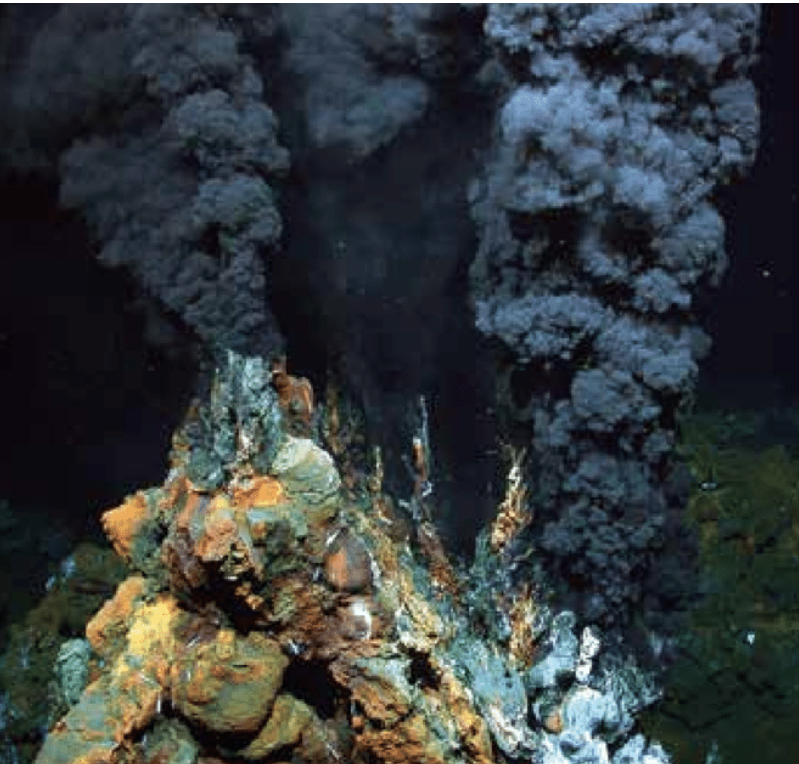
A photograph of a clear glass filled with water, sitting on a Mars bar wrapper. The wrapper is black with the word 'Mars' in large, red, stylized letters. The background is dark and out of focus. A semi-transparent white circle is overlaid on the right side of the image, containing text.

GEO 325M/398M
Spring 2021

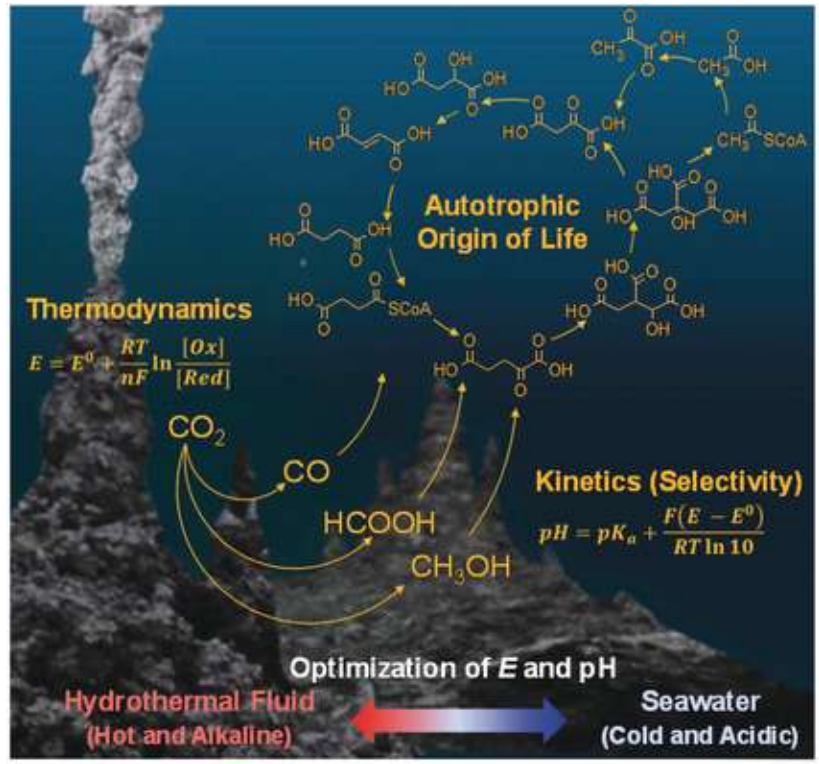
**Class project: Effect of Giant impacts
on Mars groundwater**

Origin of life at deep sea hydrothermal vents

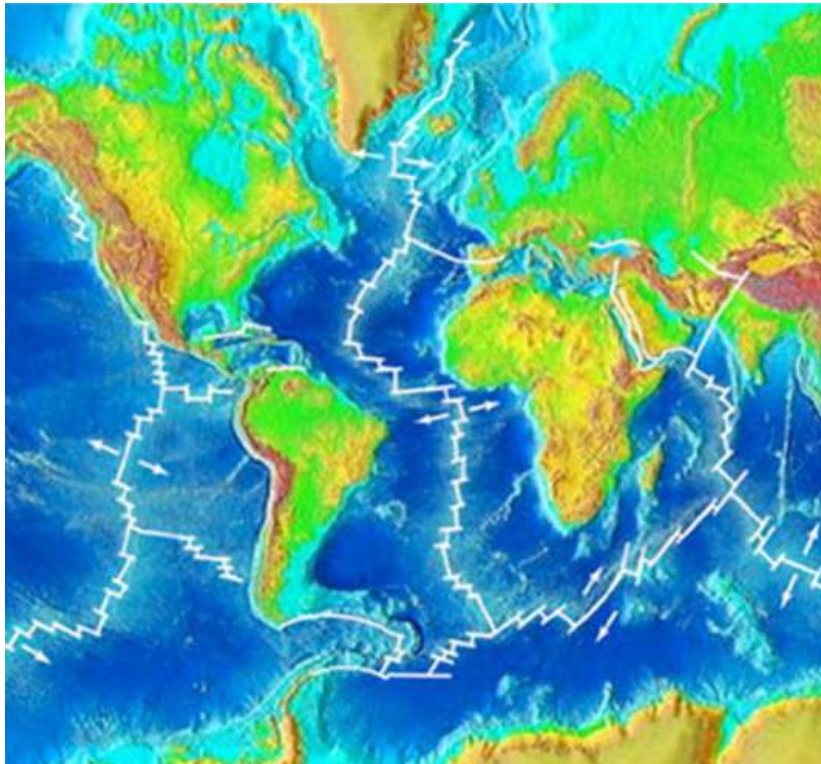
Deep sea vents (black smokers)



