



Summary:

- Formation of the planets layers/differentiation
- Sources of heat for planets
- 4 Surface Planets
- Martian Geology
- Venusian Geology (inc water on Mars and Venus)



Planetary Surfaces

Of the Rocky Planets



Recap

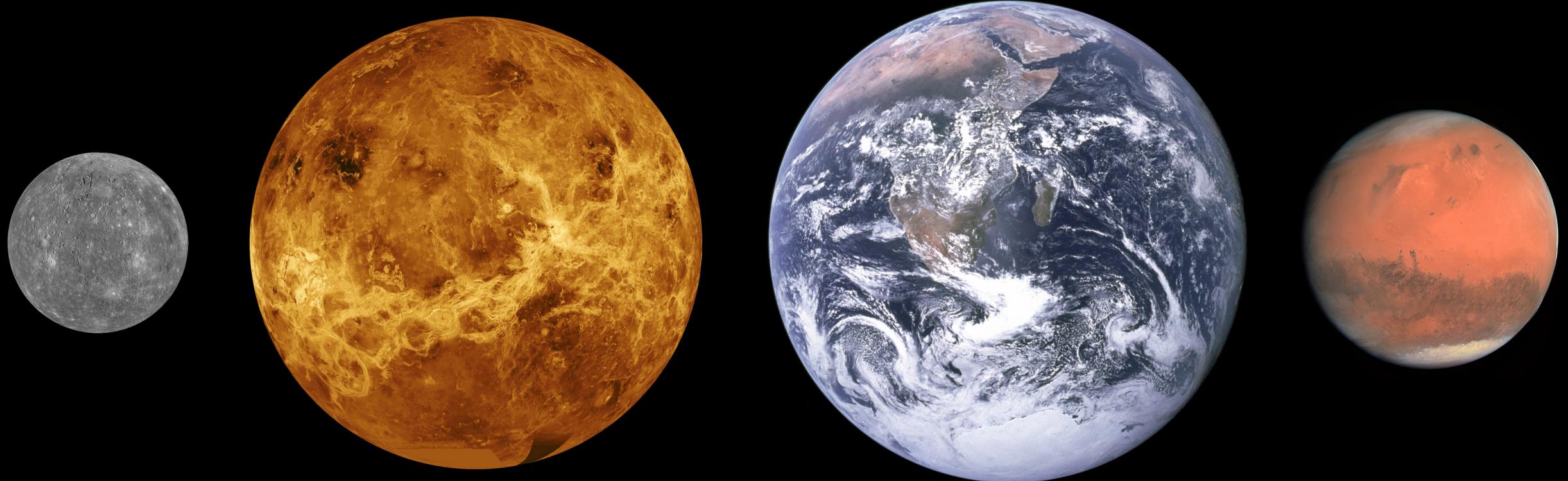


1. When a planets moon is in a prograde orbit that means what?
2. Which rocky planet has the largest core for its size?
3. Which gas giants have rings?





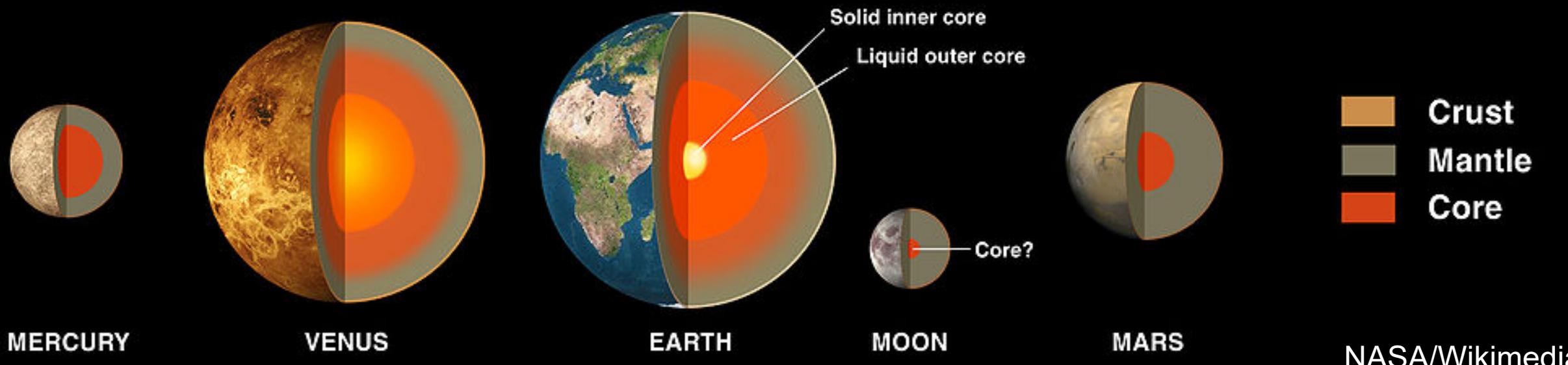
The Rocky Planets



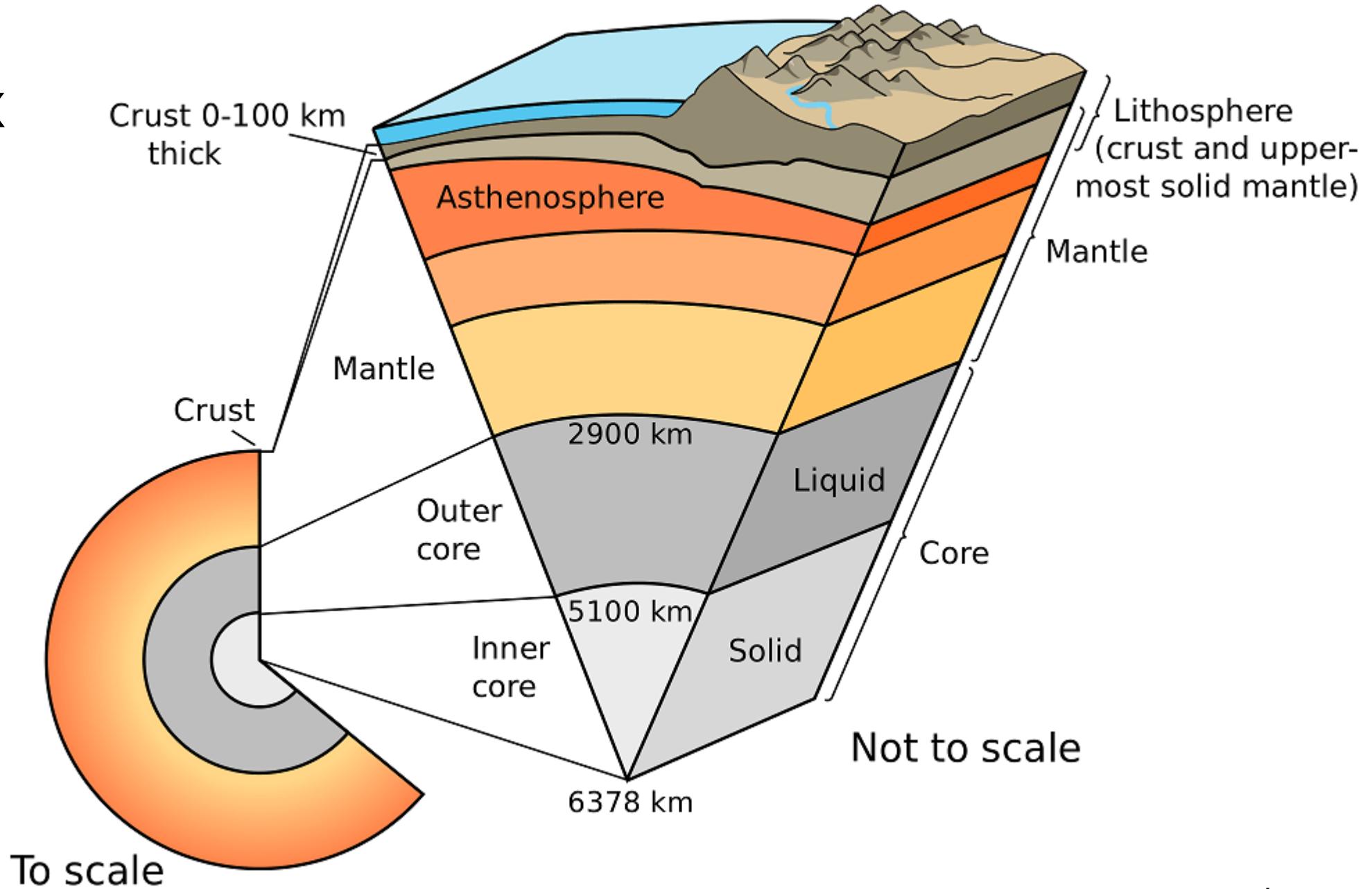
Molten Start

The planets when they formed were molten (at least partially).

