

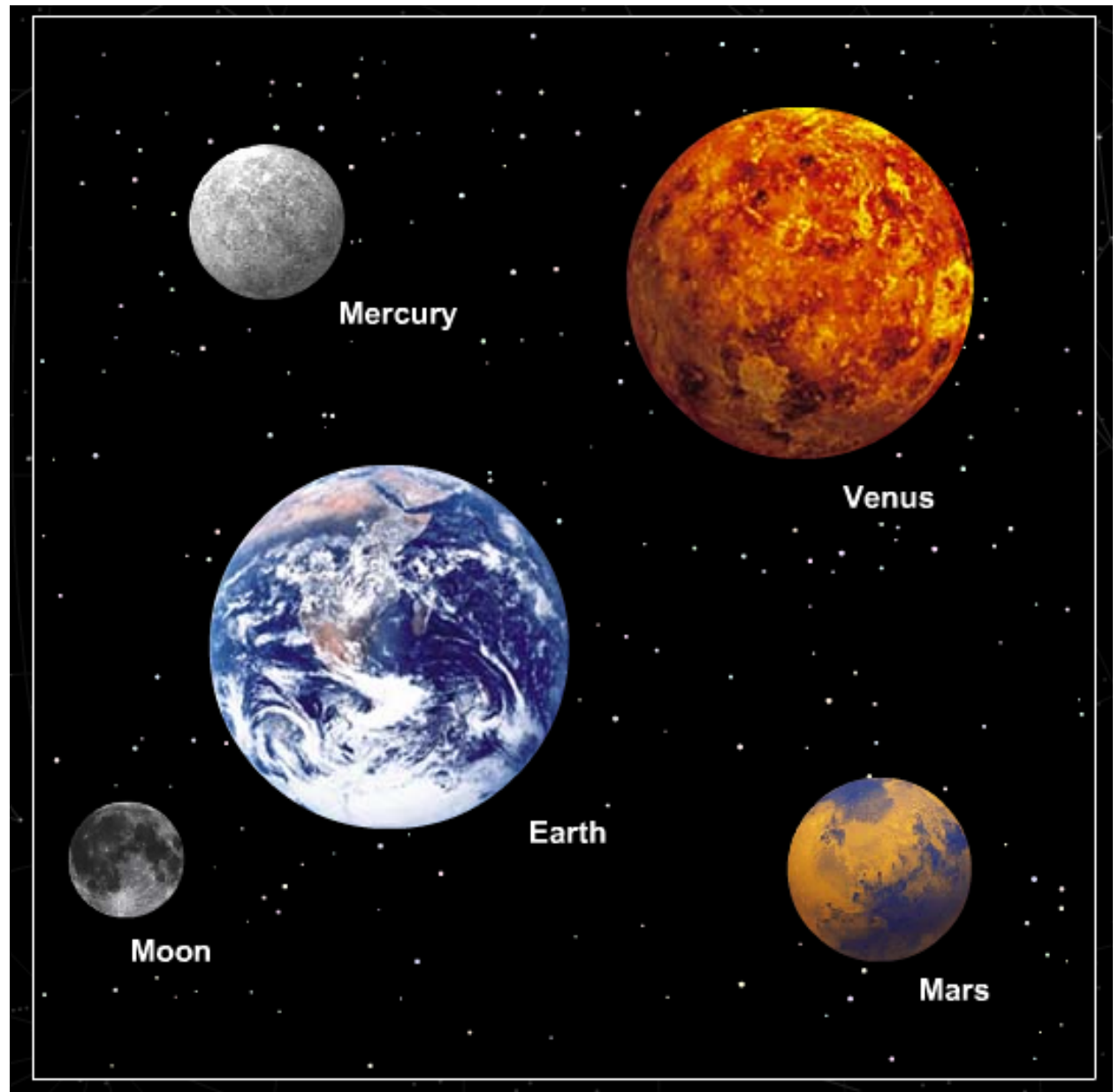
Chapter 9

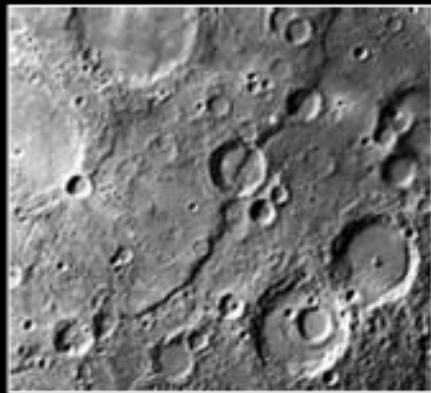
Planetary Geology: Earth and Other Terrestrial Worlds

Topics

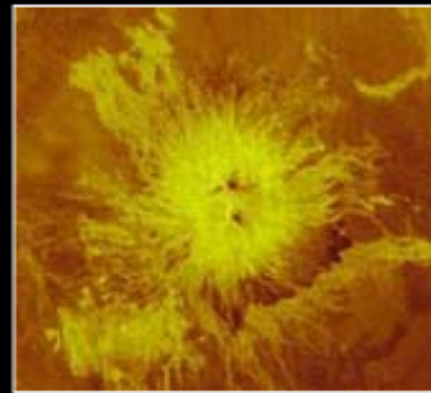
- A Diversity of Terrestrial Worlds
- Internal Structure of Terrestrial Planets
- Energetics of Planetary Interiors
- Processes Shaping Planetary Surfaces
- Geologic Tour of the Terrestrial Worlds

The Terrestrial Worlds





Mercury



Venus

**Surface images of
the terrestrial
planets
and the Moon**



Earth



Mars



Moon

Venus Unshrouded



Earth: Normal or Oddball?

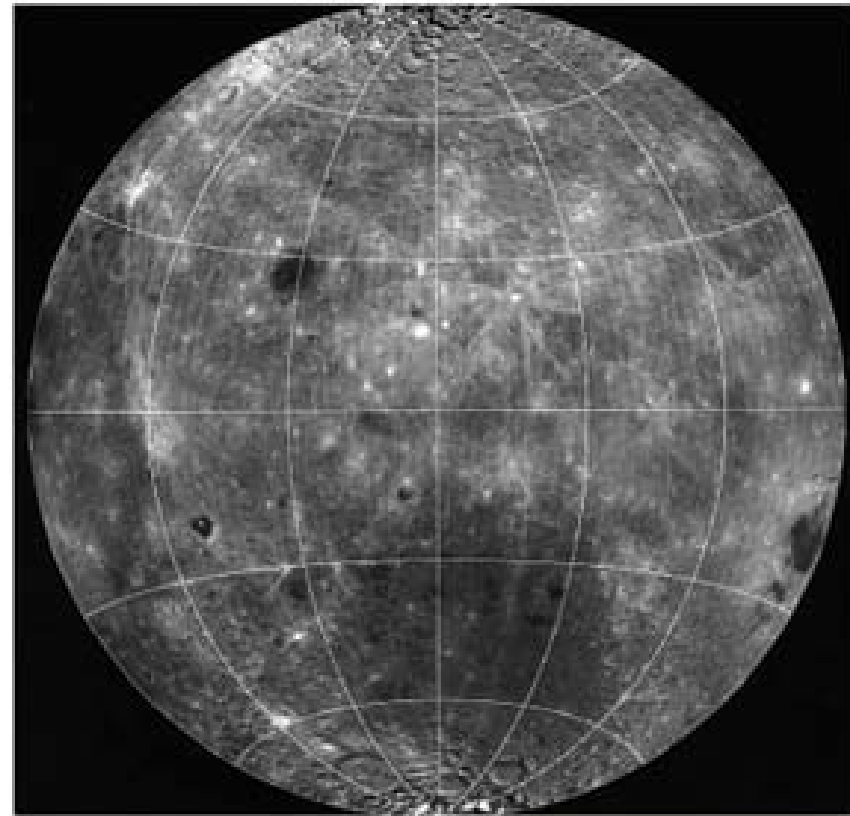


The Moon: A Terrestrial World

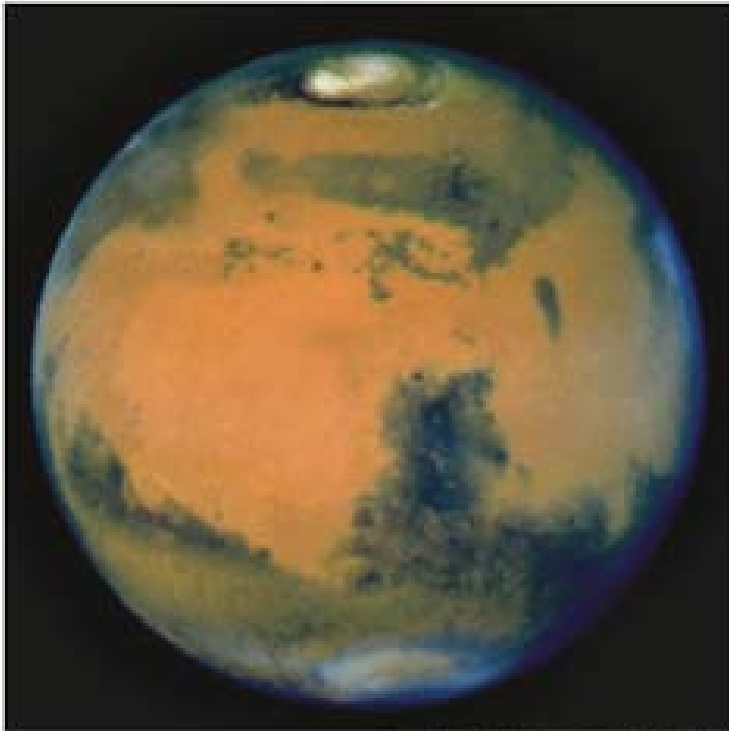
front



back



Mars: Once Like Earth?