Chemical gradients ⇒ energy



Linked to plate tectonics



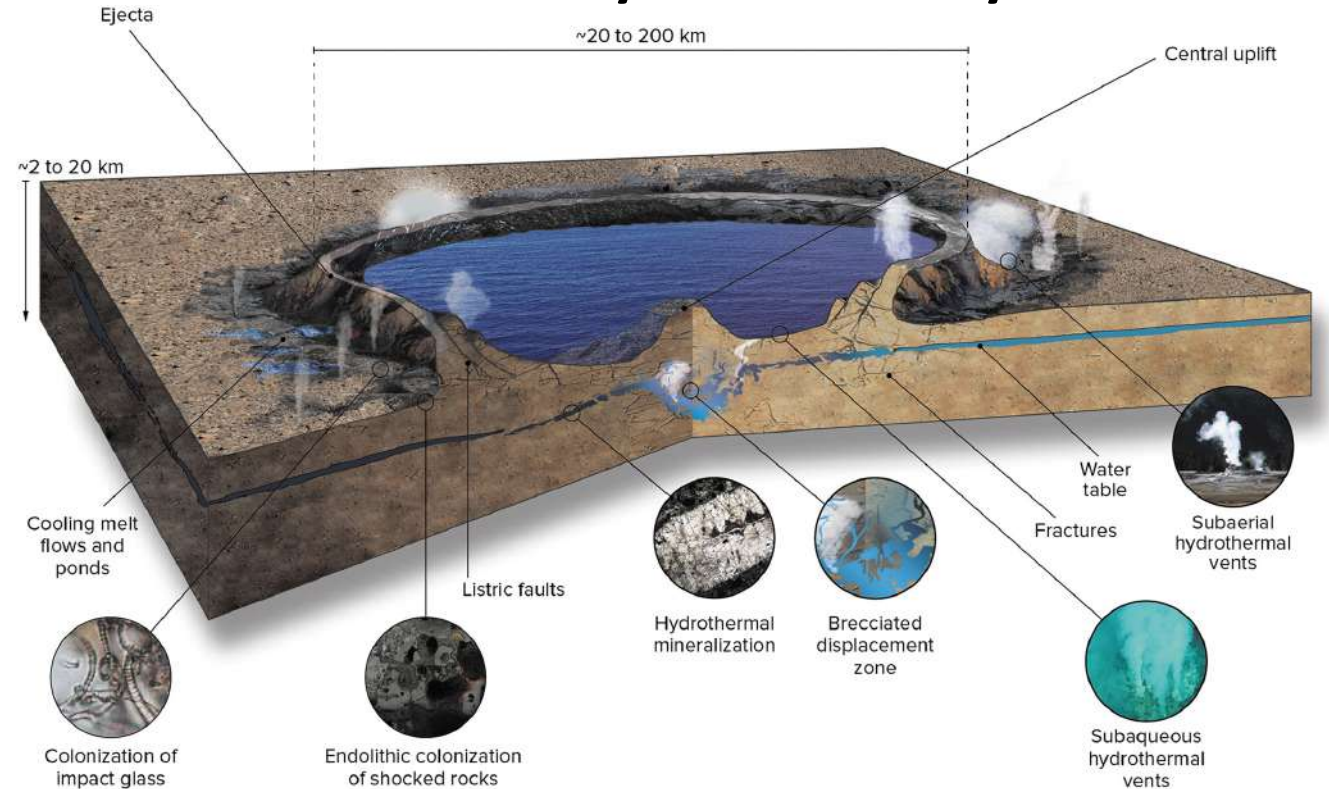
If this was the way life got started, then it would be limited to bodies with plate tectonics.

Impact induced hydrothermal systems

Chicxulub crater \Rightarrow fills with water

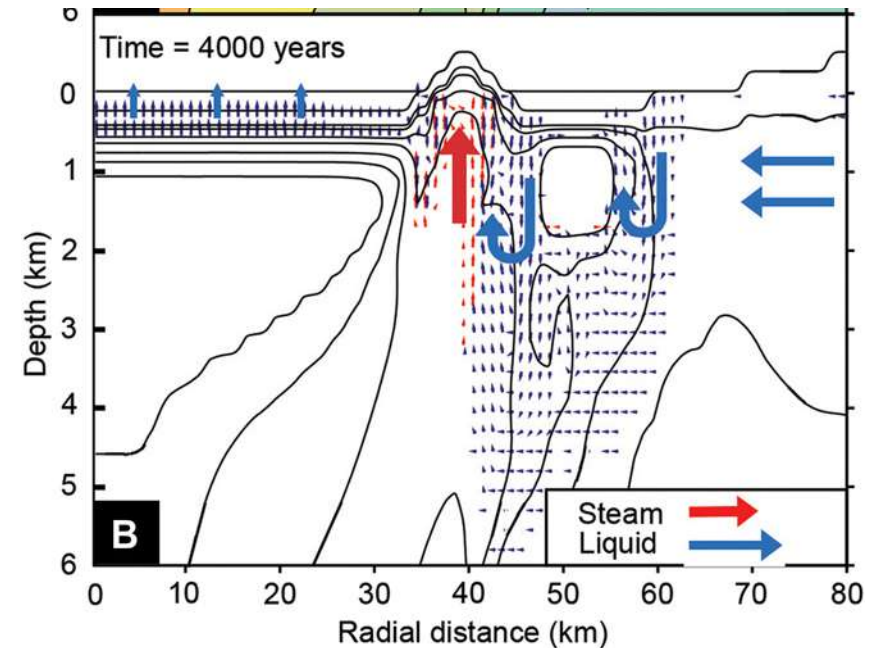
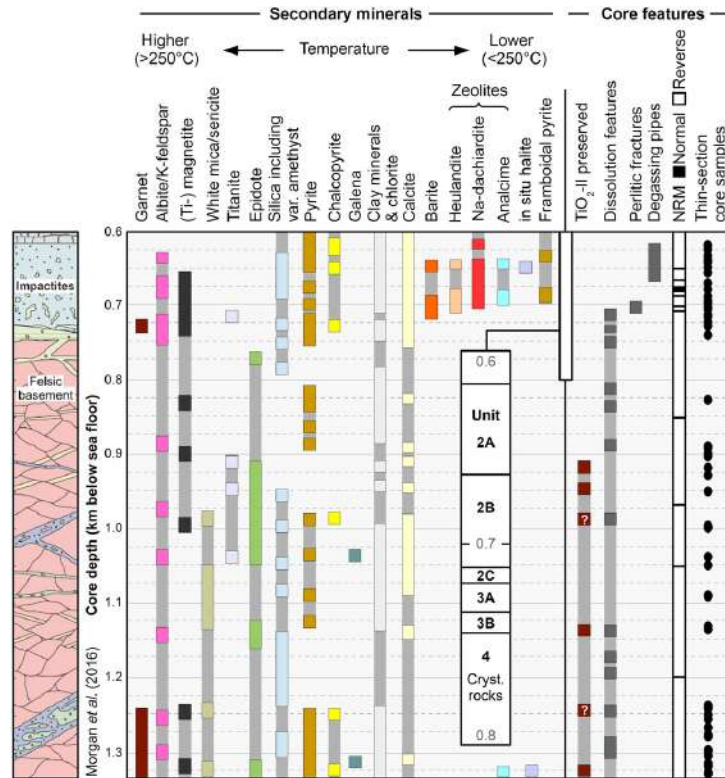