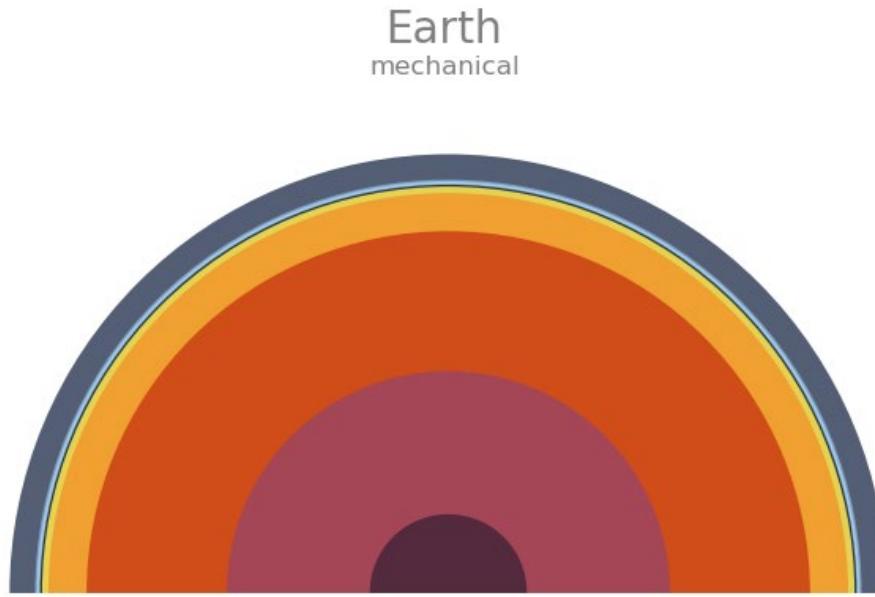
This leads to a process called **differentiation** where materials separate according to density with denser materials at the centre of the planet. This is why the rocky planets have dense iron cores and less dense rocky mantles and crusts.



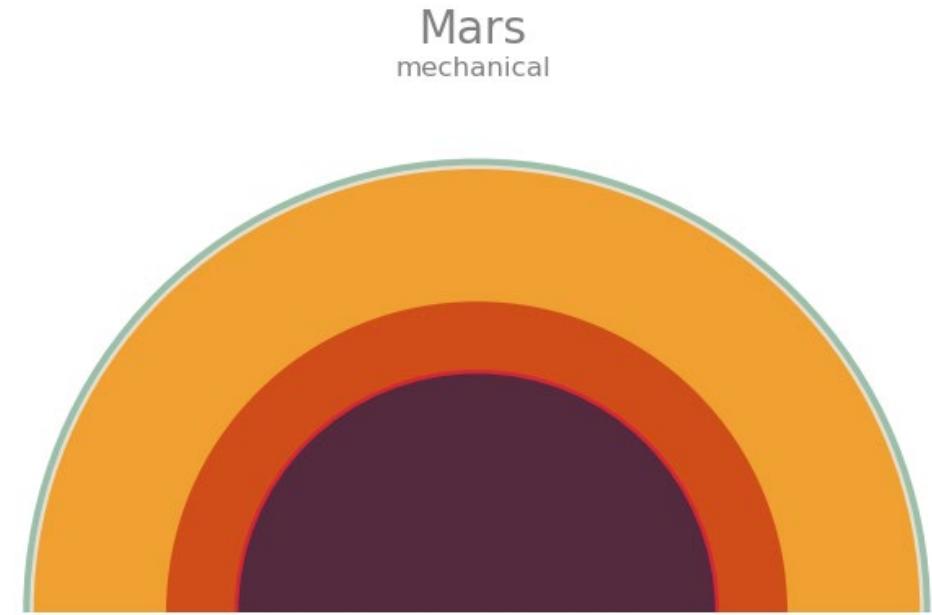
Earth's Complex Insides



Lithospheres



- | | |
|----------------|----------------|
| ■ inner core | ■ crust |
| ■ outer core | ■ troposphere |
| ■ mesosphere | ■ stratosphere |
| ■ athenosphere | ■ mesosphere |
| ■ lithosphere | ■ ionosphere |



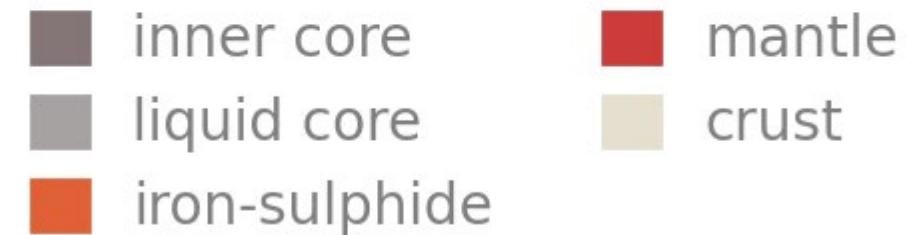
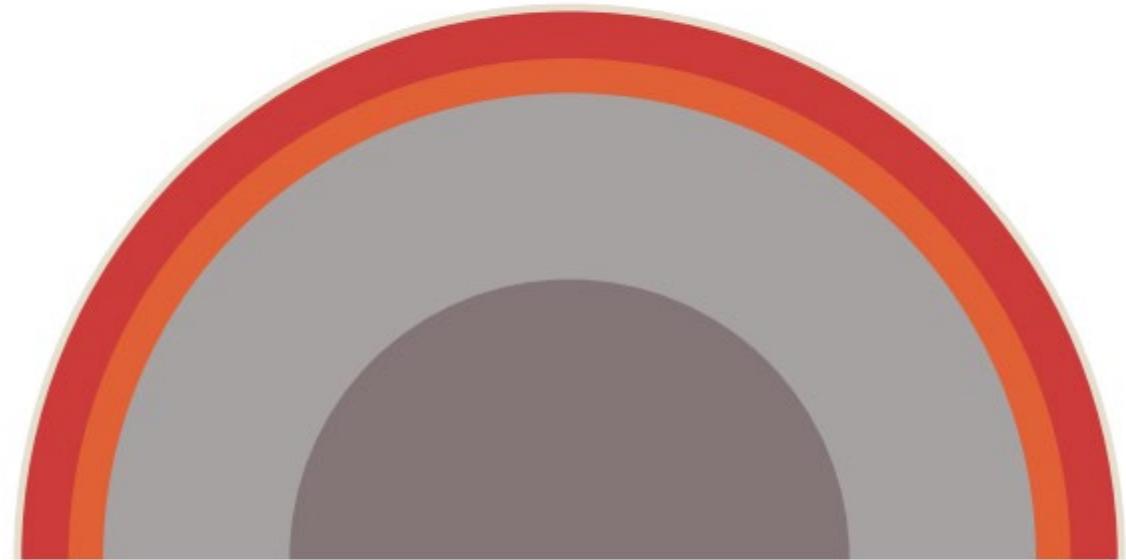
- | | |
|----------------|--------------|
| ■ core | ■ lisosphere |
| ■ mesosphere | ■ crust |
| ■ athenosphere | ■ atmosphere |

Lithospheres

Smaller planets which cool faster or have cooled already have thicker and stronger lithospheres.

This means they have less geological activity.

Mercury
mechanical

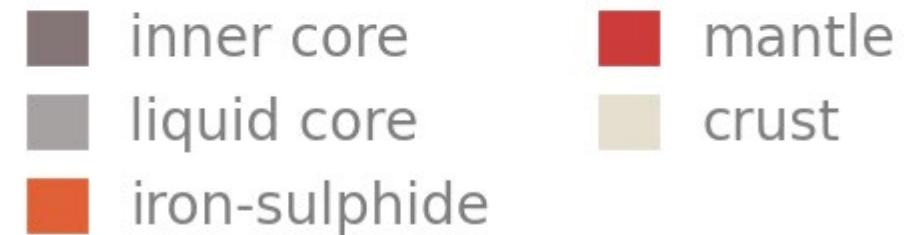
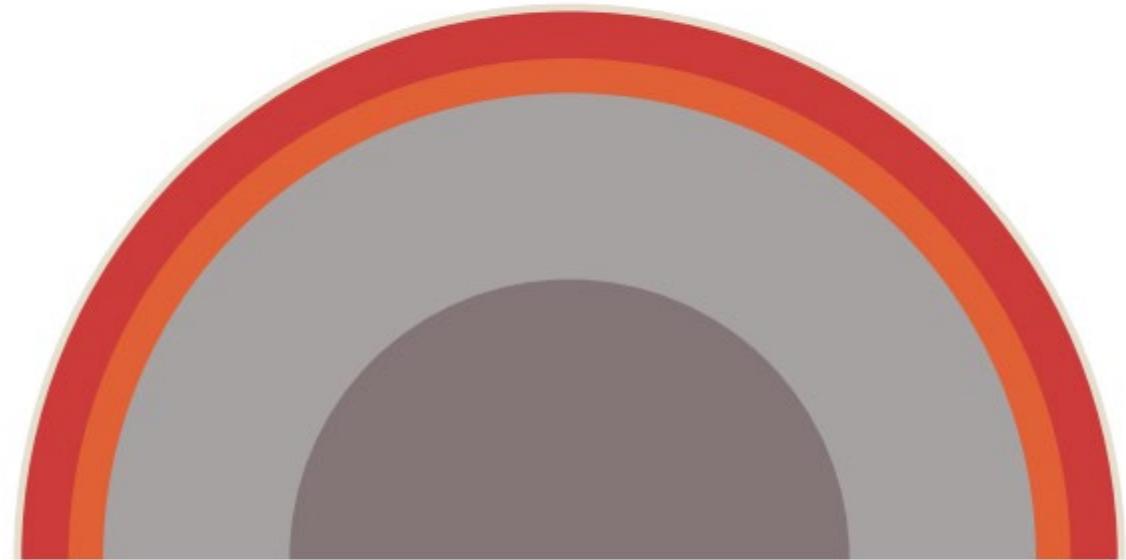