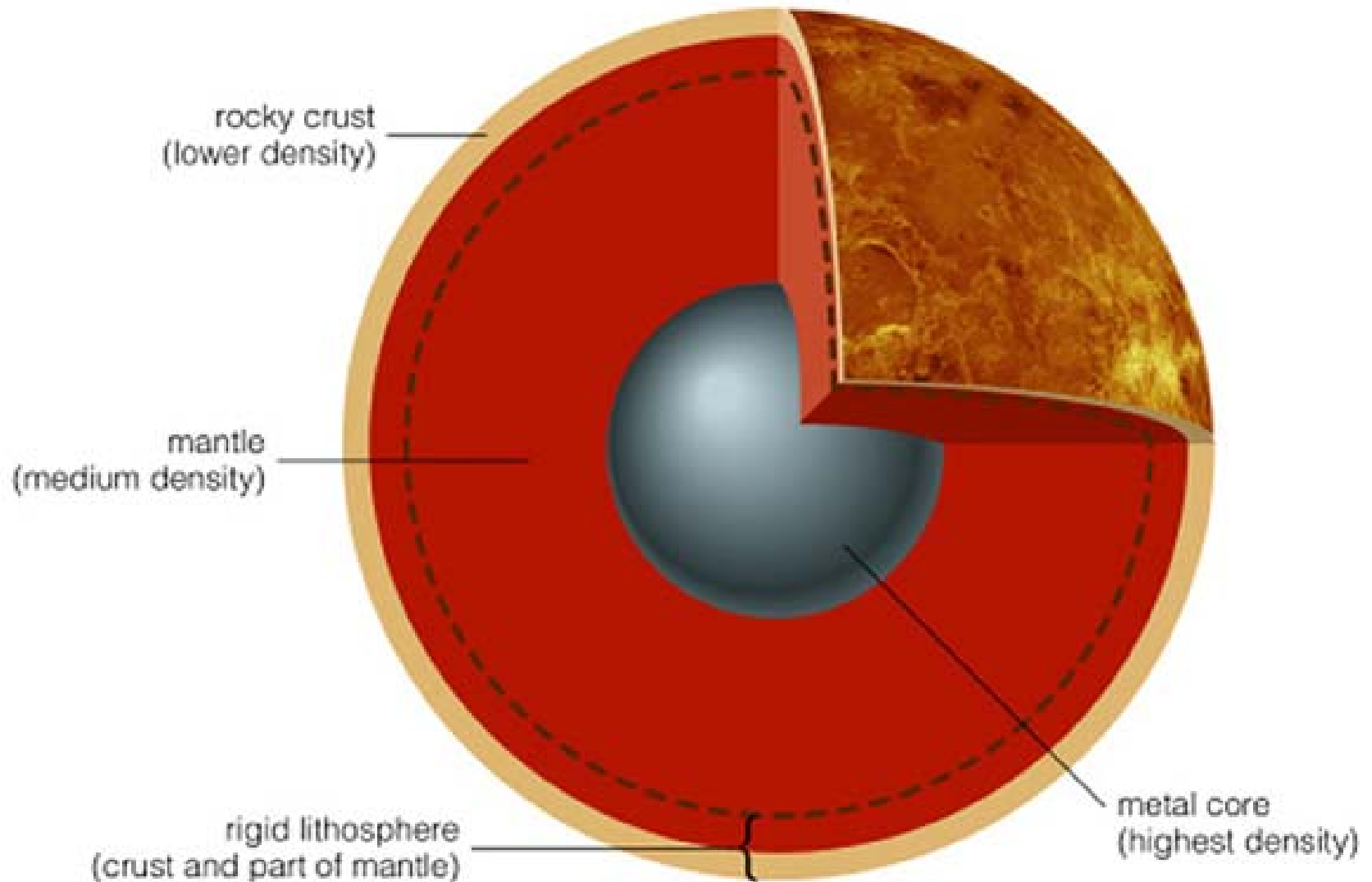


(a)

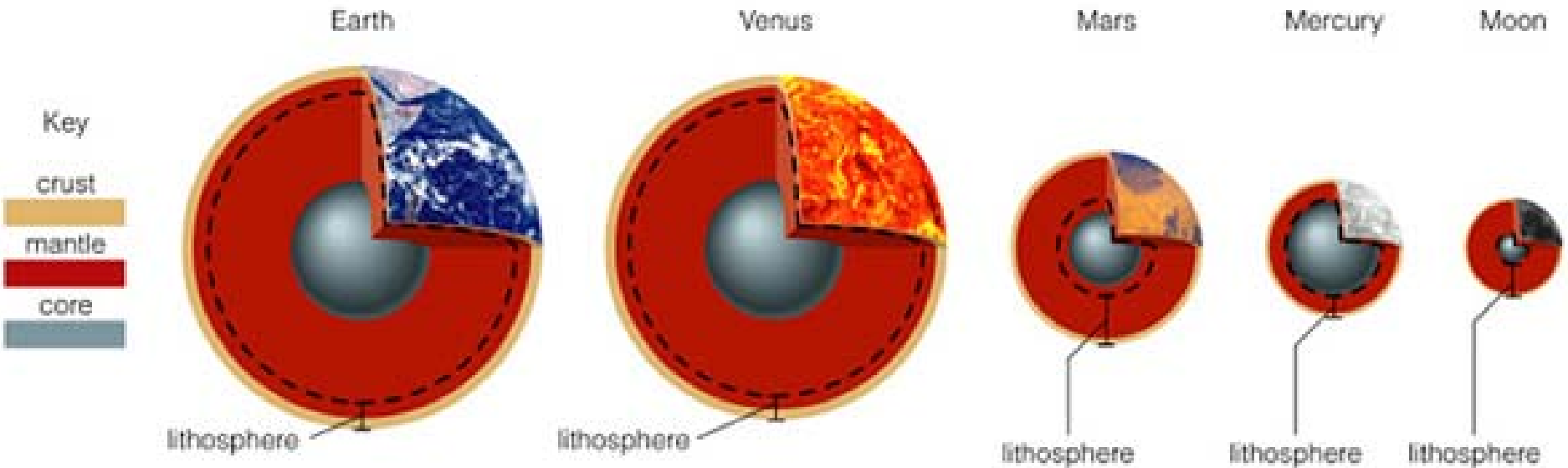


ancient river valley

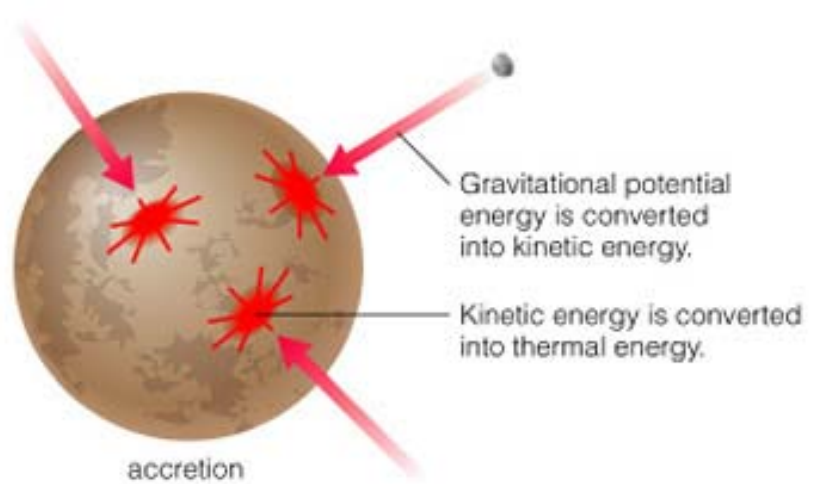
The Earth's Interior



How do the other's compare?

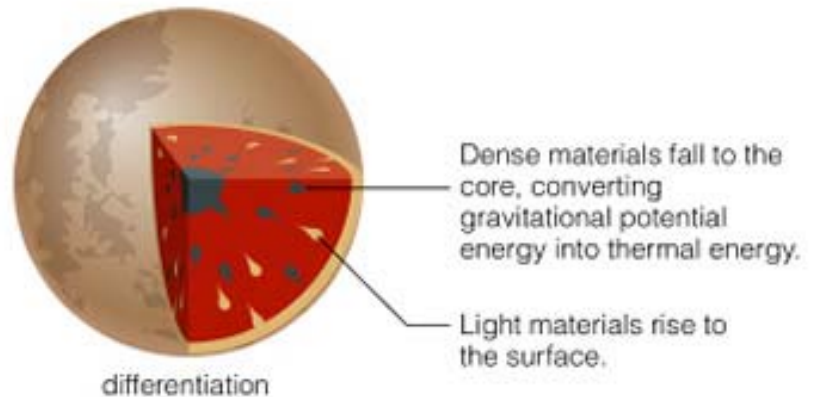


Three Energy Sources Inside Planets

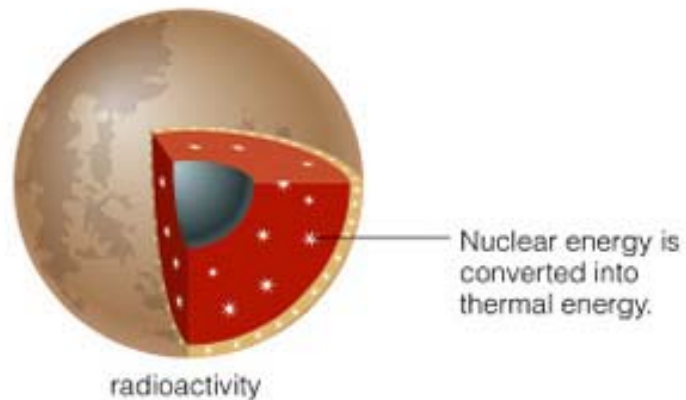


Accretion: only important during planet formation

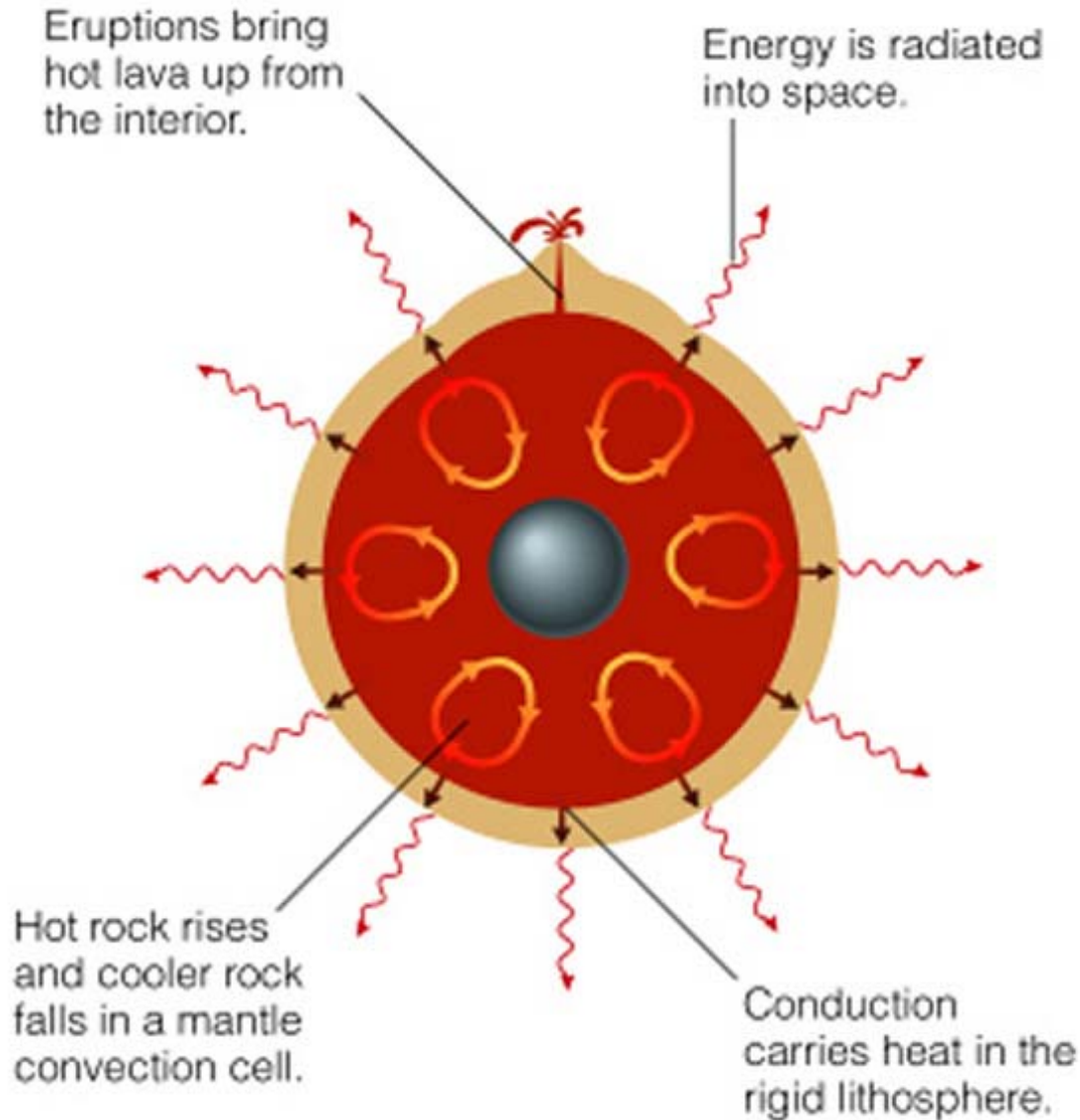
Differentiation: only important during planet formation