Heat + water = hydrothermal system



How long do hydrothermal systems last?

Observations from Chicxulub



Suggest that hydrothermal system was long-lived, in excess of 1 million years.

Impact craters are ubiquitous in solar system

Moon



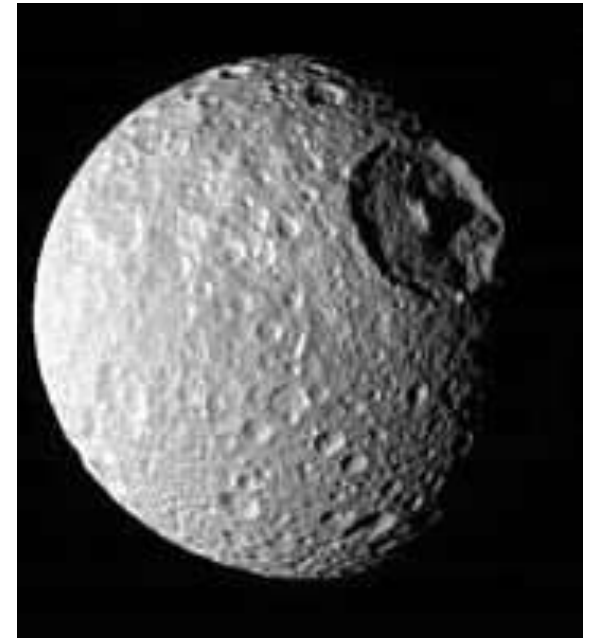
Mars



Mercury



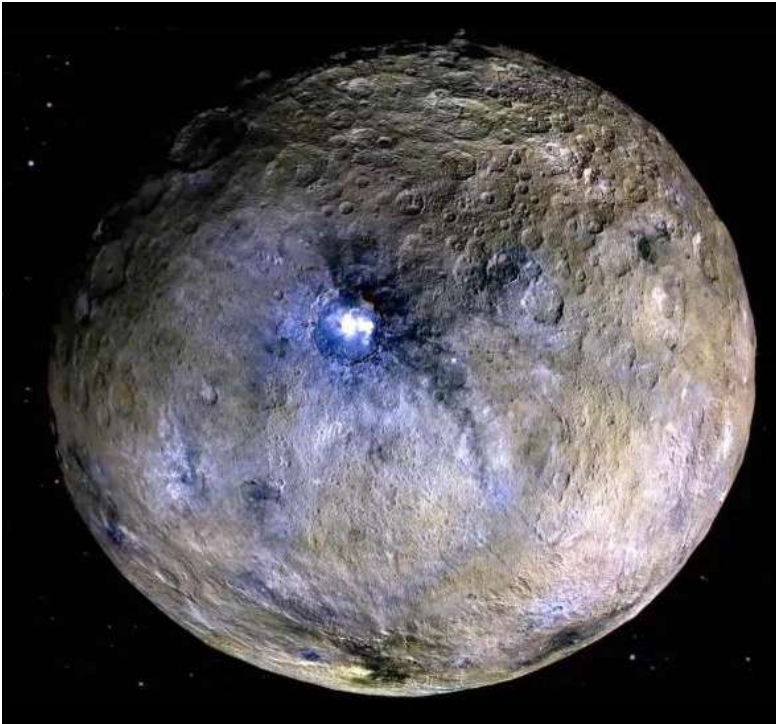
Mimas



Impact generated hydrothermal systems could provide habitable environments.

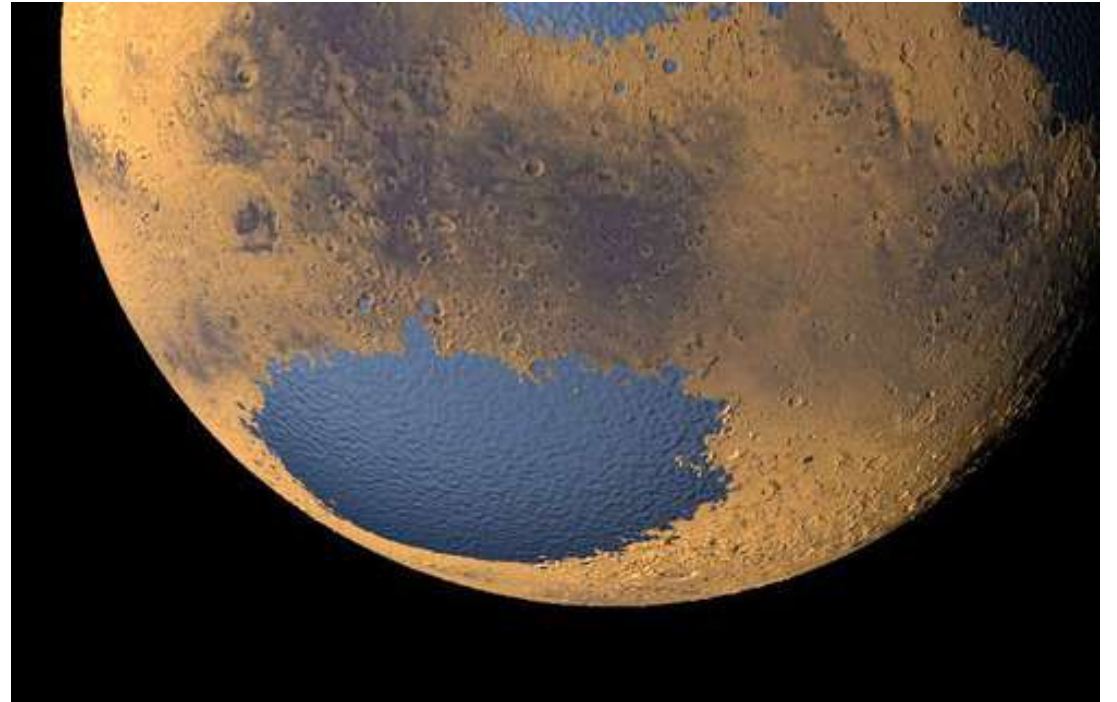
but we need water ...

