe usually different landforms – although up to about 10 % of them describe possibly the same landform type, but our current knowledge is not enough to firmly unify them into one class.

Problem area: Working with various groups of landforms, their classification is important and difficult task. Altough morphometry has been used for several decades to characterize and classify them, the classification is still problematic because several numerical values should be considered for every landform. Beside this problem of multi-dimensional qanalysis, the local/regional context also influences the classification. A widely used approach is the comparison to Earth analogues [5,6] as on the Earth several classes are relatively well established. In comparative planetology a basic assumption is that the same processes produces similar morphology landforms, regardless of the given planetary body or what type of materials was involved. Thus terrestrial morphological analogs are helpful in the research of extraterrestrial landforms [4]. Surveying various planetary bodies for selected landforms, a matrix shaped summary can be seen in Table 1 to indicate their occurrence according to different bodies.

Results and approaches: It is well known that the same forces might produce similar appearance surface structures even from different material. Using the example of magmatic (rising plastic/liquid body) and volcanic (surface effusion/eruption) process could produce similar looking morphological features on different bodies, including channels, lava tubes, cones, shields, flow branches and plains. These processes could produce convergence using different materials: the morphology of the produced landform might converge toward the same morphology.

planetary surface feature type (only rough, unifficial morphological classes)	Mercury	Venus	Earth	Mars	Moon	Io	Europa	Ganymedes	Callisto	Enceladus	Titan	Triton	Pluto
volcanic cone	■	■	■	■	■	■					■ ?		
elongad volcanic fissures		■	■	■	■	■	?	■		■			
"lava" plains (flow produced smooth area)	■	■	■	■	■	■	■	■			■	■	■
lava conduit (collas, subsurface liquid flow)		■	■	■	■	■							
debris slopes from mass movements	■	■	■	■	■	■	■	■	■	■	■ ?	■	■
collapsed pits by volatile release	■ ?		■	■								■ ?	■ ?
dunes (accummulated particles)		■	■	■							■		
yardangs, wind erosional scours		■	■	■							■ ?		
fluid erosional channels	■	■	■	■		■					■		
plastic flow produced erosional channels			■	?	■								
banks of standing liquid bodies		■	■	■	■						■		
patterned ground (by volatile changes)			■	■									

Table 1. Ocurrence of different surface structure classes (1. row) on different planetary bodies (other rows at right), where "?" marks the uncertain cases.

We separated two types of converngence: strong and weak form. *Weak convergence* is for similar surface structures on different bodies but of the same material (for example liquid water flow produced channels on Mars and Earth), while *strong convergence* is for the same structure types of different materials on different planetary bodies (for example liquid water or lava produced channels on the Moon, Mercury, Venus, Earth, Mars, Io). Some examples can be seen in Figure 1. for various types and phase materials, while Figure 2. shows examples for cathastrophic flow features produced surface structures on different planetary bodies.

phase / composition	solid	liquid	gas phase
silicates	lava plains and cones (Me, Ve, Ea, Mo, Ma)	lava flow, channel, lava pond, lake (Io)	volcanic ejection, dark patchy deposits (Moon)
sulfur	volcanic cones (Io)	lava flow, channels, plains (Io)	eruption, ejecta, backfall rings (Io)
H_2O	glaciers (Ea, Ma), cryovolcanic plains (Eu, Ti, En, Tr)	liquid water flow (Ea, Ma)	vapour jets, areas of fallen grains (Eu, En)
CH_4		liquid CH flow (Ti)	

decreasing temperature ↓

Figure 1. Example groups of surface structures/features for "strong" convergence: similar processes produce resemble surface structures of different materials on different bodieds (in brackets with the first two characters of the given name)