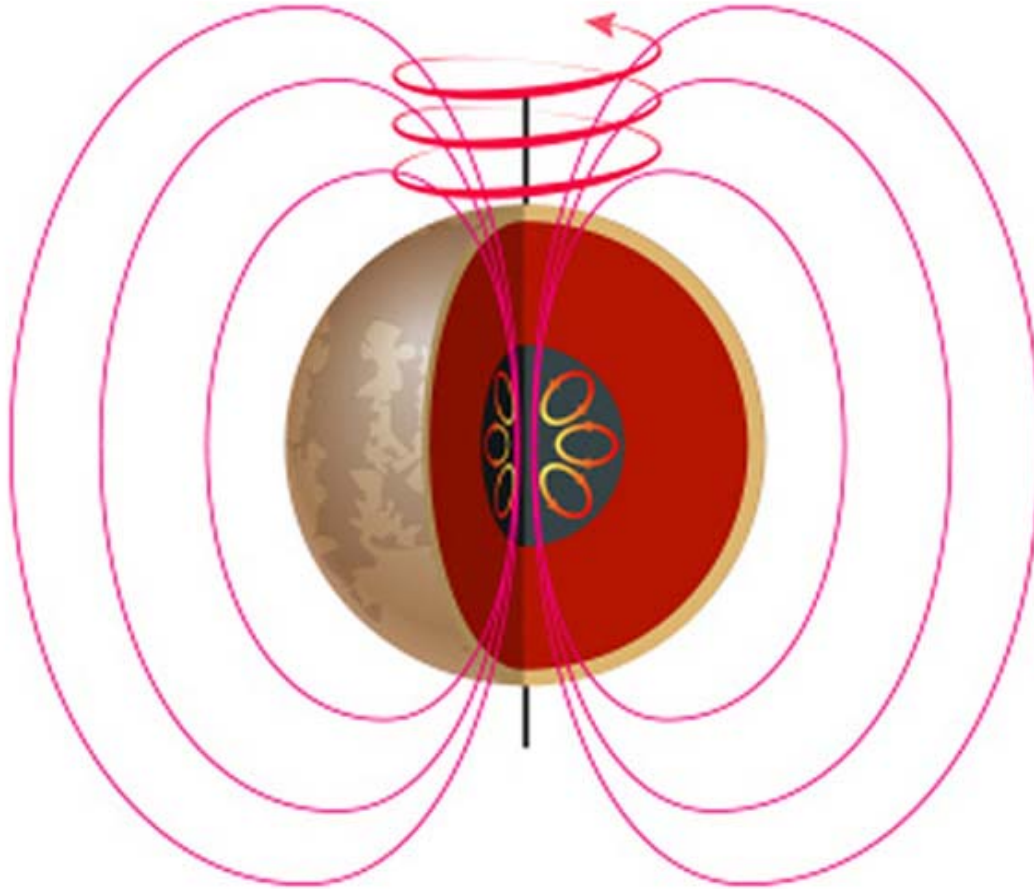
Radioactivity: important even today



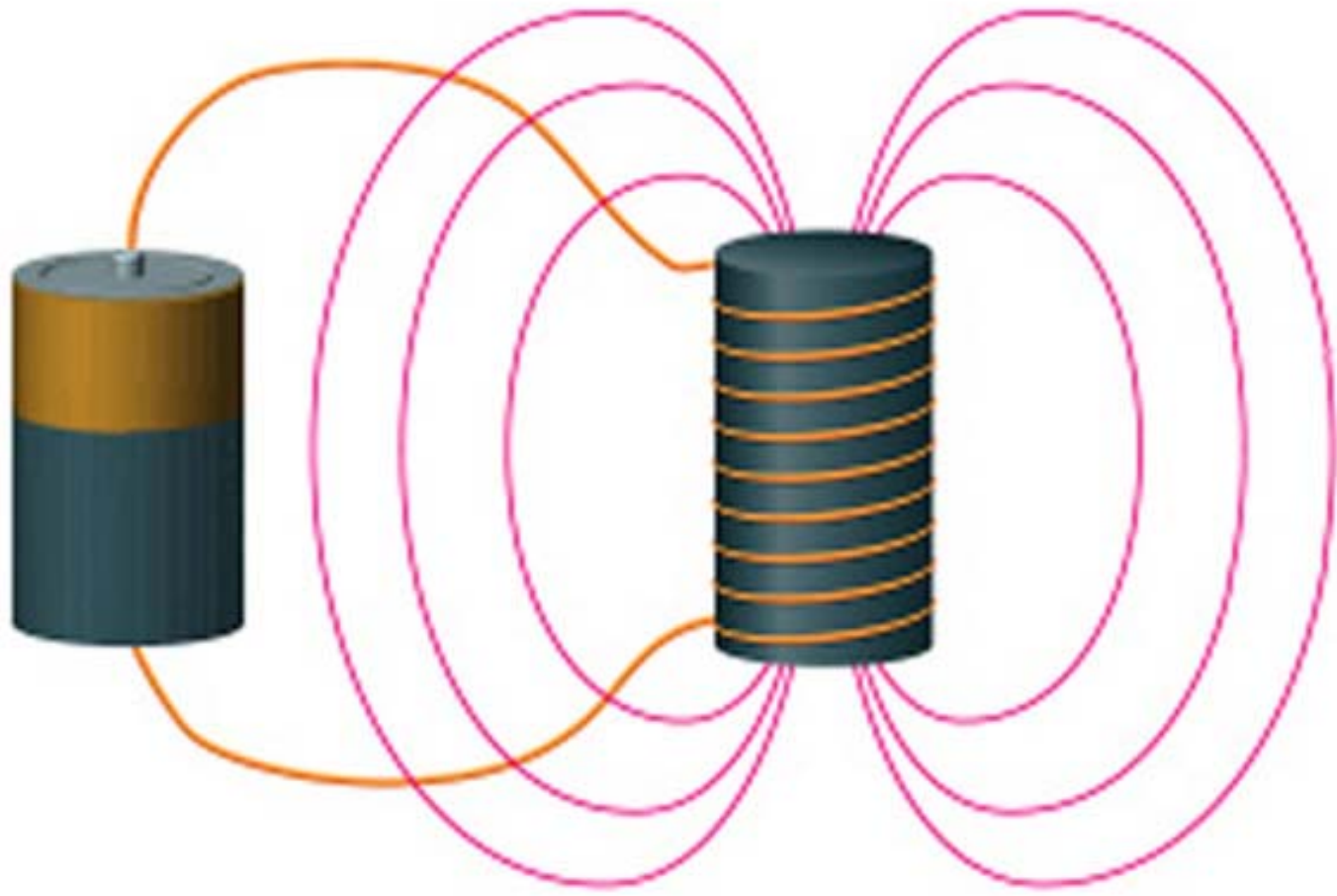
How Planets Cool Off



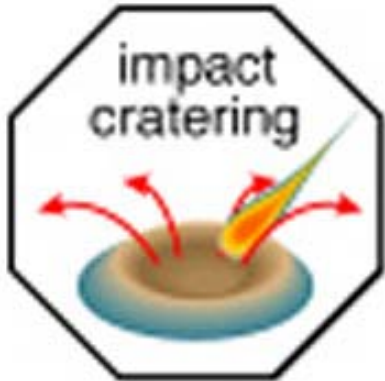
Earth's Magnetic Field [1]



Electromagnet



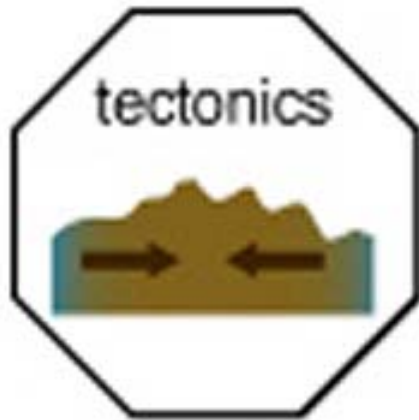
Processes Shaping Planet Surfaces



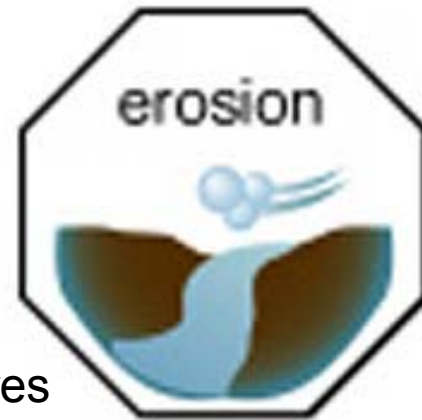
Excavation of bowls
by asteroids or comets



Eruption of molten rock
Or lava from planet's
interior



Disruption of
Planet's surface
By internal stresses

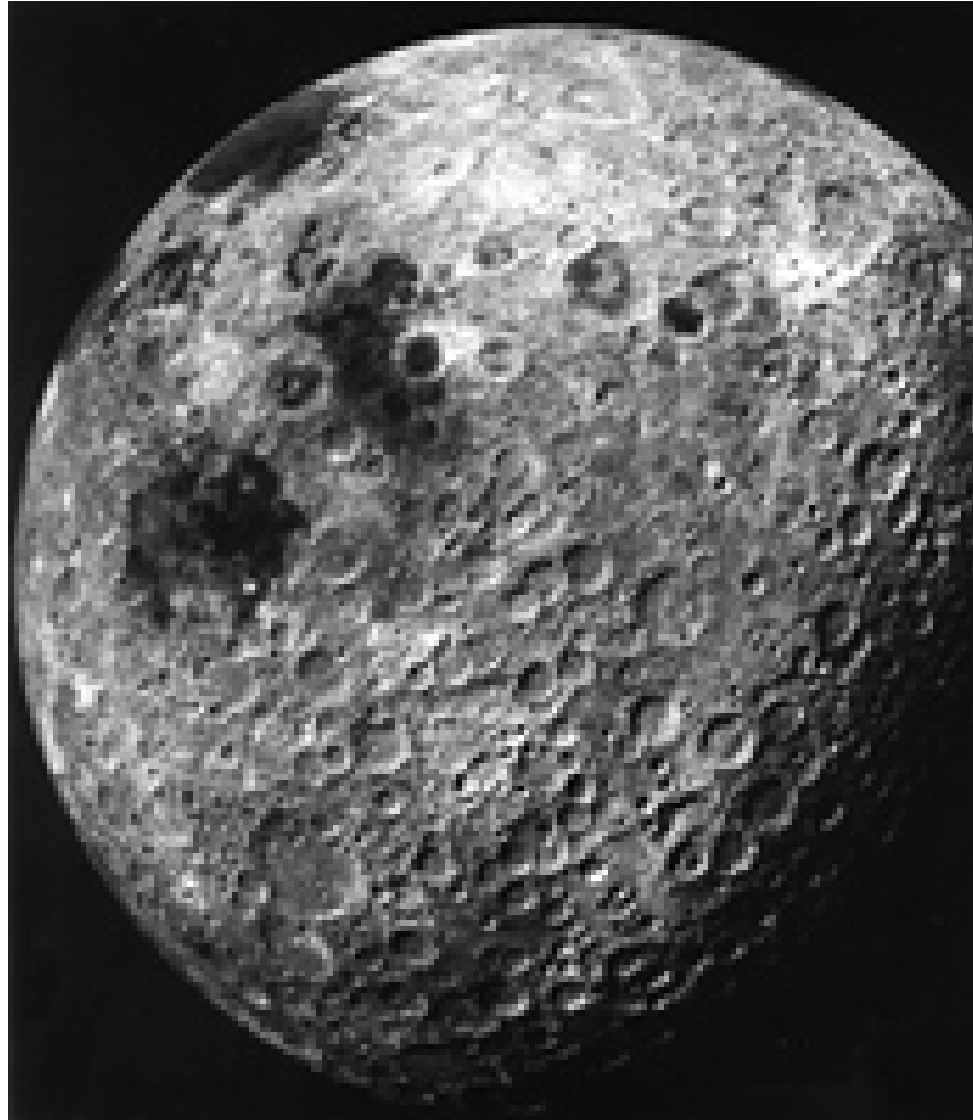


Wearing down or
Building up of features
By wind, water, ice or
Other weather phenomena