Impacts on icy bodies



**Impact generates its own water.
(Class project in 2018.)**

(Giant) Impacts on early Mars

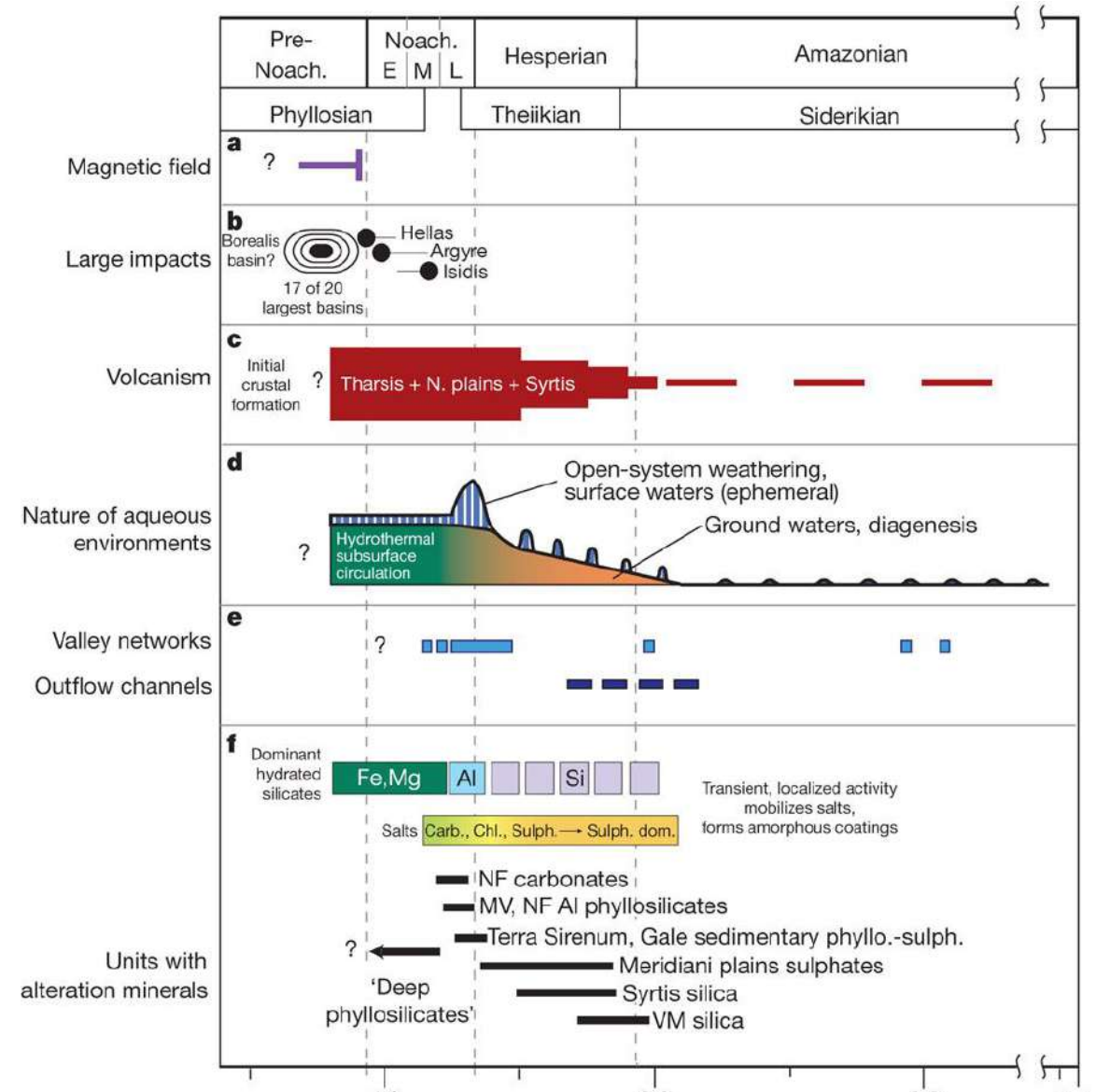


**Interaction with pre-existing groundwater.
(Class project this year.)**

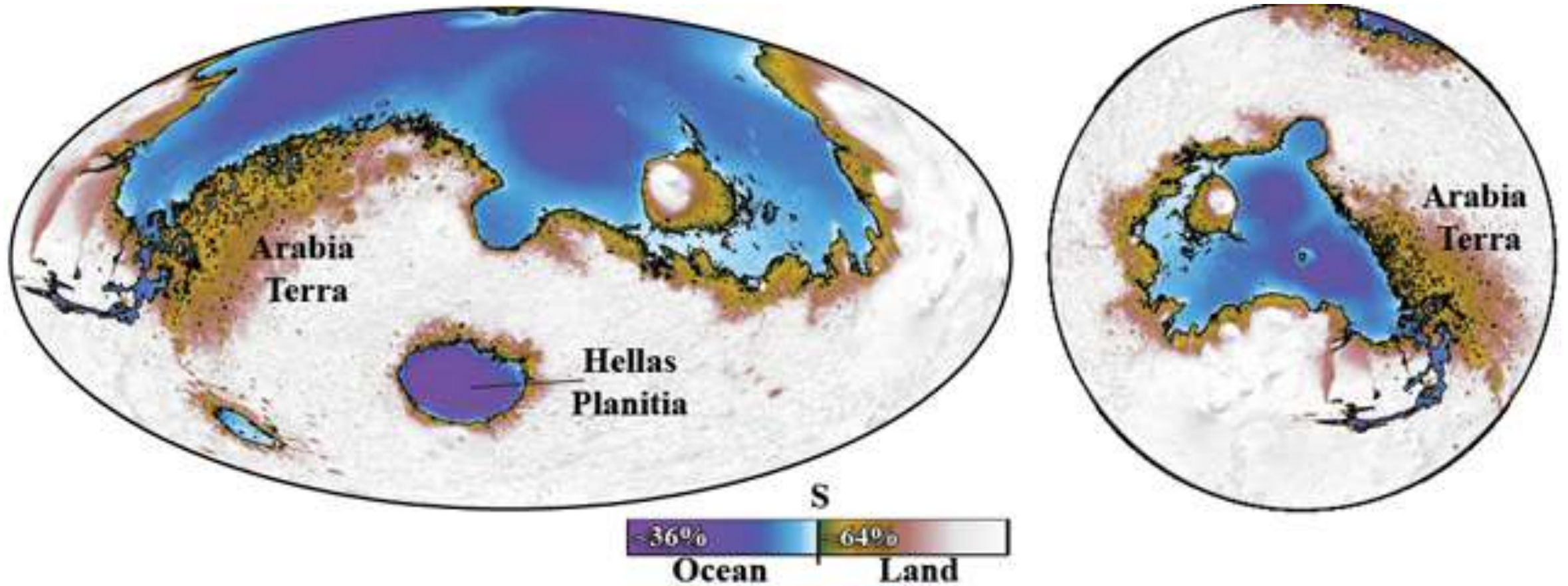