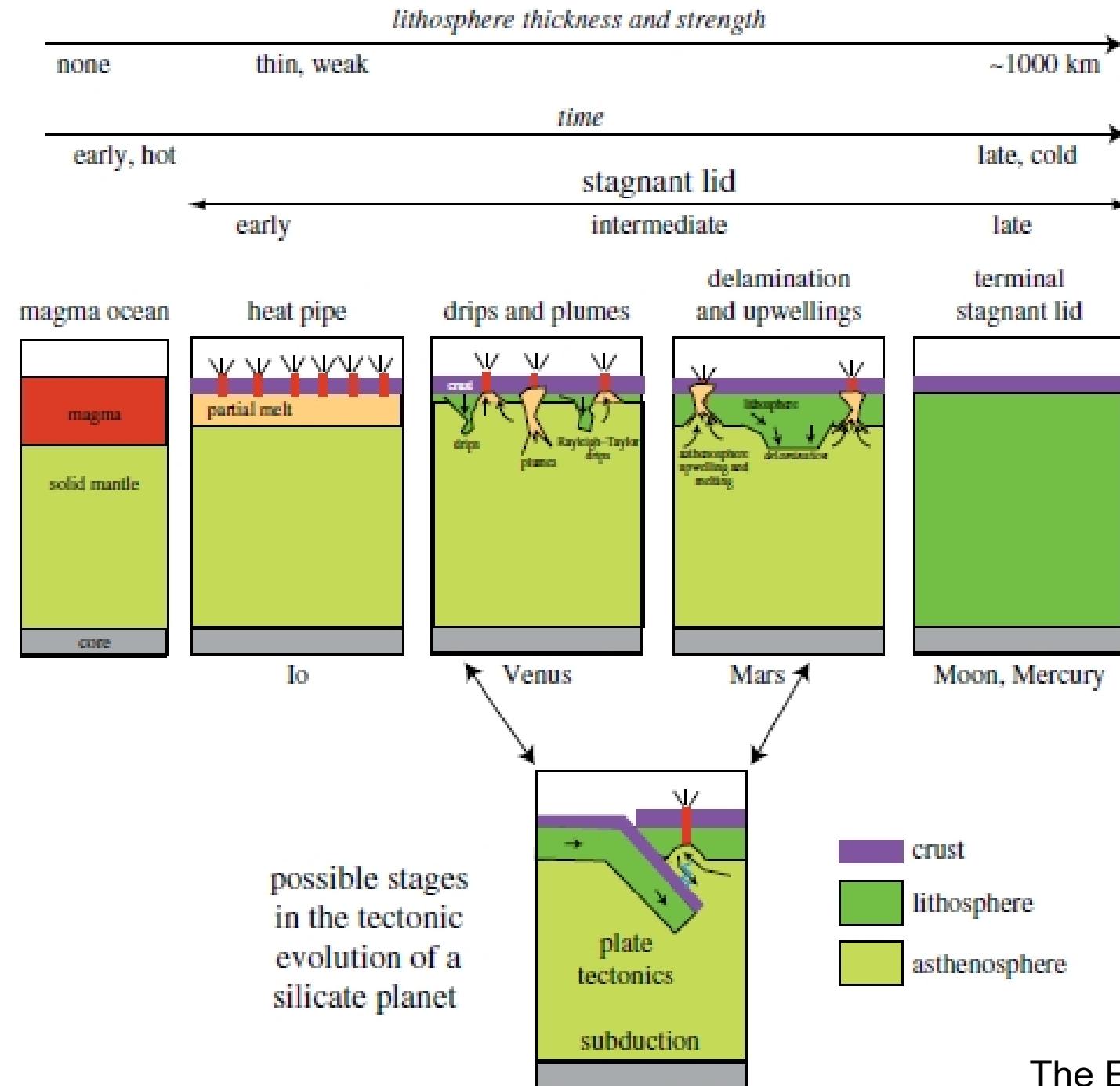
Lithospheres

When planets cool stresses form in the lithosphere leading to geological activity like rifts, earthquakes etc.

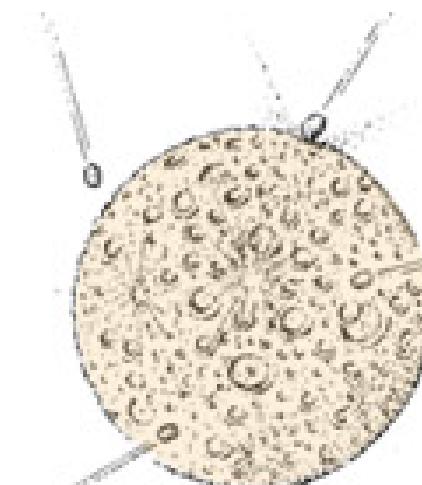
Out-gassing from the rocks creates the atmosphere!

Mercury
mechanical

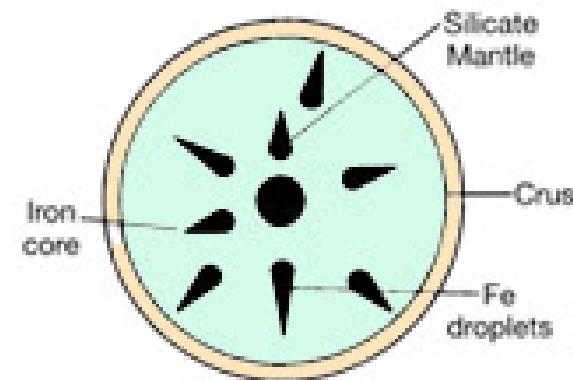




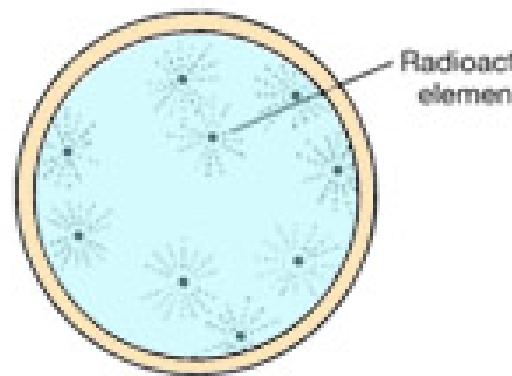
Robert J. Stern:
The Evolution of Plate Tectonics



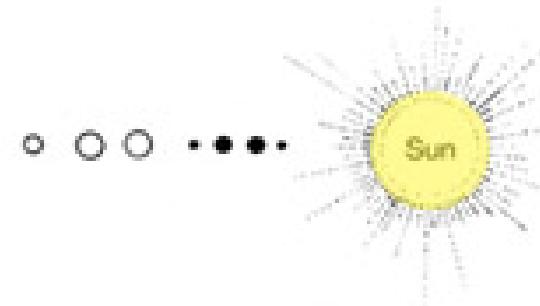
Accretionary heating



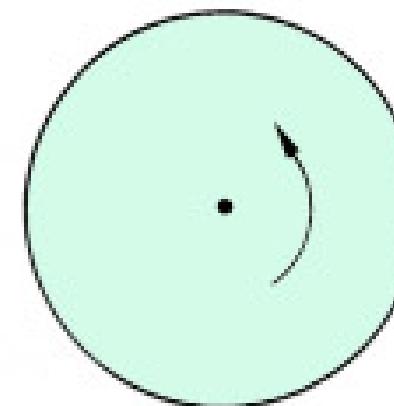
Core formation



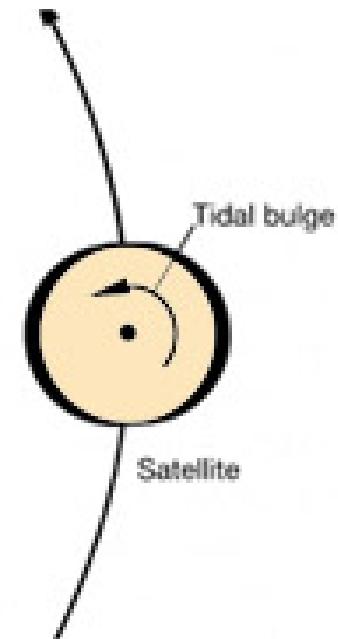
Radiogenic heating



Solar energy



Primary planet



Tidal heating



Quick Recap

- 1. Planets which cool quickly have thin/thick lithospheres.**
- 2. A thinner lithosphere means the planet has more ...**
- 3. Differentiation caused...**