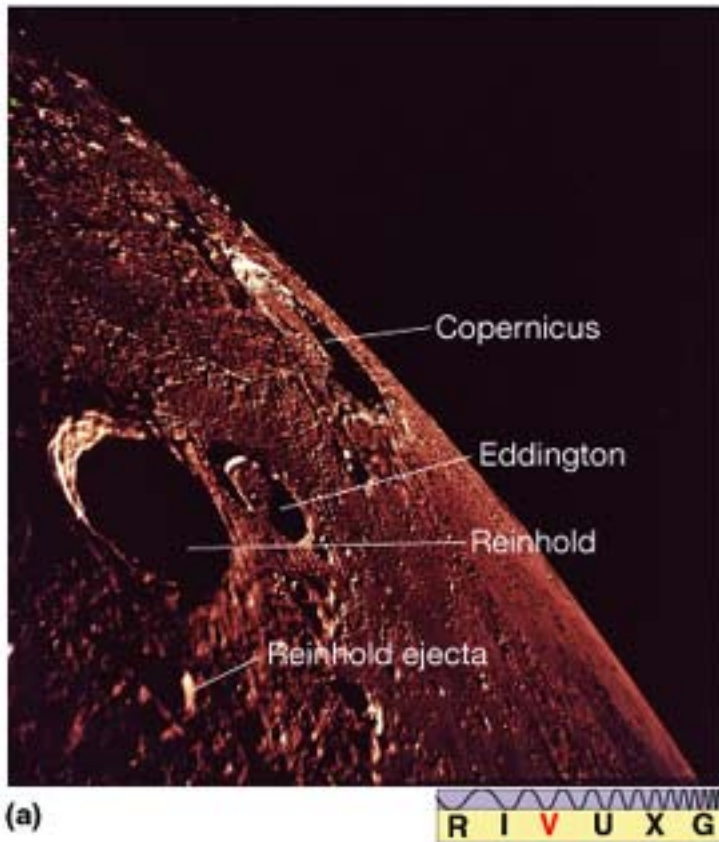
impact
cratering



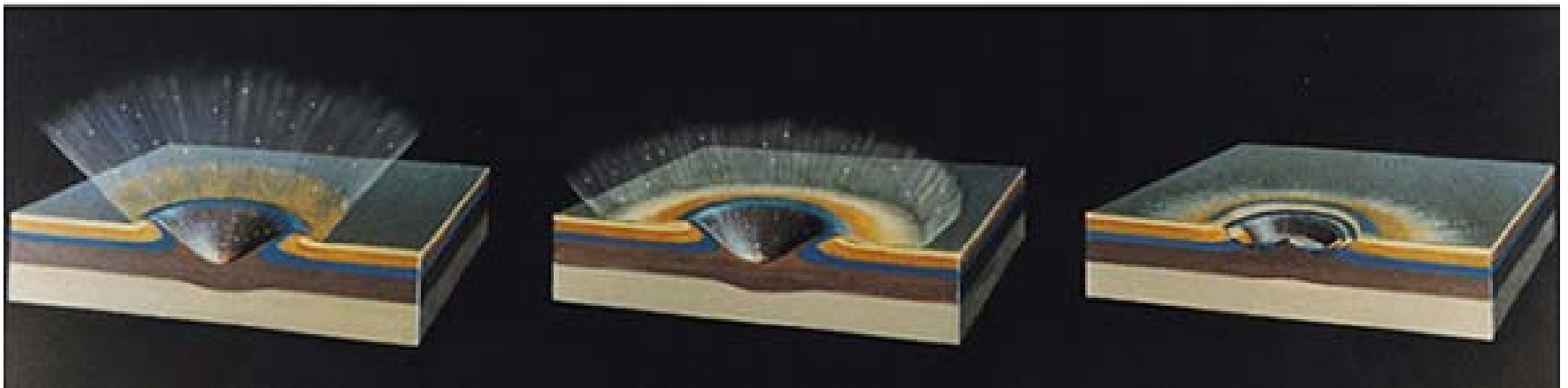
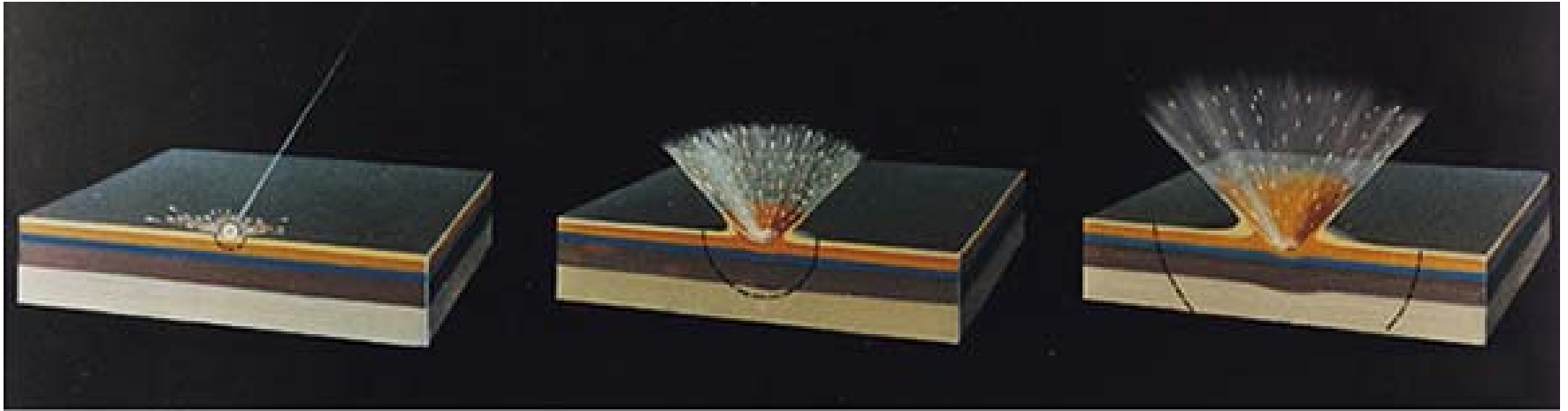
Moon's Craters



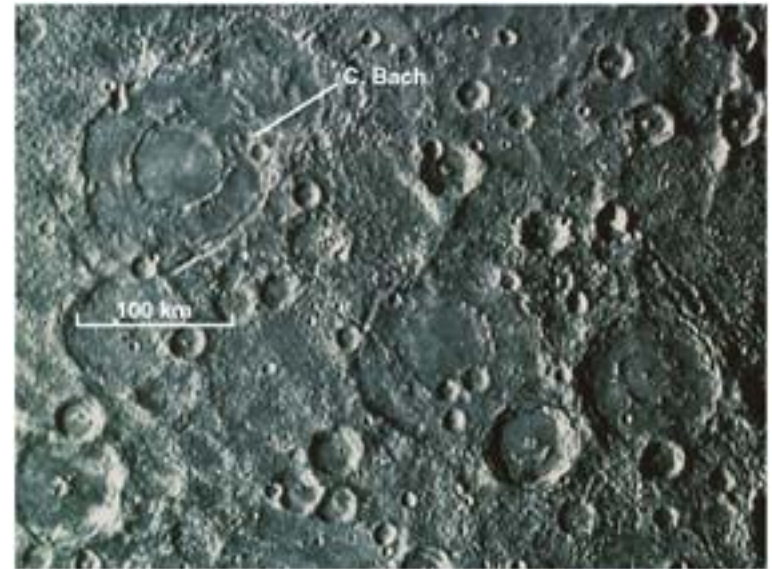
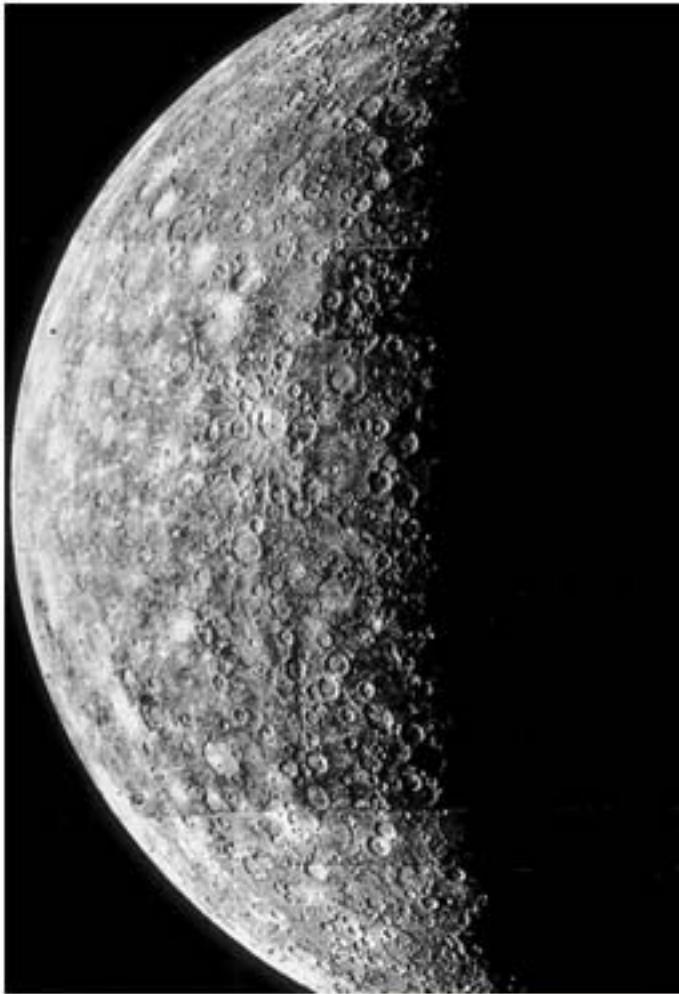
Craters and Impact Basins



Impact Process



Mercury's Surface



- heavily cratered
- no maria
- smaller rays
- long scarps
- impact basins

Martian Craters



“bowl crater”



“splash crater”

volcanism



Moon: Highlands and Maria



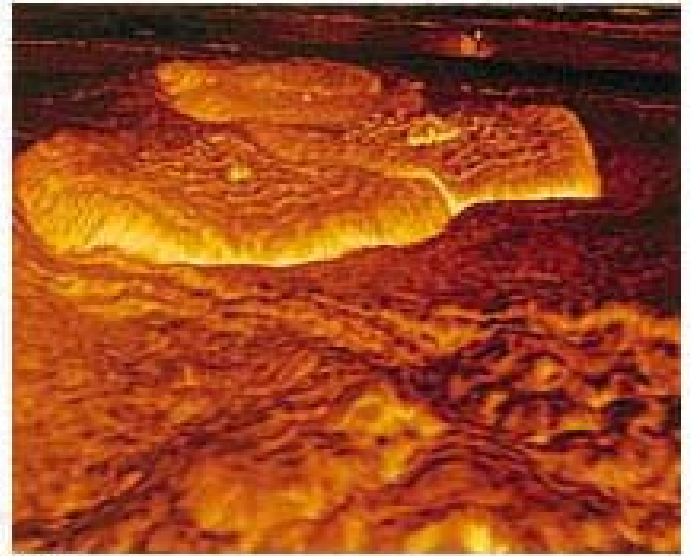
Venus's Surface

- Mapped by radar in 1979 and 1995
- +/- 4km variations in surface elevation similar to Earth
- evidence of volcanism and cratering
- lava domes