... but Mars is a pretty dusty place.



Mars was wet during formation of the giant impacts.



Mars early ocean

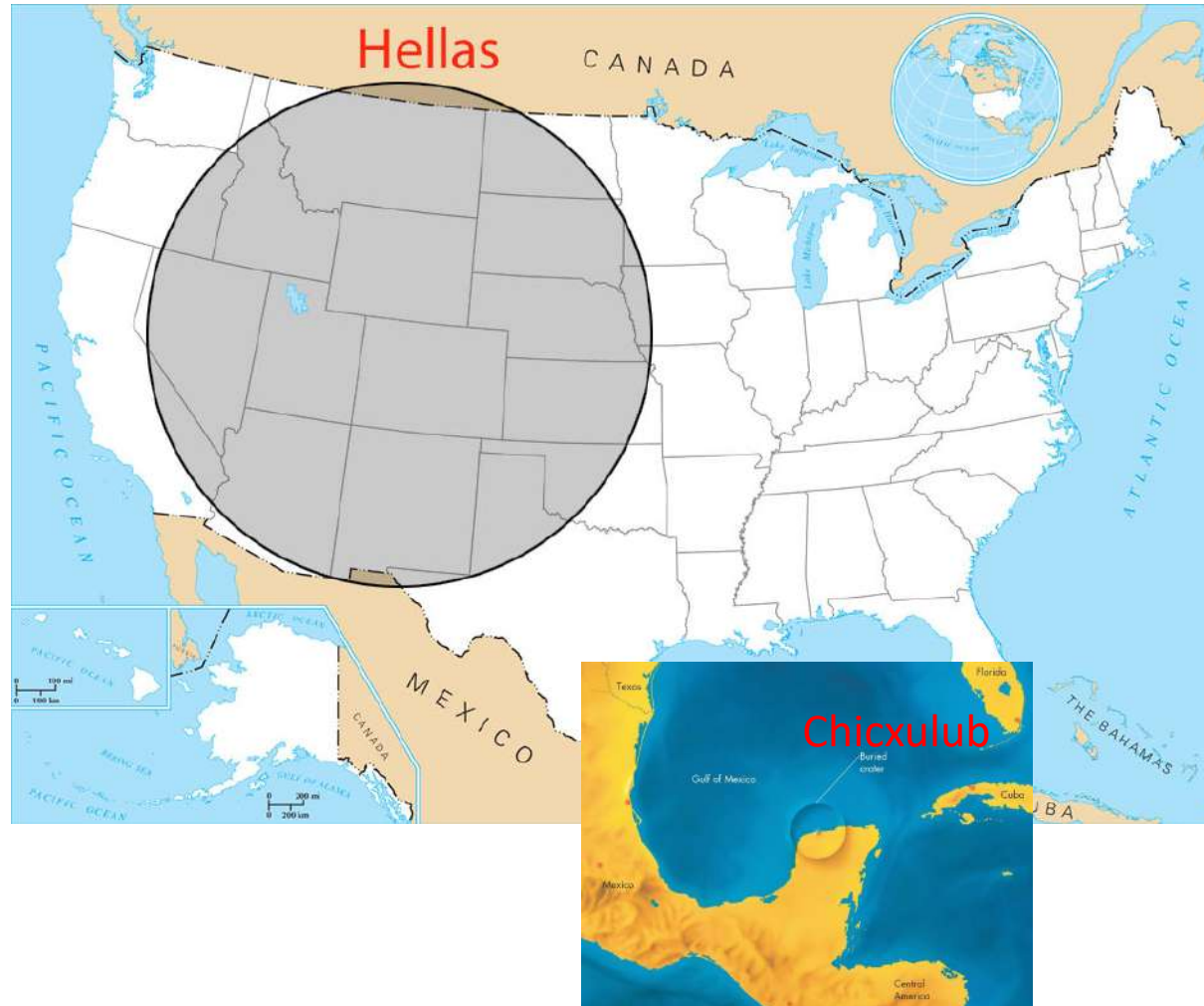


Mars has a global dichotomy: Highlands in the South – Lowlands (ocean) in the North