Surface Processes

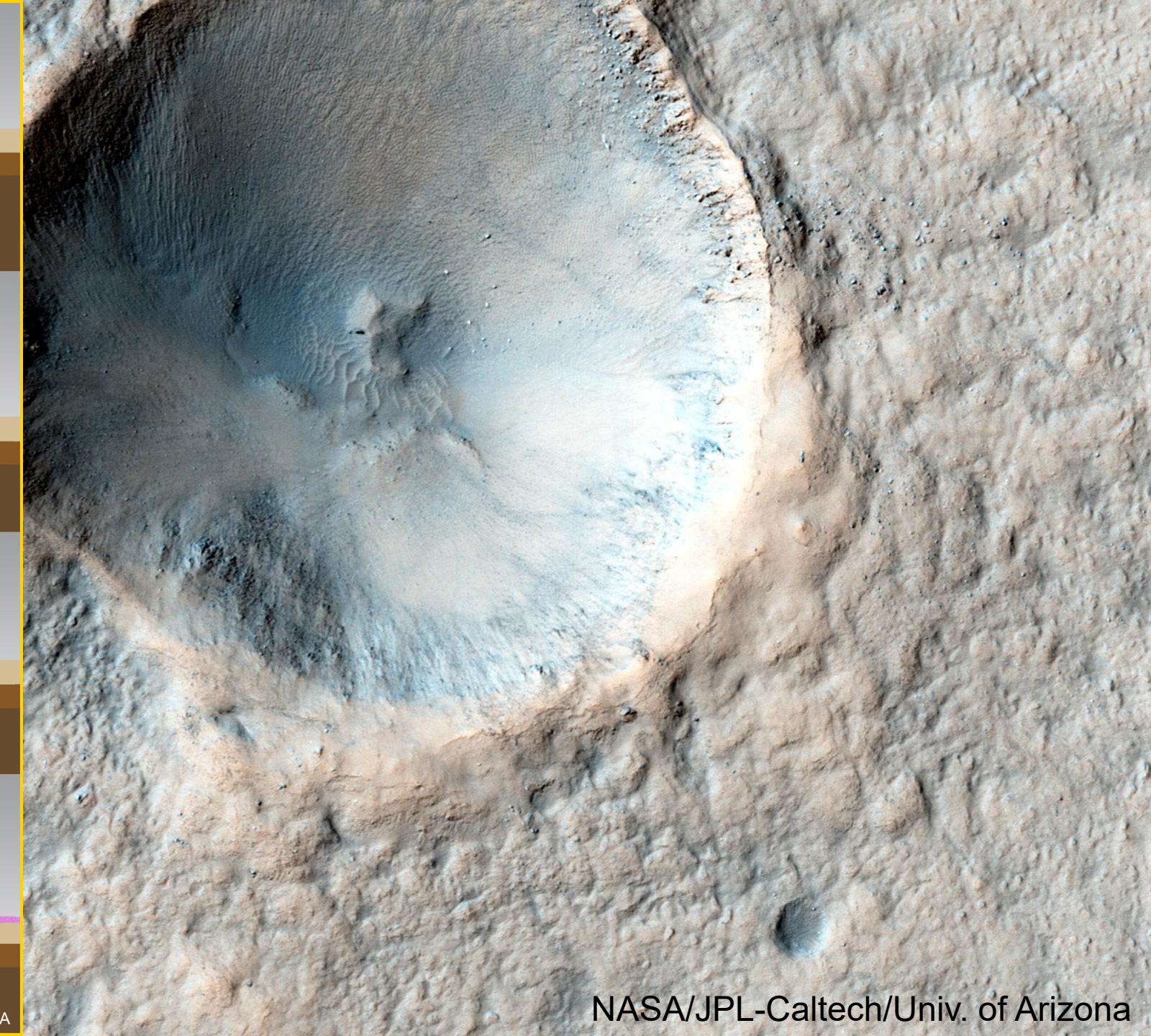
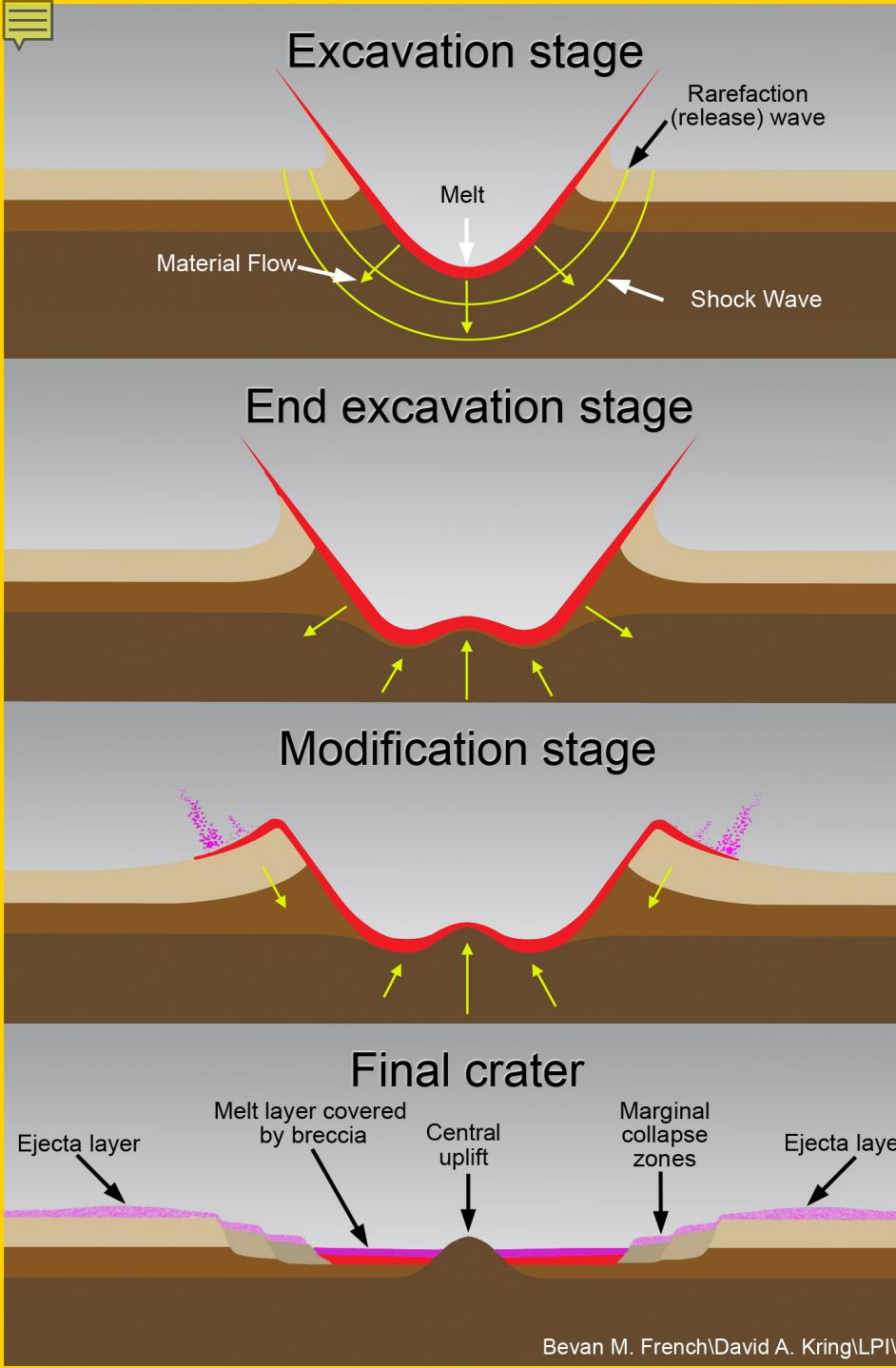
1. Impact Cratering
2. Volcanism
3. Tectonics
4. Erosion