(a)



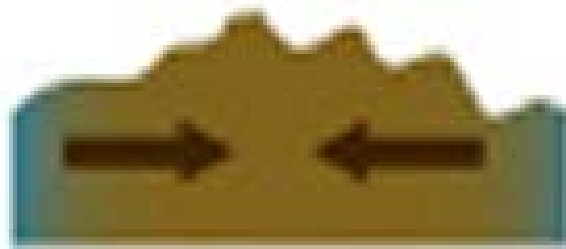
(b)

Lava Domes: Evidence of Vulcanism

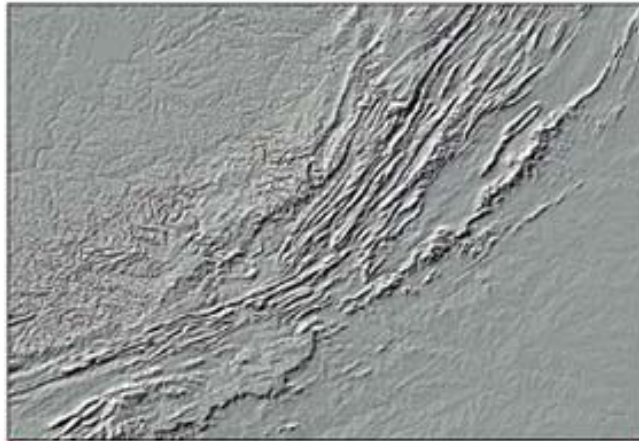


(c)

tectonics



Tectonics



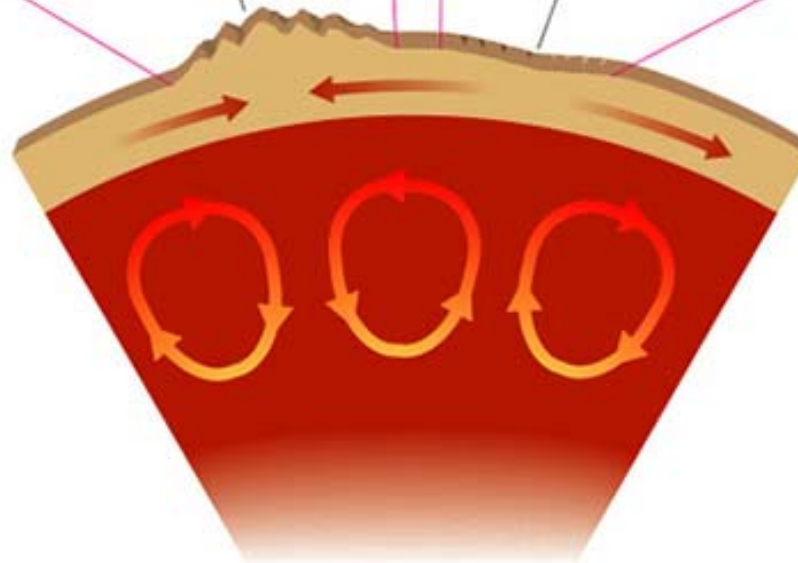
Appalachian Mountains in eastern United States

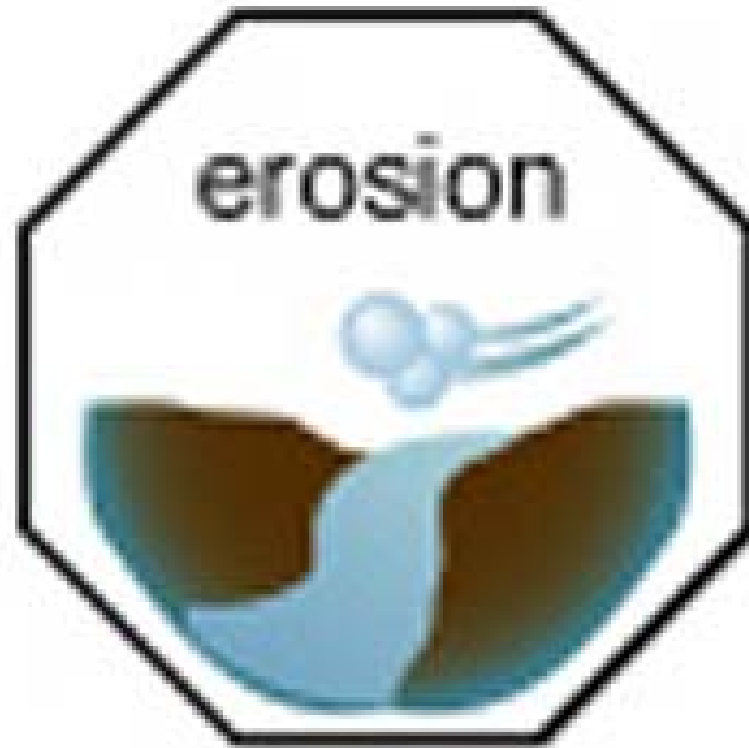


Guinevere Plains on Venus

Compression in crust
can make mountains.

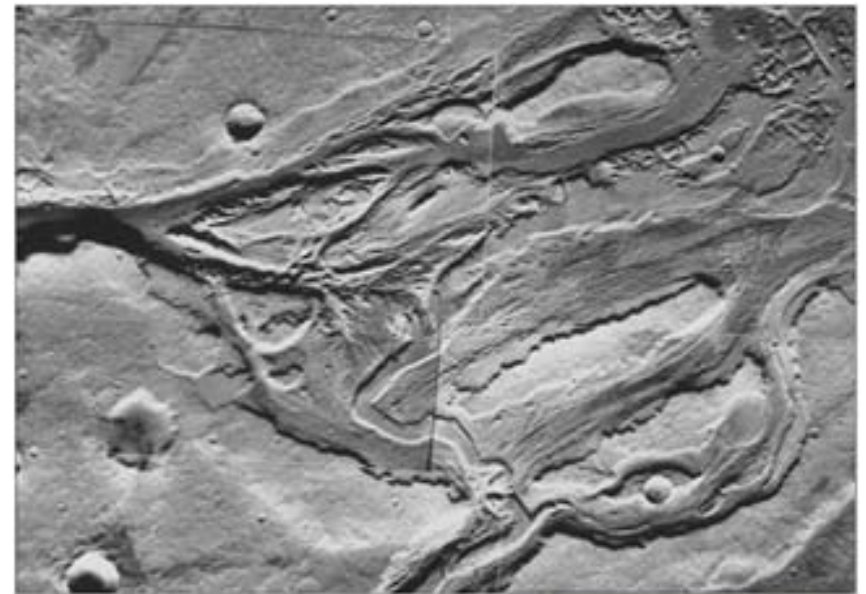
Extension can make
cracks and valleys.





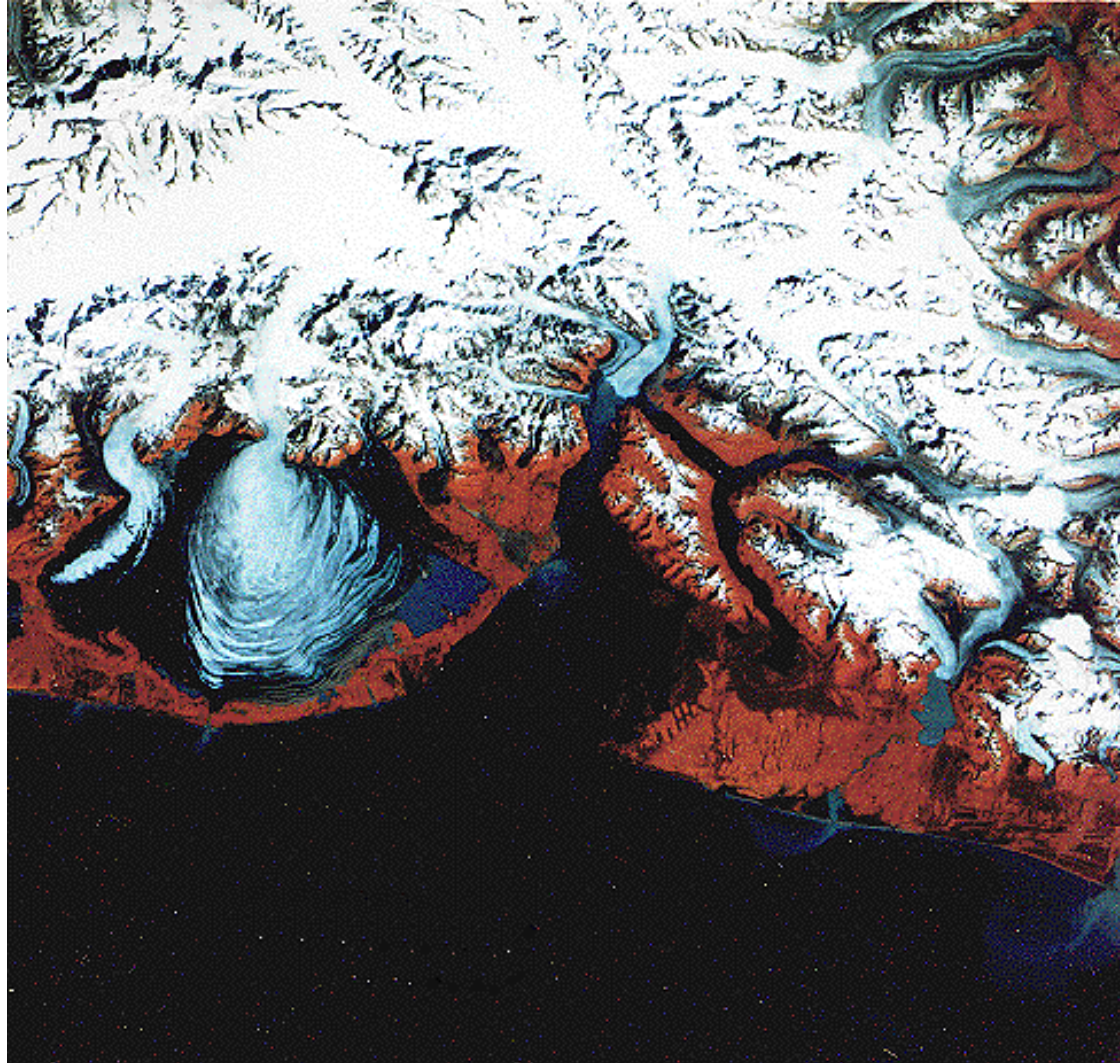
Erosion on Mars

- Erosion caused wind and flowing liquids (e.g., water)
- Water most effective
- Evidence of erosion on Mars is extensive, implying existence of liquid water sometime in its history