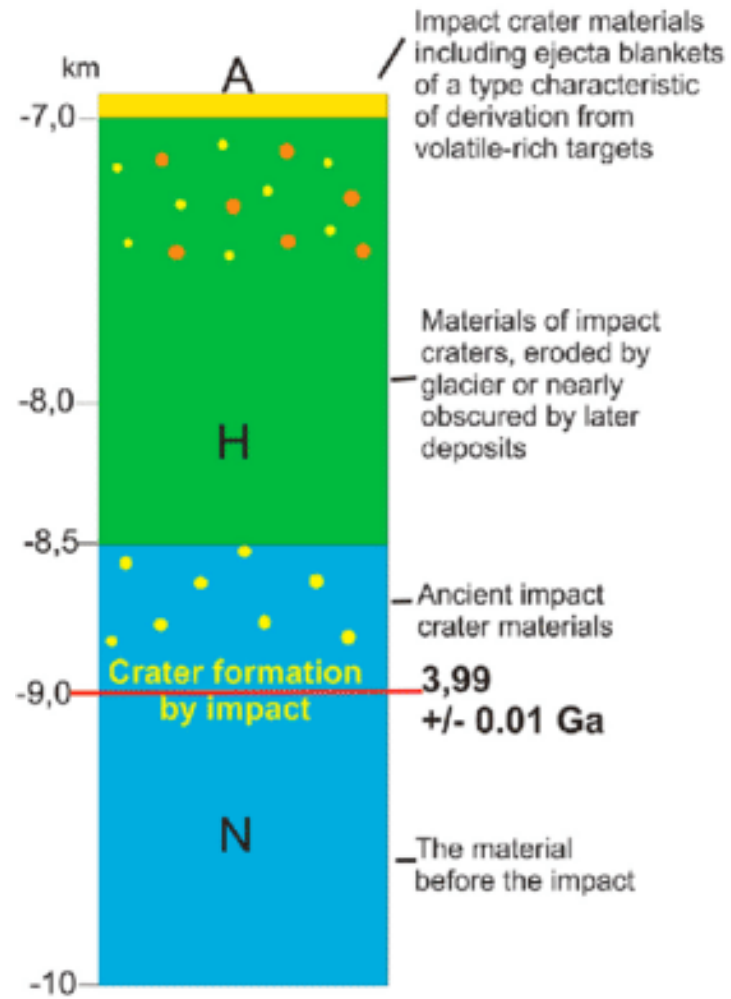
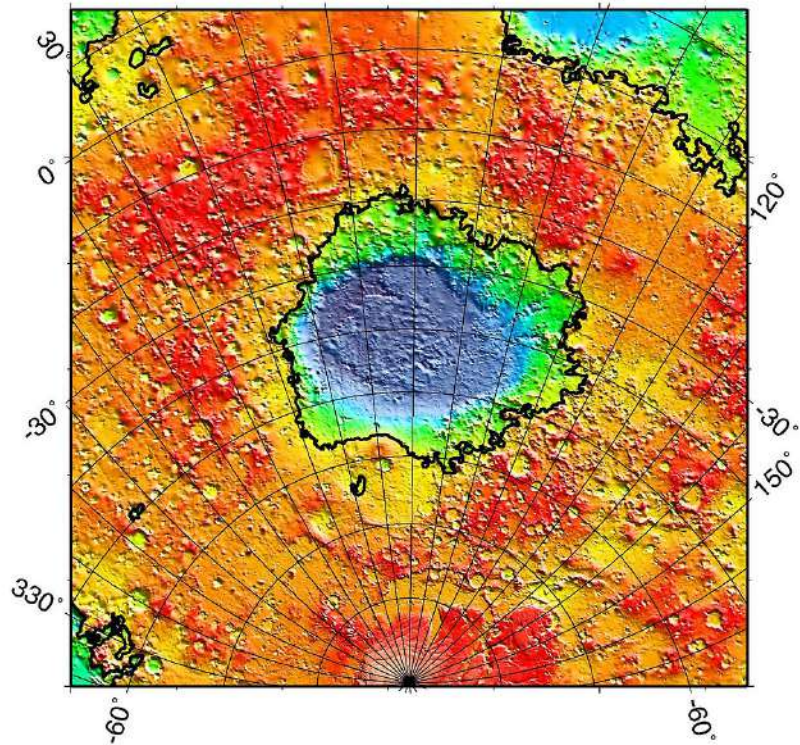
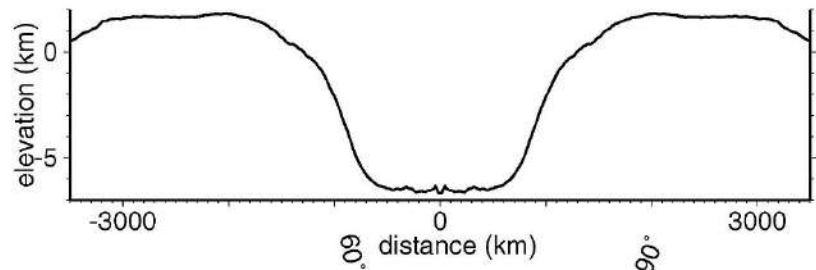
Life on Mars

Could life have originated in hydrothermal systems of Mars giant impacts

How do Mars' impacts differ from Earth's?



Much bigger!



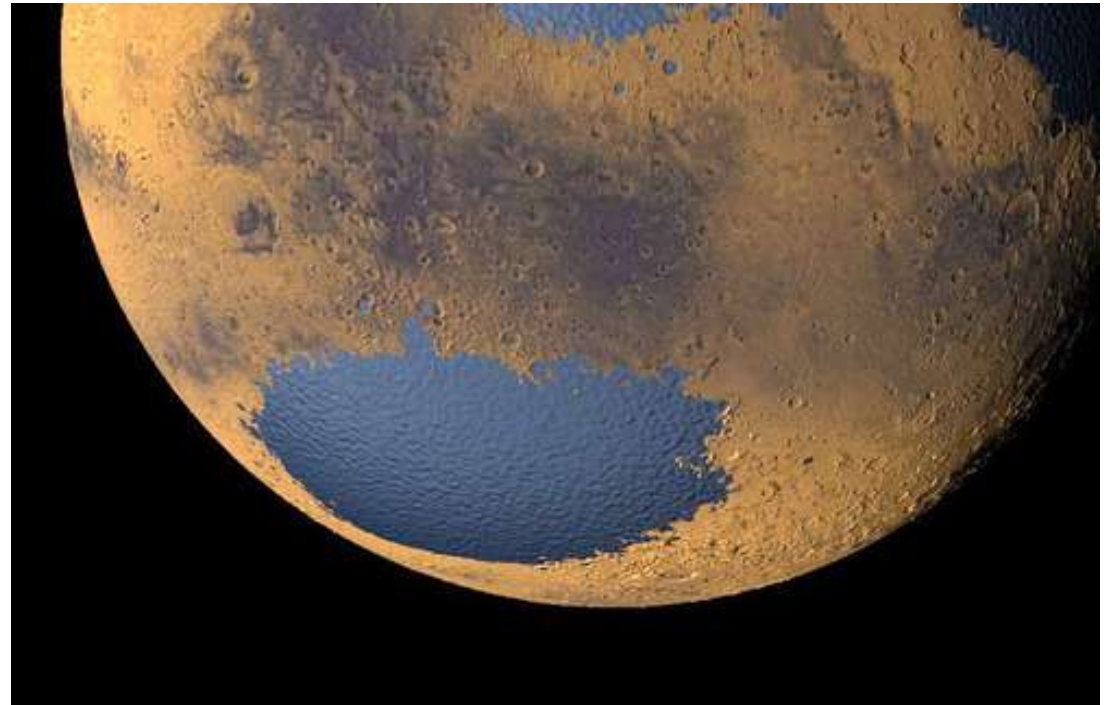
Much deeper!