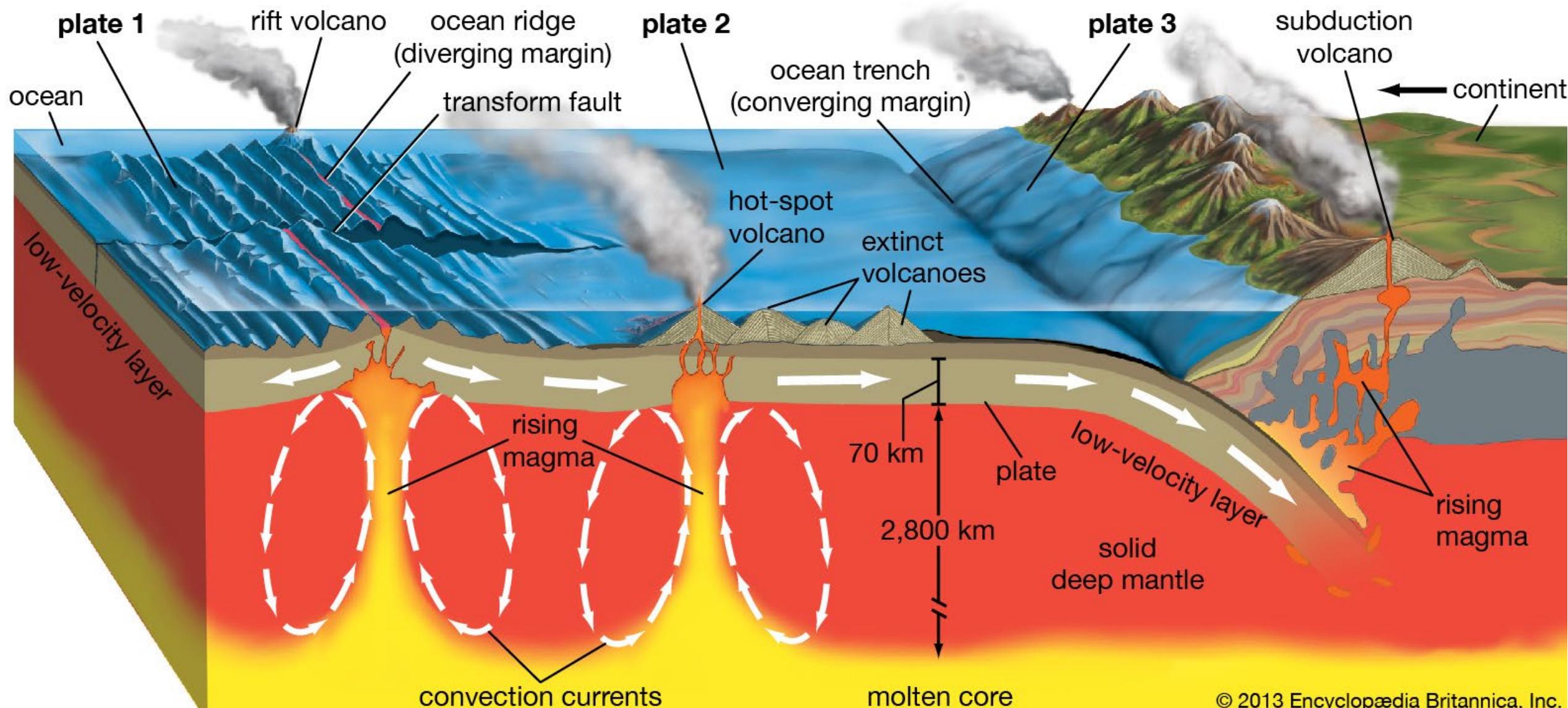
Impact Cratering

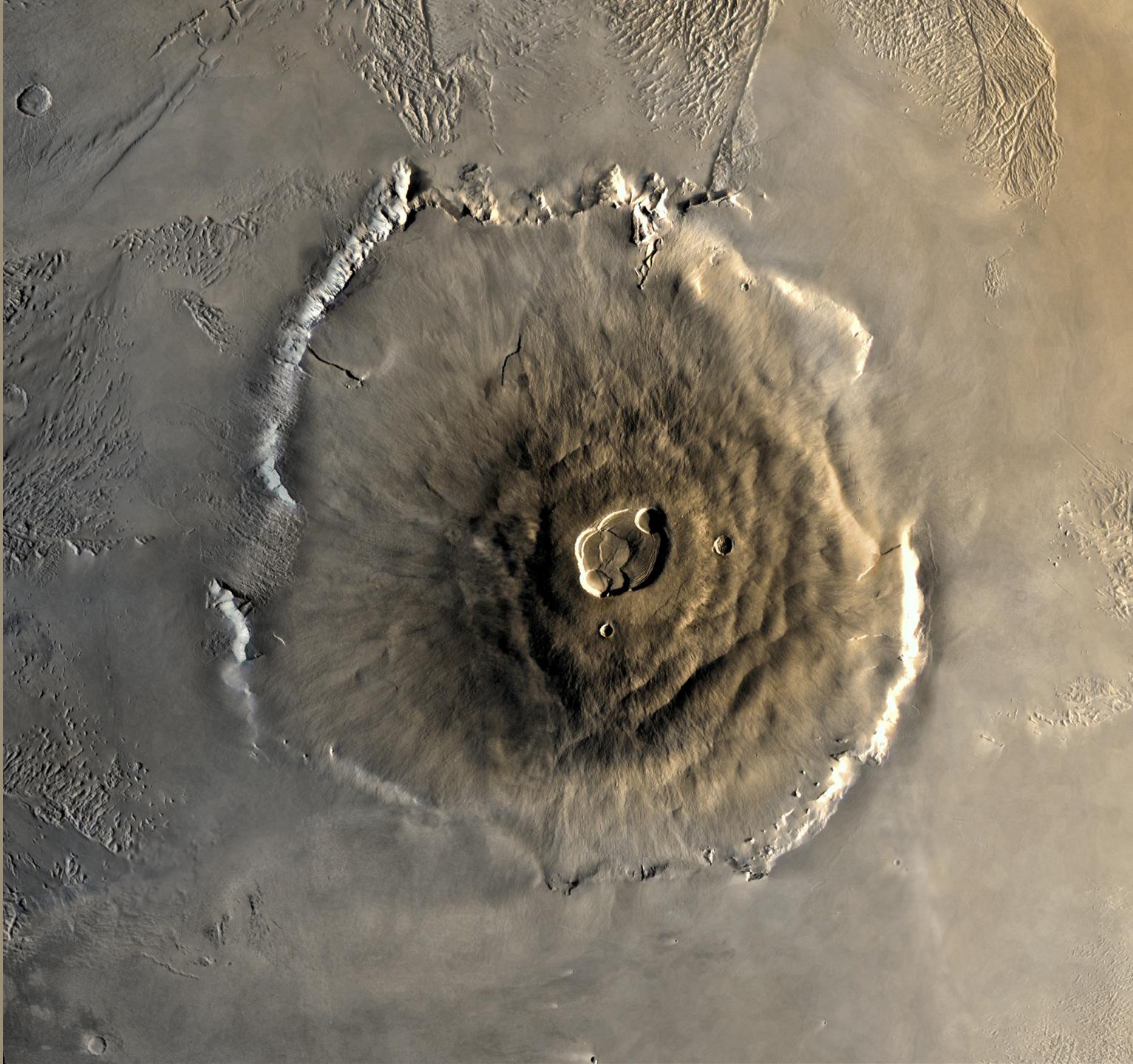


Erik Charlton

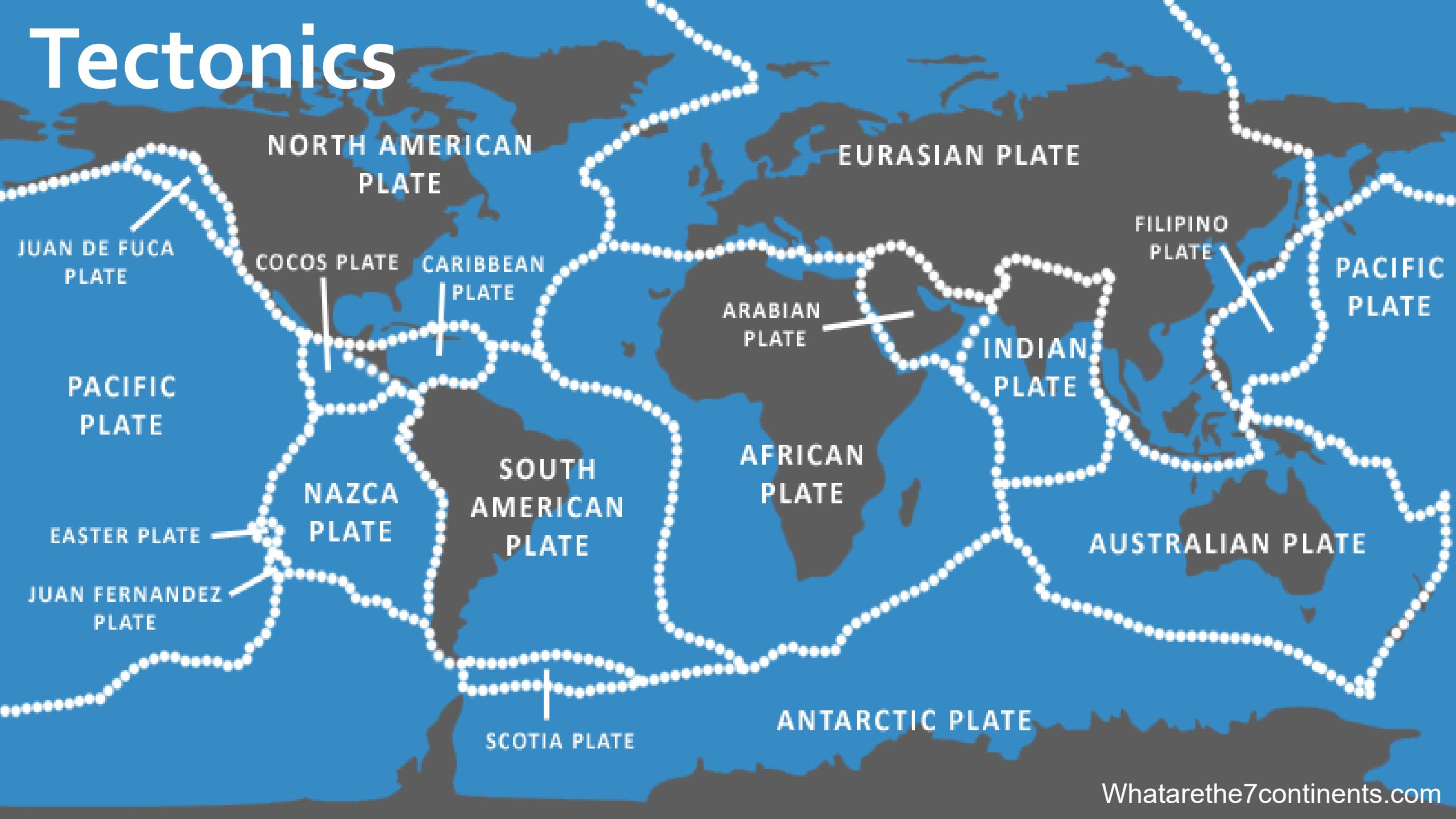


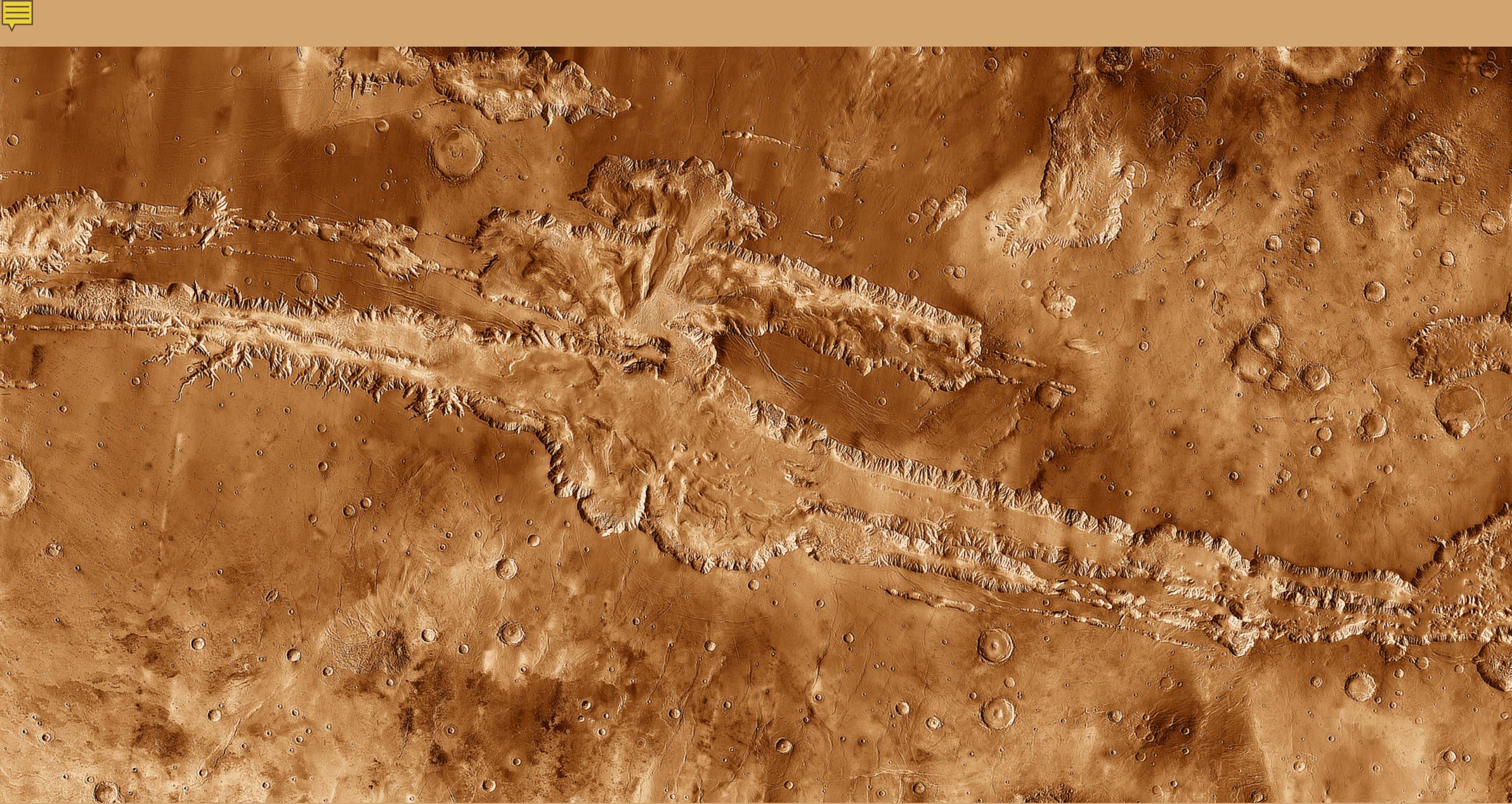
Volcanism





Tectonics





Erosion

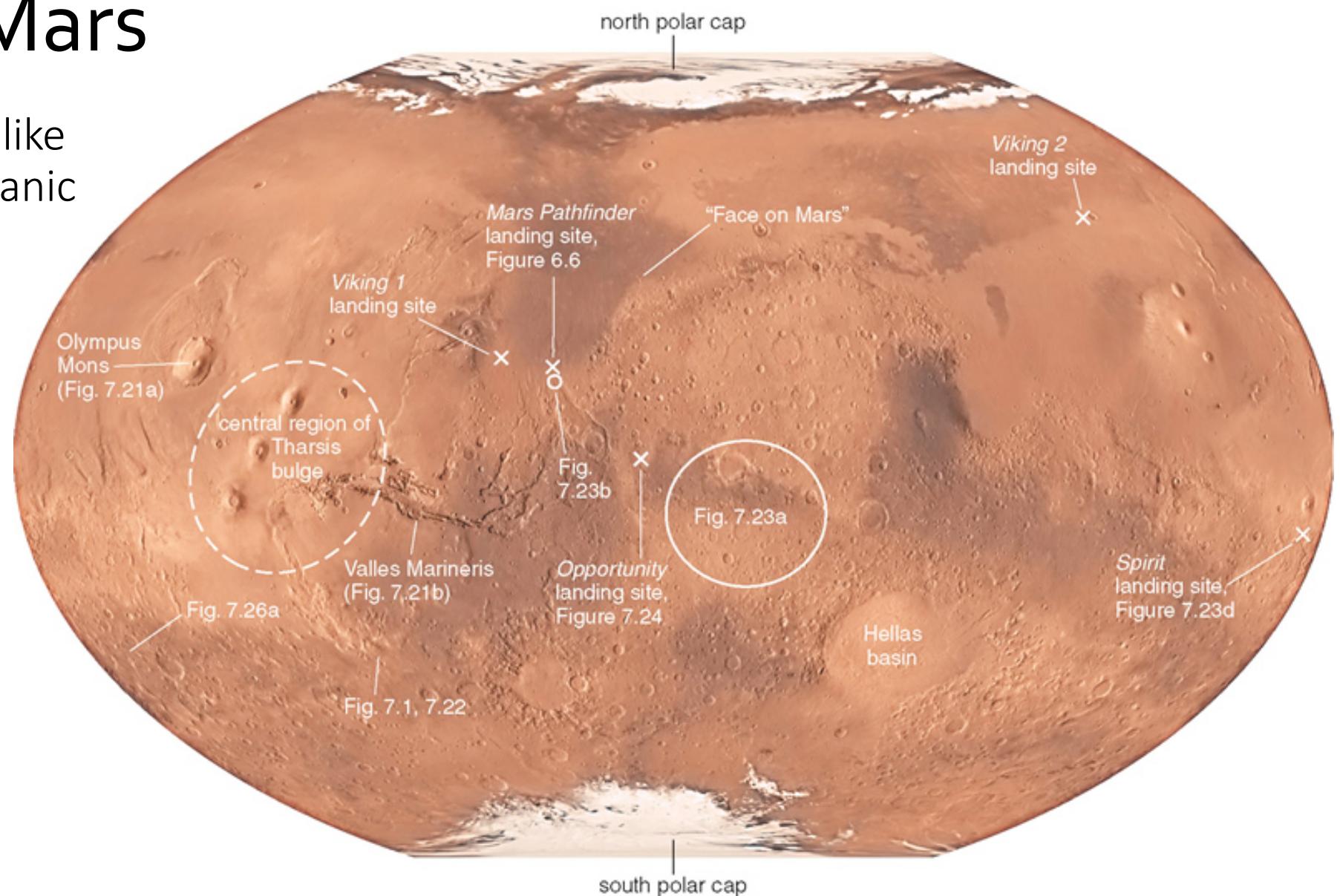