ancient river valley

Glaciers: Large Scale Erosion

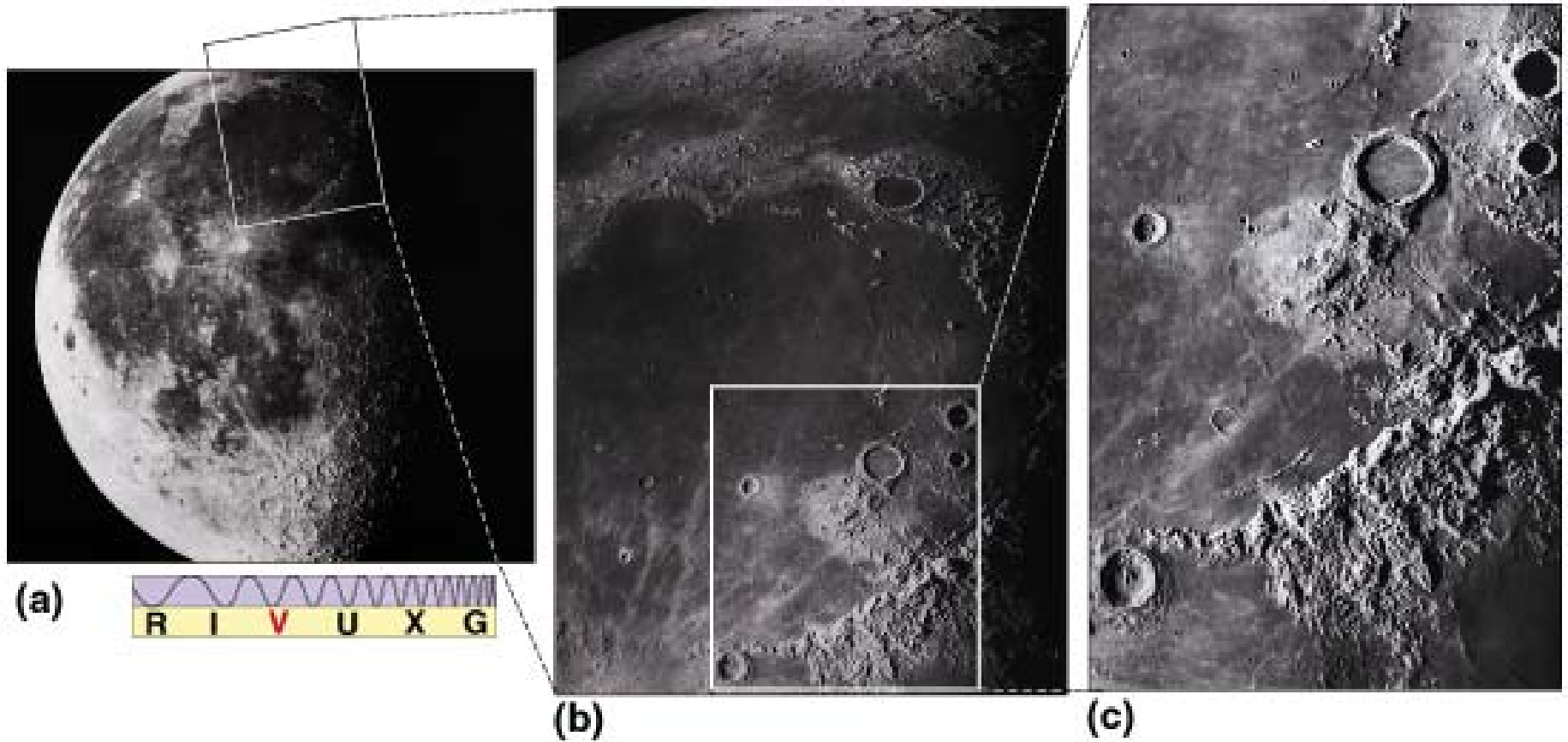


Malaspina Glacier, Alaska (USGS)

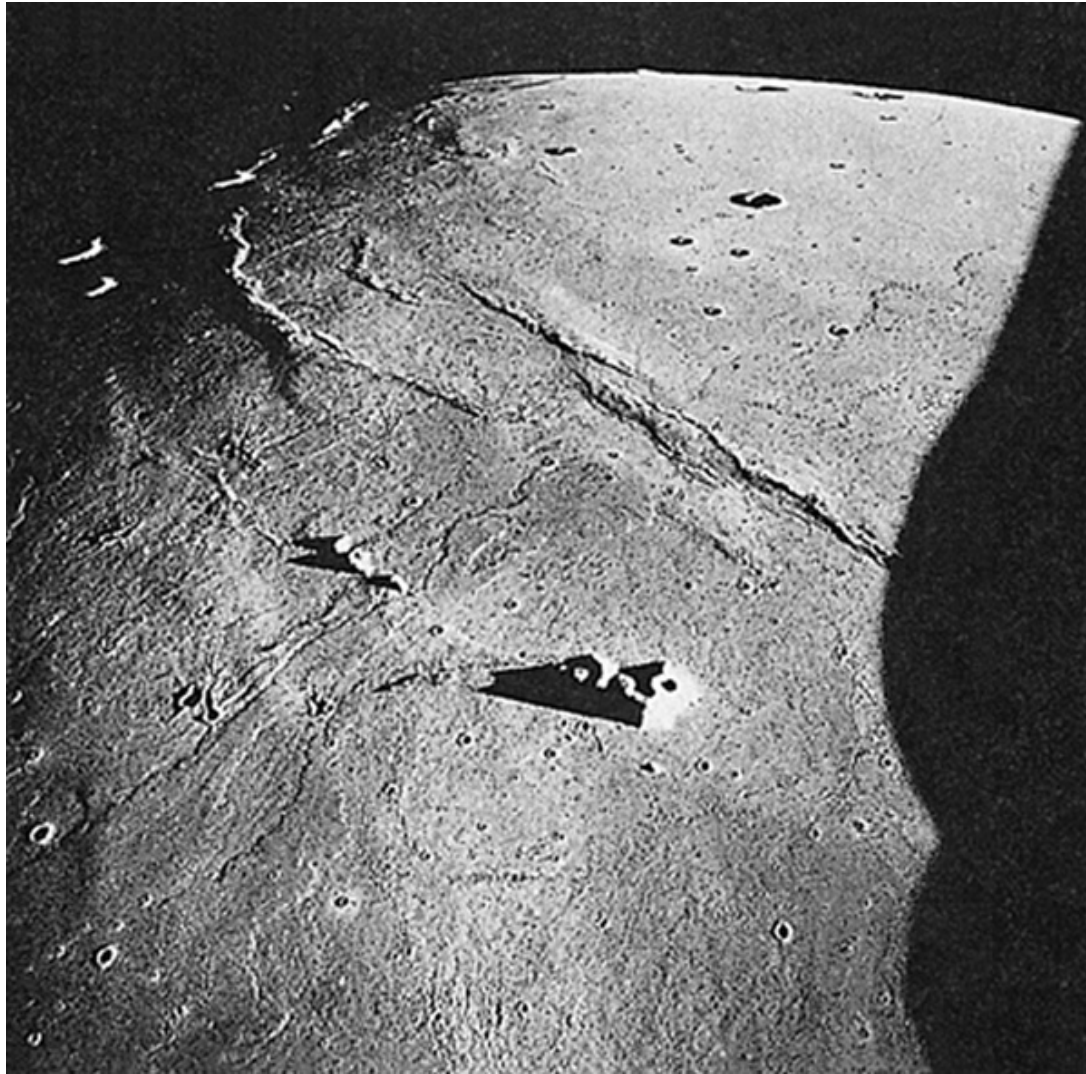
Tour of the Terrestrial Planets

- Order: from smallest to largest
 - Moon
 - Mercury
 - Mars
 - Venus
 - Earth
- Will see that “size matters”
 - larger planets retain atmospheres and molten interiors==>volcanism, tectonics erase craters
 - smaller planets loose atmosphere and solidify==>craters, evidence of early volcanism/tectonics

Lunar Mare (Seas)