How quickly did crater fill with water?

Ocean instantaneously filled Chicxulub



Hellas filled slowly with groundwater



Shorelines in Hellas basin?

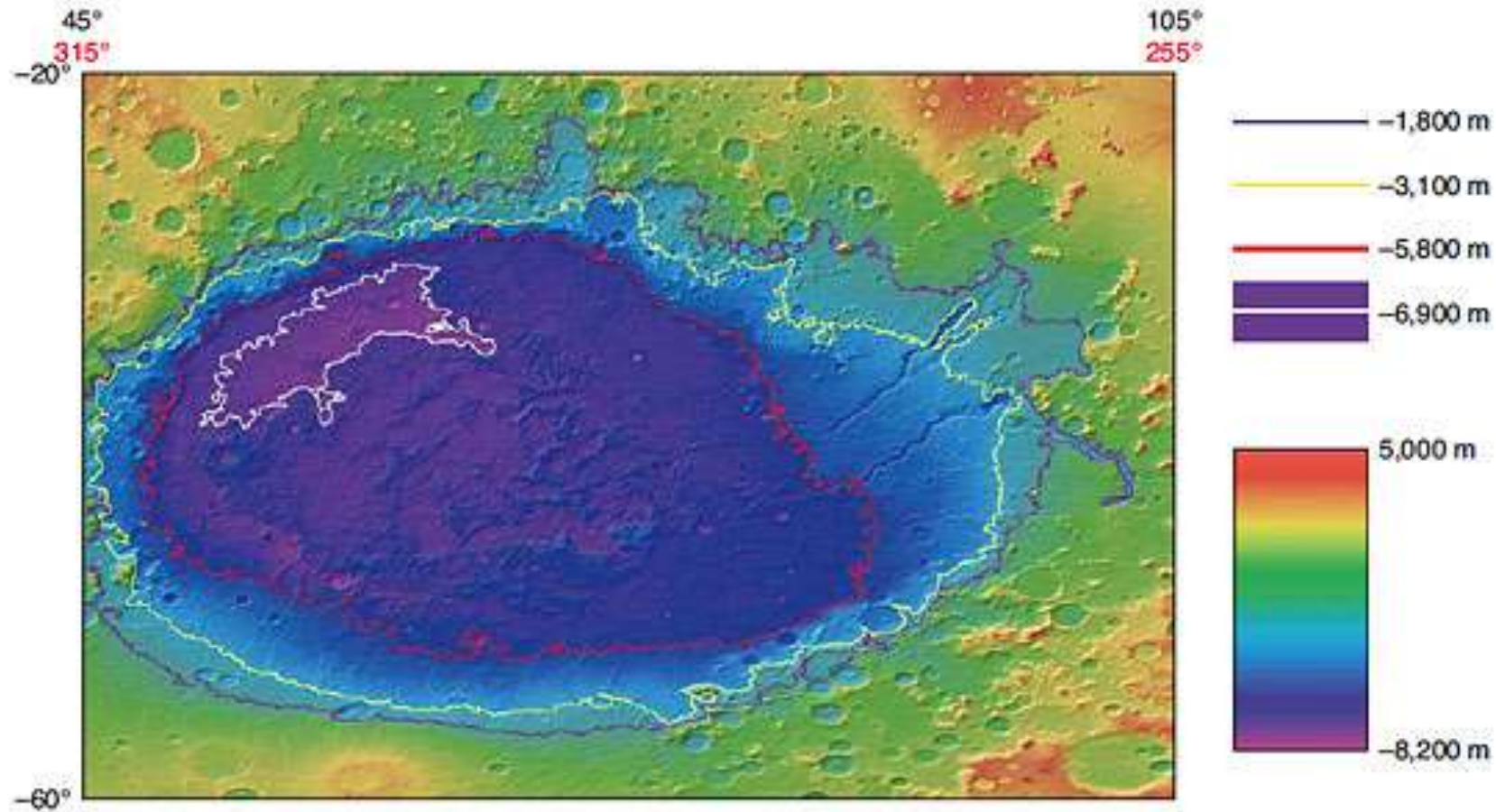


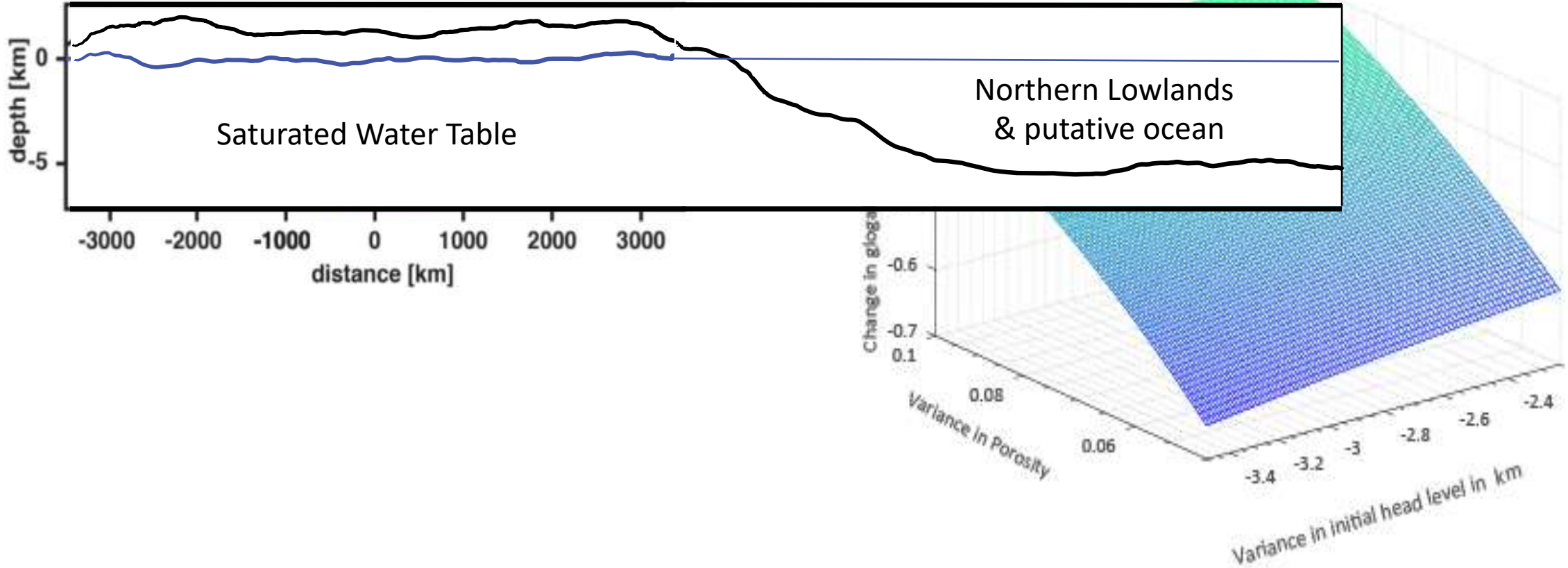
Figure 2. MOLA 128 pixel/degree DEM with contour intervals or shorelines: -6,900 m, -5,800 m, and -3,100 m (Moore and Wilhelms, 2001, 2007) and -1,800 m (Crown and others, 2005). Shorelines follow and are