Surface processes that remove material from one location and move them to another.

Can be done by wind, ice, water, sand etc. It is most significant on planets with substantial atmospheres, flowing water/ice.



Geology of Mars

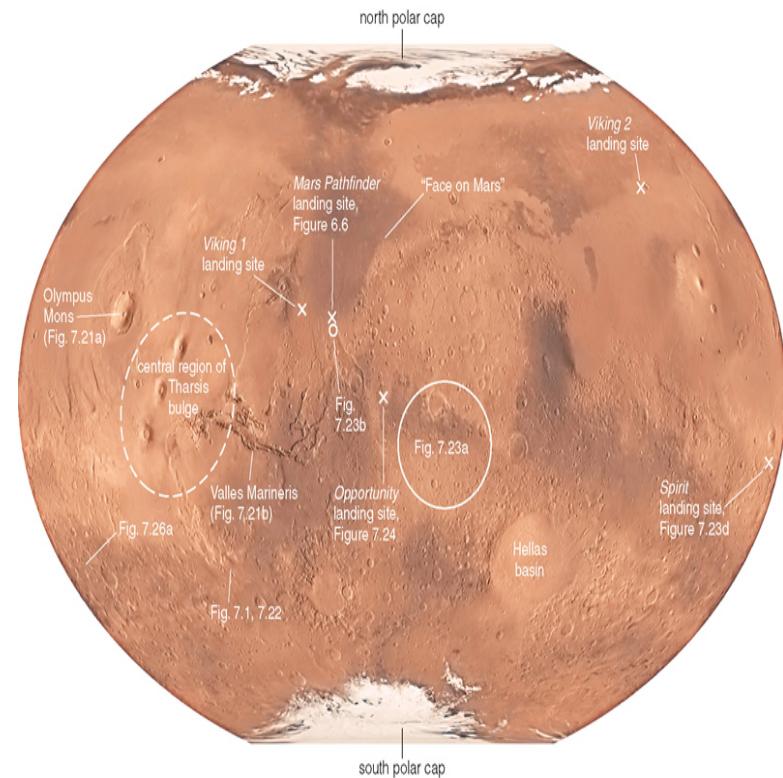
The Martian surface is like Earth's desert and volcanic plains.