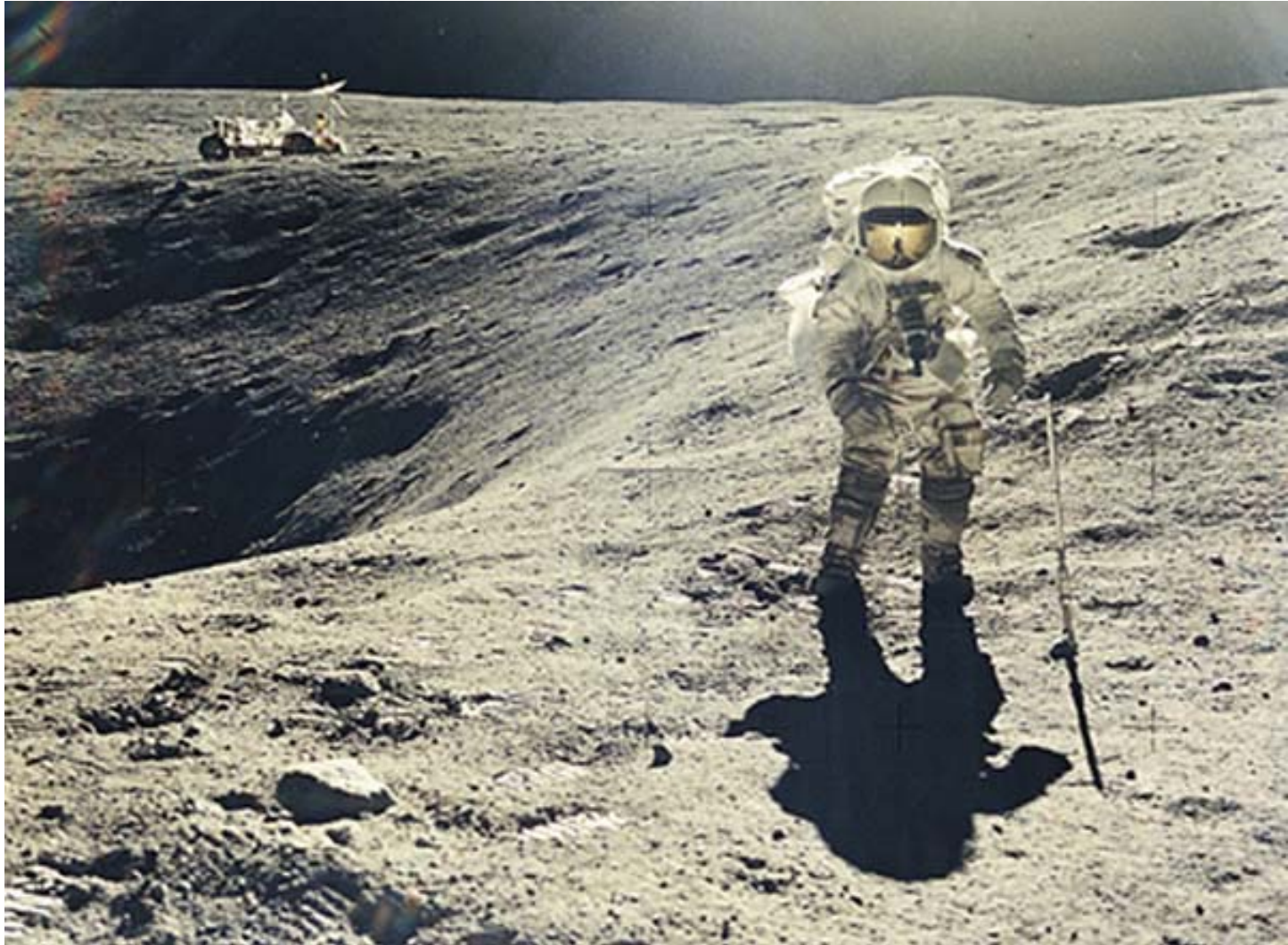


Lunar Vulcanism & Tectonics



Mare Imbrium seen from lunar orbit

Astronaut on Moon



Ancient Lava River



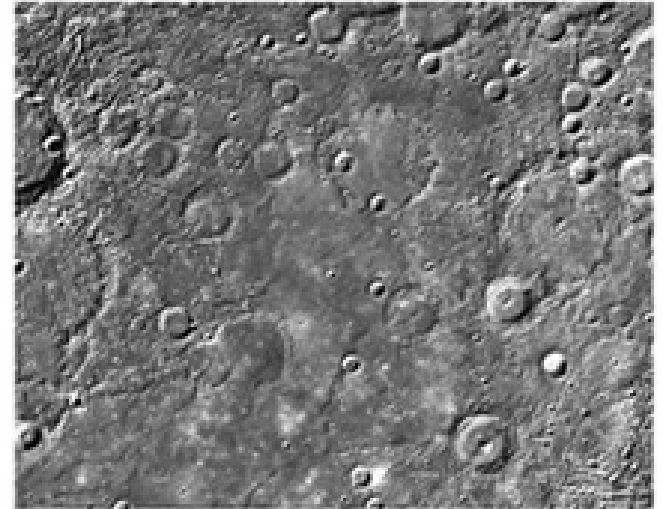
Mercury: Cratering and Vulcanism



a Edge of Caloris Basin

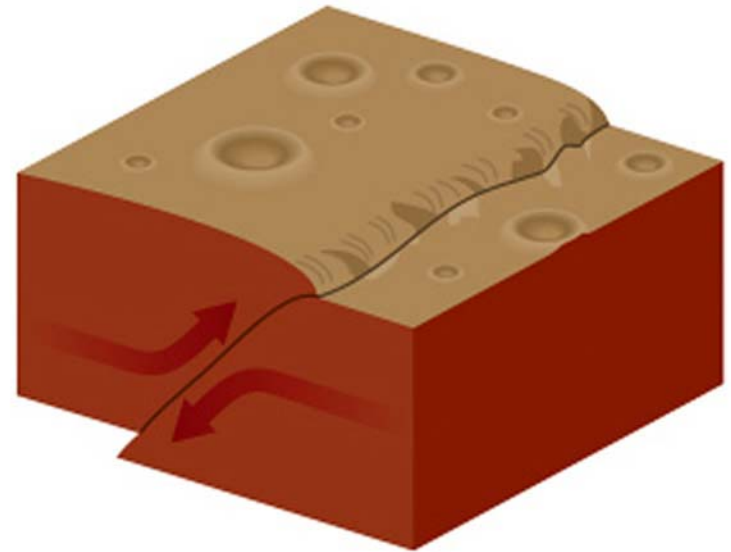
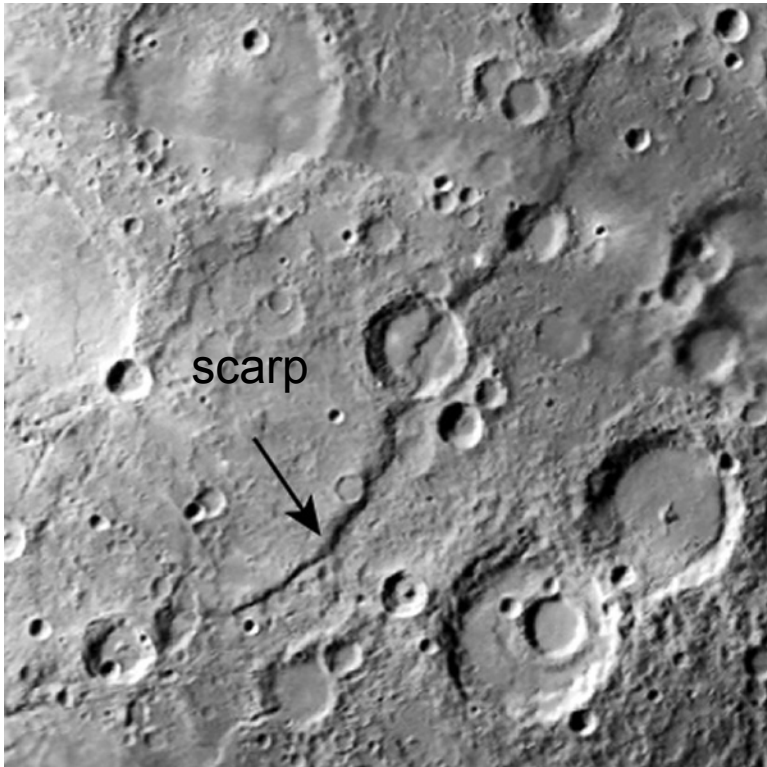


b Mercury

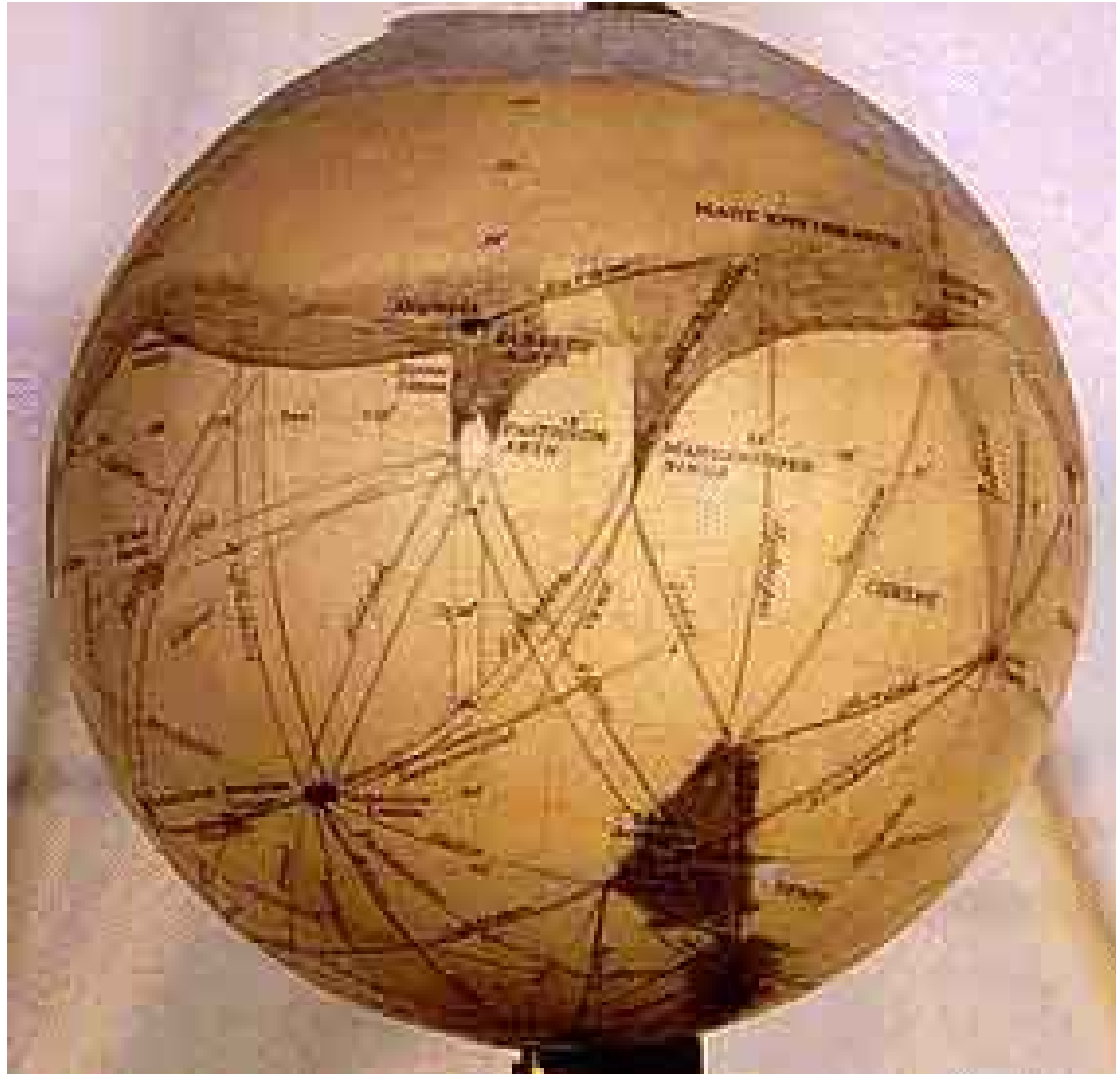


c Closeup view showing small lava plains that have covered up craters.

Evidence of Tectonics on Mercury

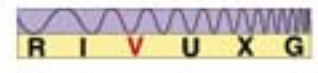
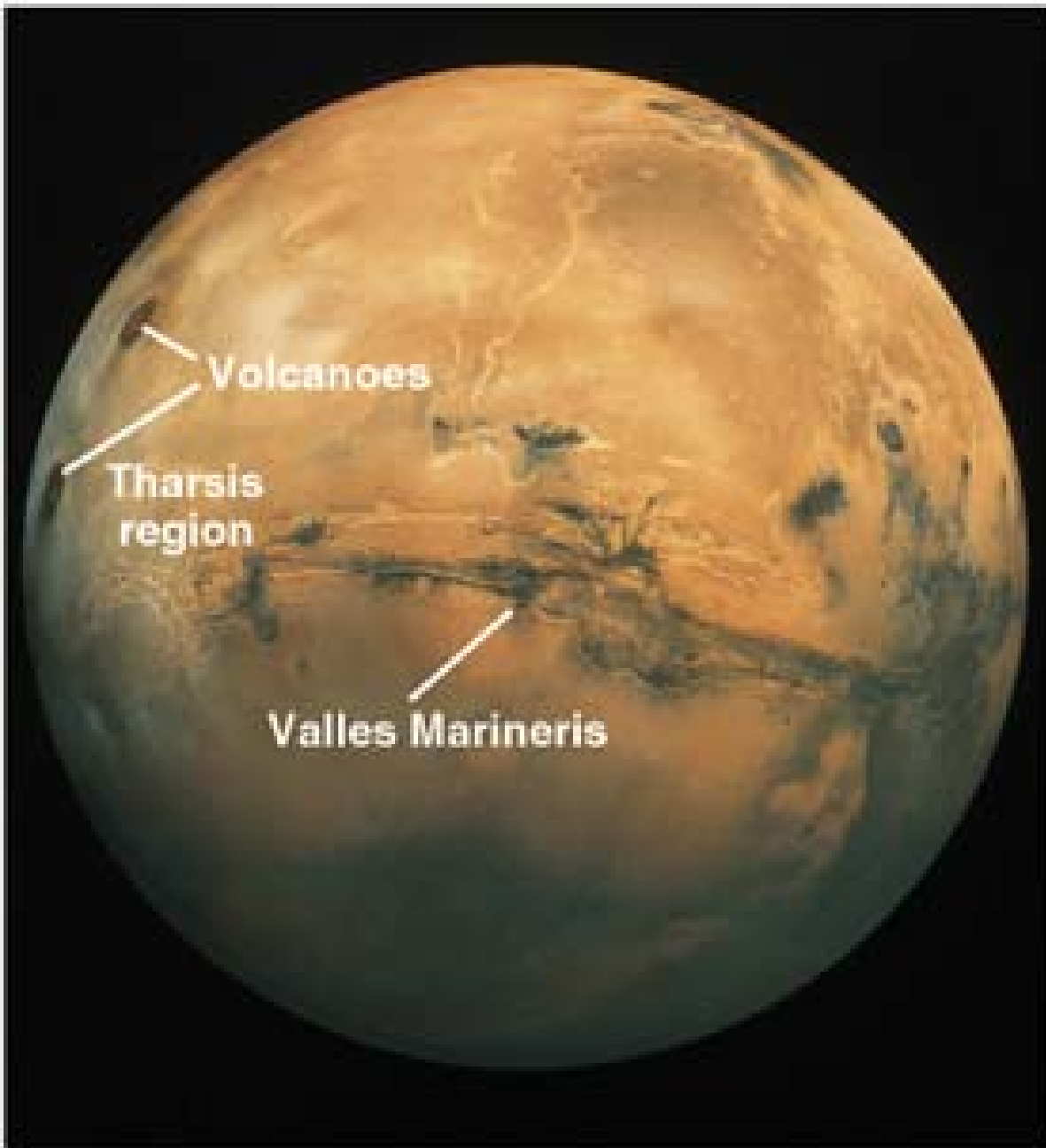


Martian Canals?