characterized by distinct changes in surface morphology, including crater retention.

How long would hydrothermal system in giant impact last?

How long does it take to fill a
giant impact crater?

Global Scale Hydraulic Head Gradients

Hellas Basin forms ~ 3.99 Ga



Do impact craters exchange water?

Coevolution and Habitability

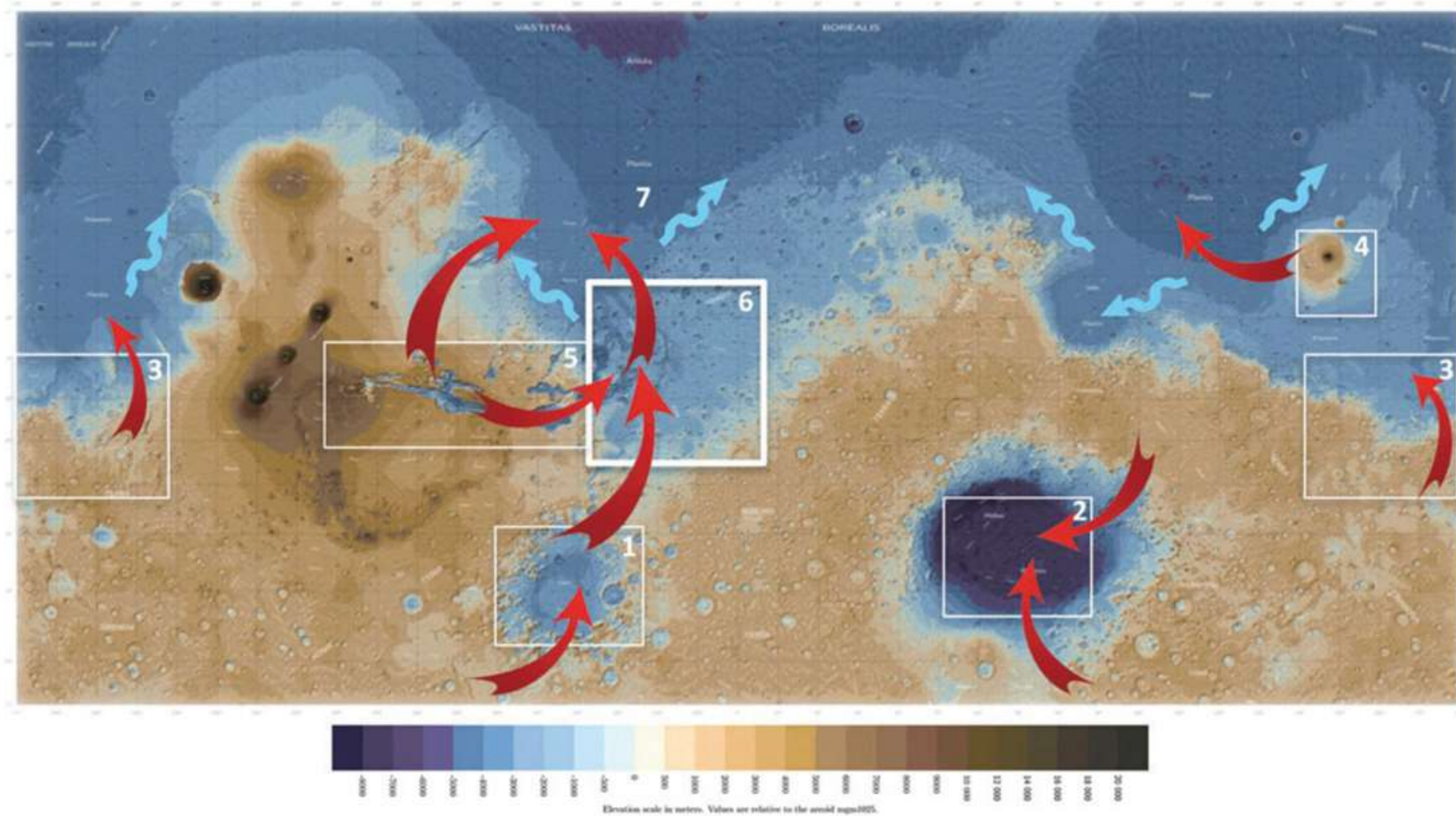


Figure: Modified from Cabrol 2017

Could life/pre-biotic chemistry migrate?