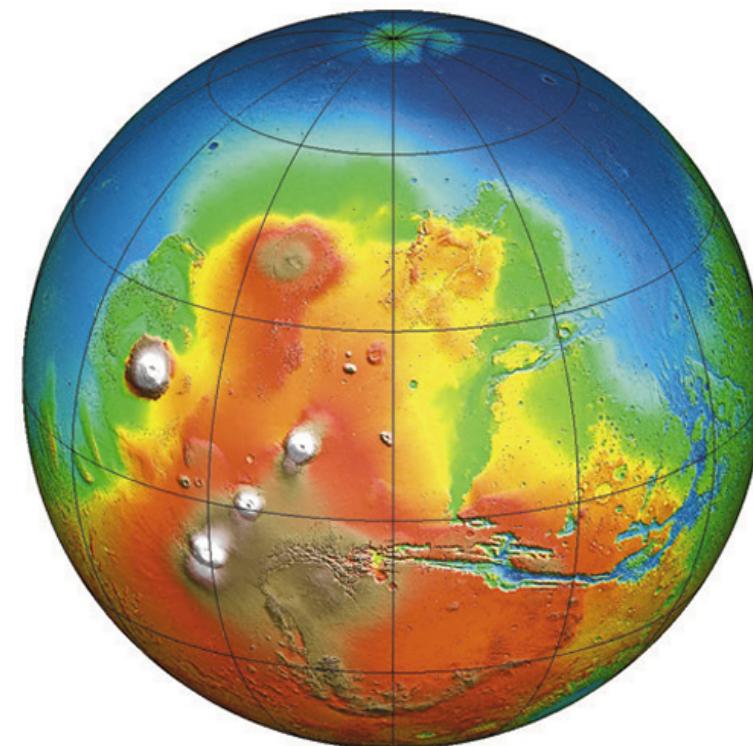


Ancient Martian Ocean?

Mars might have had an ocean covering the lower blue areas in the elevation map on the right.



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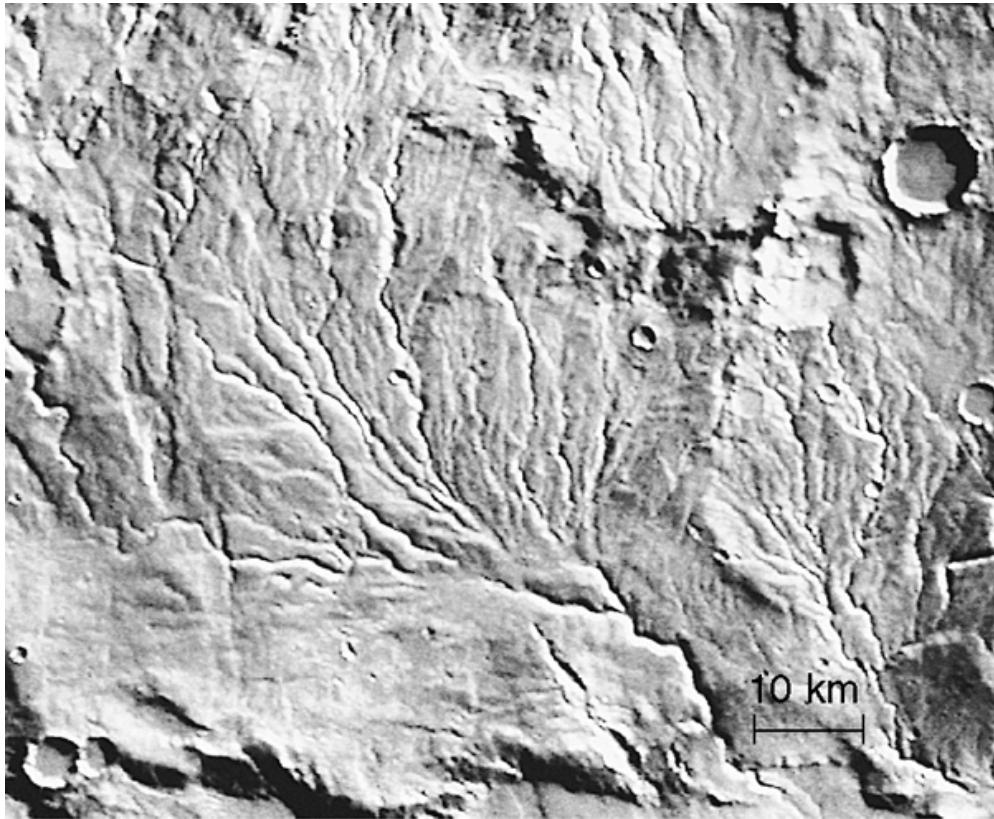
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Joshua E. Barnes

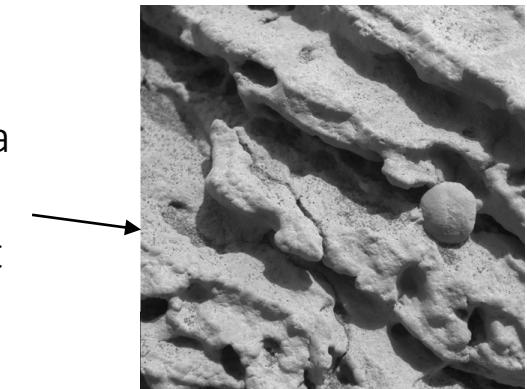


Water on Mars in the Past?

Riverbed?

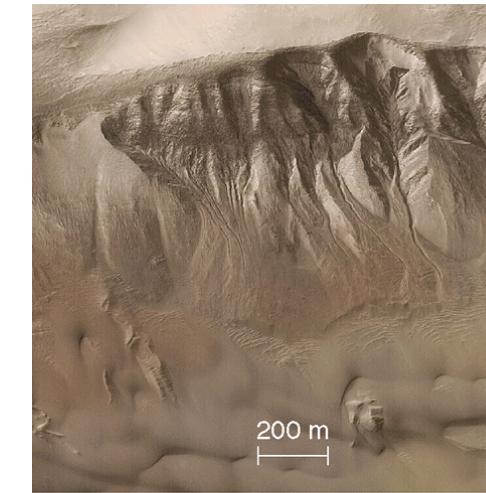


Images from Mars Rover *Spirit* at a suspected ancient lake site showed rock structures consistent with those formed from sediments in standing water



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Gullies?



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Lake Bottom?