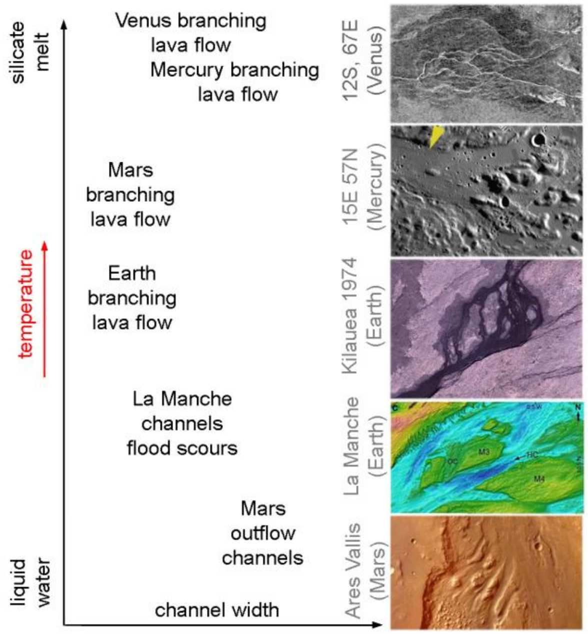

Figure 2. Comparison of cathastrophic flow features produced landforms on Mecury, Earth, Mars and Venus. (NASA, JPL, University of Cambridge, Google Earth).

In theory small difference in the formation conditions might also produce divergence, the small starting differences results significantly different landforms. The connections between the formation conditions and materials are indicated in Figure 3. with a schematic diagram.

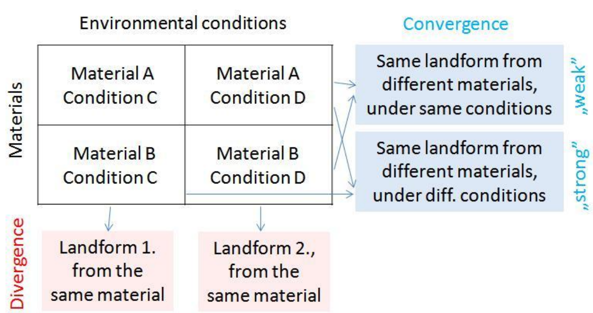

Figure 3. Schematic representation of the divergence and convergence together with the formation conditions and starting materials as context.

It is also worth mentioning that morphological similarity does not necessarily mean similar formation agents. For example small holes of non-impact origin could be produced by collapse into previously existing voids (like skylight holes of lava tubes), collapse by subsurface volatile release (cryokarst), eruption by subsurface stored volatile release, or eruption by deep rooted volcanic bodies.

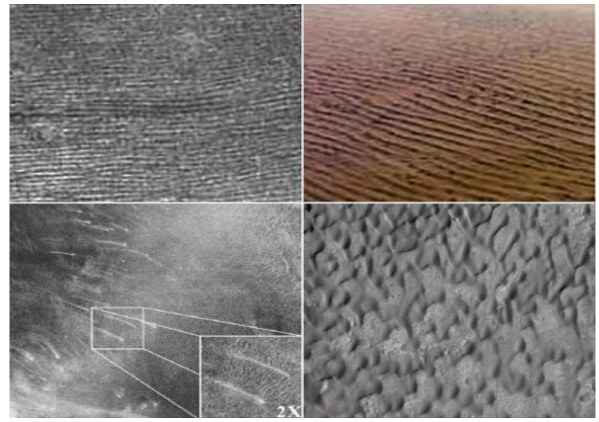

Figure 2. Examples for he same surface structure type (dunes) on Titan (top left), Earth (top right), Venus (bottom left) and Mars (bottom right) (NASA, JPL)

Future outlook: Improved understanding in the identification of convergent surface features might help the identification of certain surface modification processes. Currently there are several structures especially on Mars, related to deposition and sublimation of surface ice and dust, which are probably the result of almost the same processes, and the morphological differences are small, produced also by small differences between the certain locations. Understanding convergence and divergence beyond provides insight into the realization of physical and geological processes, also improve any paleo-environmental reconstruction.

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