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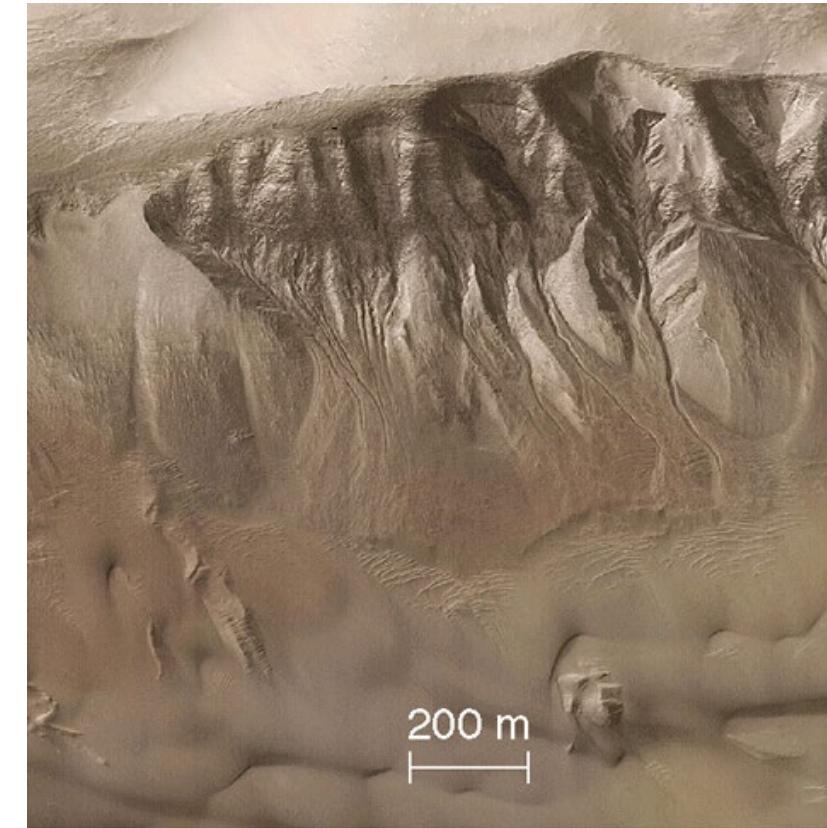
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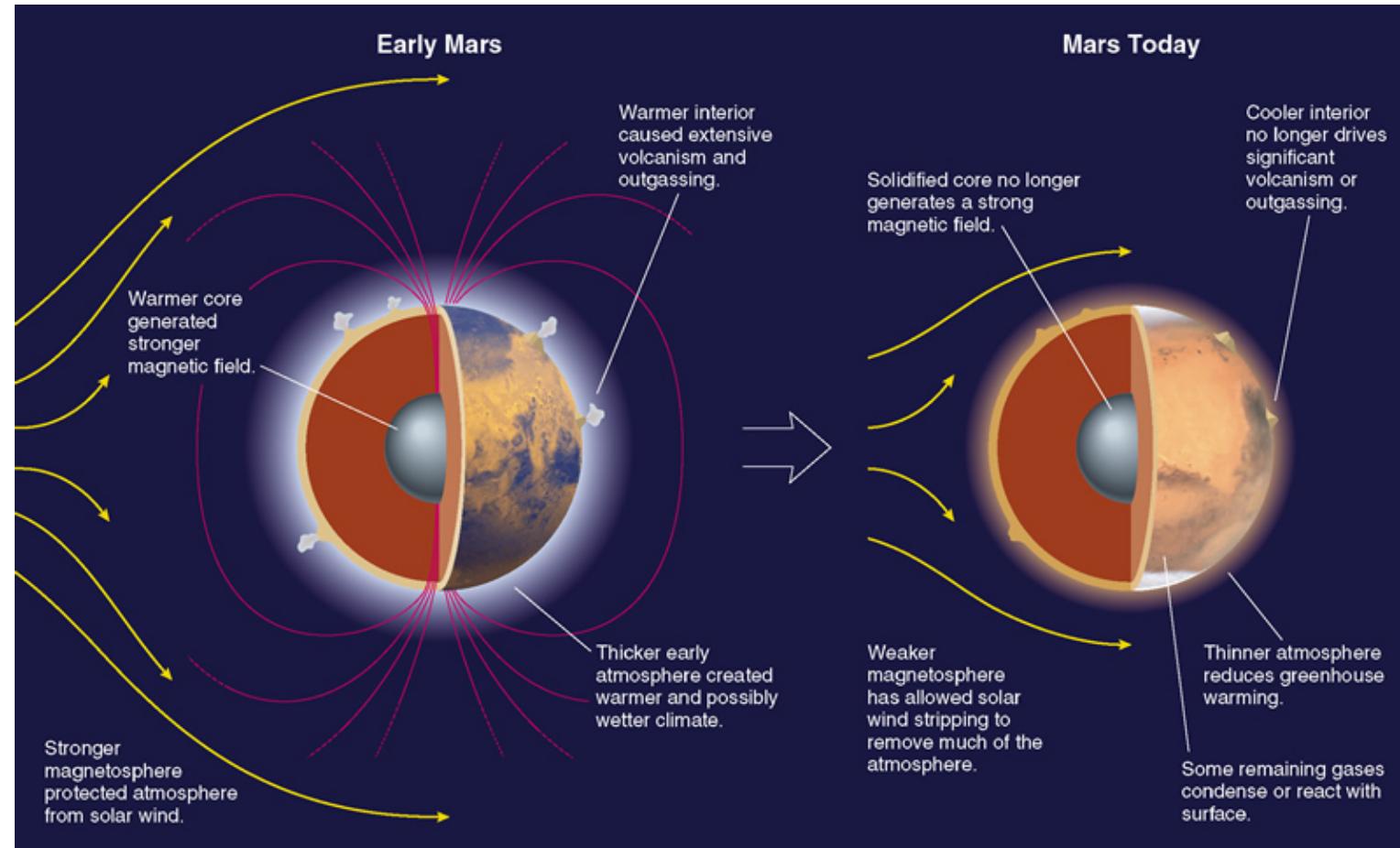
Water on Mars Today?

“Gullies form when snow accumulates on crater walls in winter and then melts away in spring. Because the gullies are relatively small, they should be gradually covered over by blowing sand during Martian dust storms. Thus, gullies that are still clearly visible must be *no more than a few million years old*. Geologically speaking, this time is short enough to make it quite likely that water flows are still forming gullies today.”



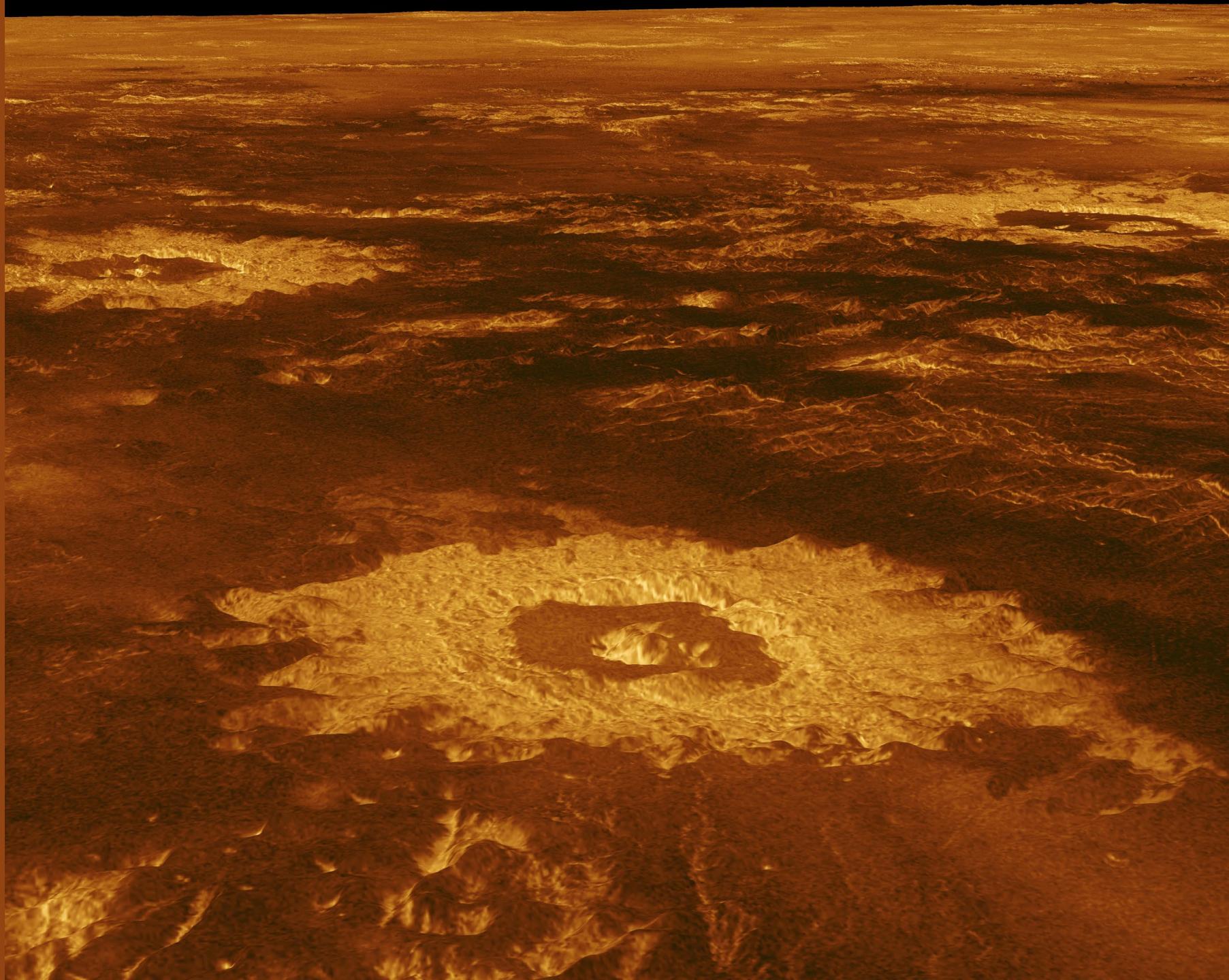
Why doesn't Mars have water today?

If Mars used to hold a large amount of water, then why is Mars so different today? What caused it to lose its water?





Geology of Venus



NASA/JPL

Why doesn't Venus have water?

Given the similarities between Earth and Venus, why is the atmosphere of Venus so different from Earth's?

Venus is too hot!

- The proximity to the Sun keep the temperature on Venus high, even without greenhouse effect. Any water on Venus (from out-gassing of water trapped inside the planet) are vaporized into gaseous phases (water vapor).
- Water vapor and CO₂ are both greenhouse gas, causing the atmosphere to warm up more \Rightarrow *runaway greenhouse effect* $\Rightarrow T = 740 \text{ }^{\circ}\text{K}$
- At 740 $\text{ }^{\circ}\text{K}$, the molecules of gases has much higher average kinetic energy (recall the definition of *temperature*) \Rightarrow higher average velocity.
- If the velocity of the gas molecules exceed the *escape velocity*, then they can escape into space...
- Light gases (H, H₂O, O₂, N₂) escape, heavy gases (CO₂) stay. *Why?*
- Without liquid water, CO₂ doesn't have a place to go, except to stay in the atmosphere... *in comparison*, most of the CO₂ on Earth are locked in rock or liquid water...

Recap



- 1. What surface process dominates on Mars? Why?**
- 2. What surface process dominates on Venus? Why?**
- 3. What is the main source of heat for the Earth?**





Up next:

Kepler's Laws & Gravity