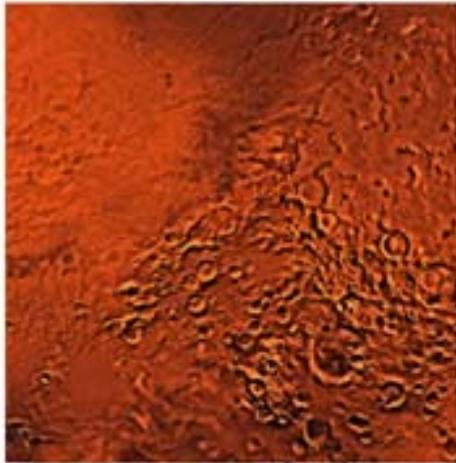


Sciaparelli (1877), Percival Lowell (1895)

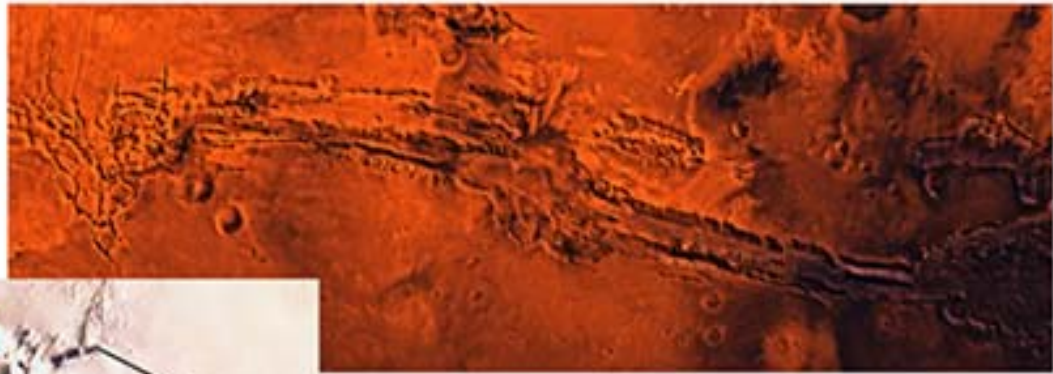
Large-Scale Topography: Mars



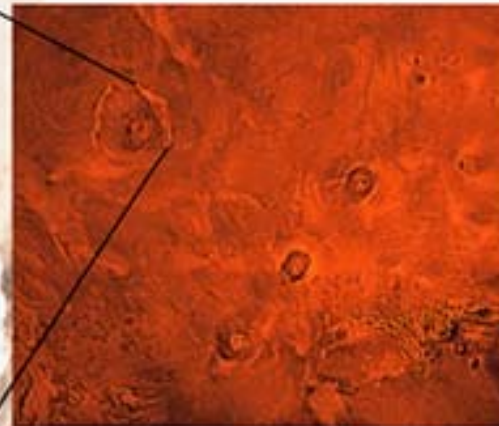
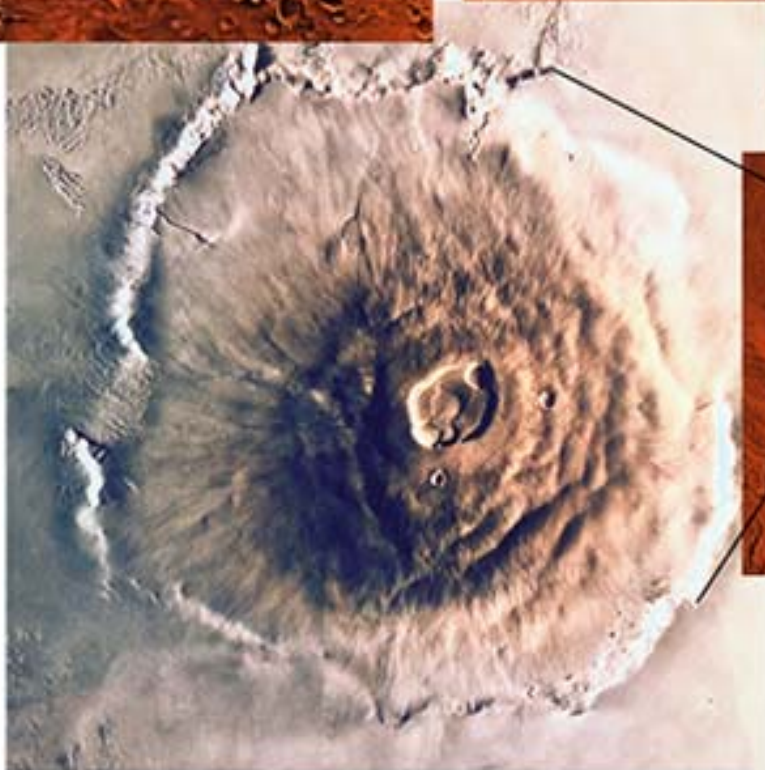
Mars: Vulcanism and Tectonics



a The southern hemisphere of Mars is heavily cratered. The image spans several hundred kilometers.

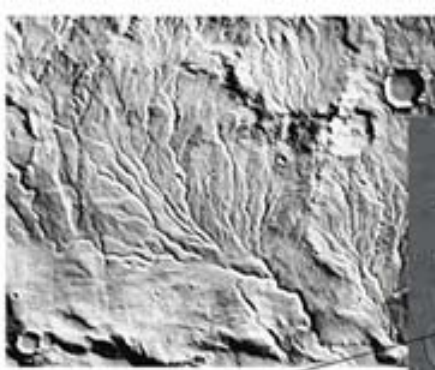


b Valles Marineris is a huge valley created in part by tectonic stresses.



c A mantle plume below the Tharsis Bulge region was probably responsible for the volcanoes near the bottom of the image and the network of valleys near the top.

d Olympus Mons – the largest shield volcano in the solar system – covers an area the size of Arizona and rises higher than Mt. Everest.

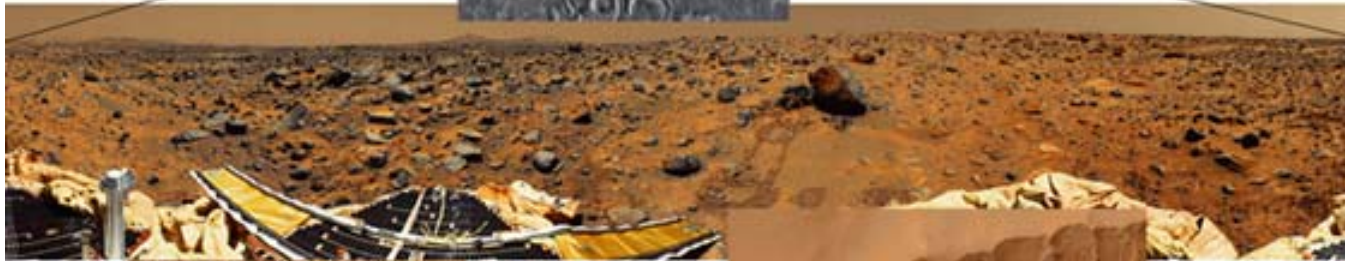


● This Viking photo (from orbit) shows ancient riverbeds that were probably created billions of years ago.

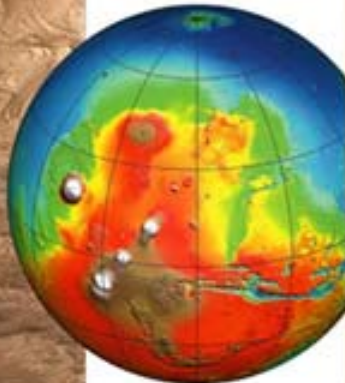


■ This photo shows winding channels and sandbars that were probably created by catastrophic floods.

■ View from the floodplain (see ■ above) from the Mars Pathfinder: the Pathfinder landing site is now known as Carl Sagan Memorial Station. The Sojourner rover is visible near the large rock.



■ Close-up view of the floor of the eroded crater shown in Figure 9.13c. Billions of years ago, the crater was apparently a pond, and layer upon layer of sediment was deposited on the bottom. The water is long gone, and winds have sculpted the layers into the astonishing patterns captured in this photograph from the Mars Global Surveyor.



● Topographic map of Mars with low-lying regions in blue and higher elevations in red, brown, and white. The white patches are tall volcanoes; Valles Marineris cuts through the terrain to their right. Some planetary geologists believe that an ocean once filled the smooth, low-lying northern regions shown in dark blue.



■ This photograph from Mars Global Surveyor shows gullies on a crater wall; scientists suspect they were formed by water seeping out from the ground during episodic flash floods. The gullies are geologically young, but no one yet knows whether similar gullies may still be forming today.

Erosion on Mars!

Venus Unshrouded

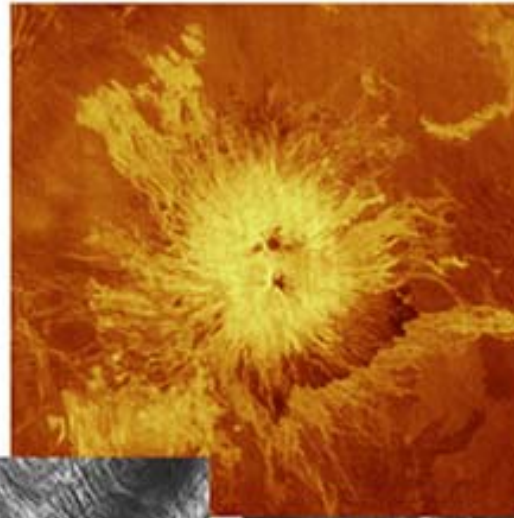


Venus: Vulcanism & Tectonics

a Impact craters like these are rare on Venus.



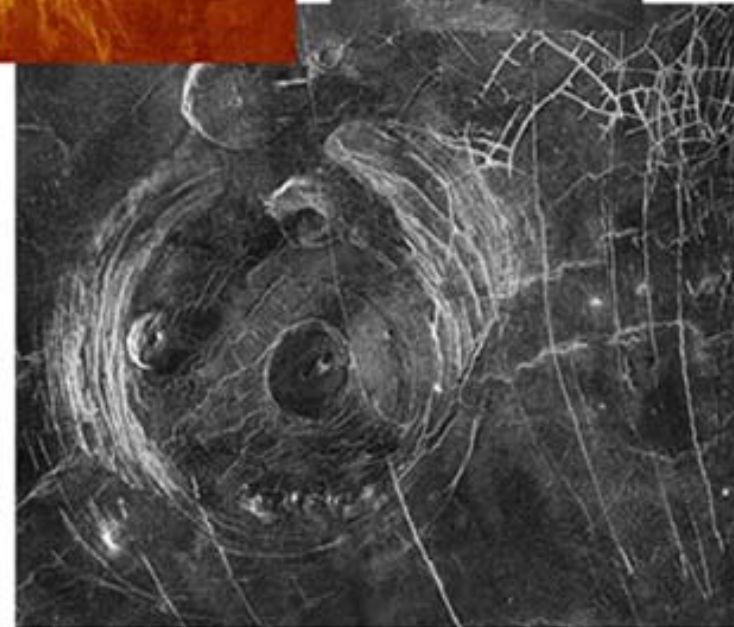
b Shield volcanoes like this one are common on Venus.



c These volcanoes were made from viscous lava.



d Tectonic forces have fractured and twisted the crust in this region.

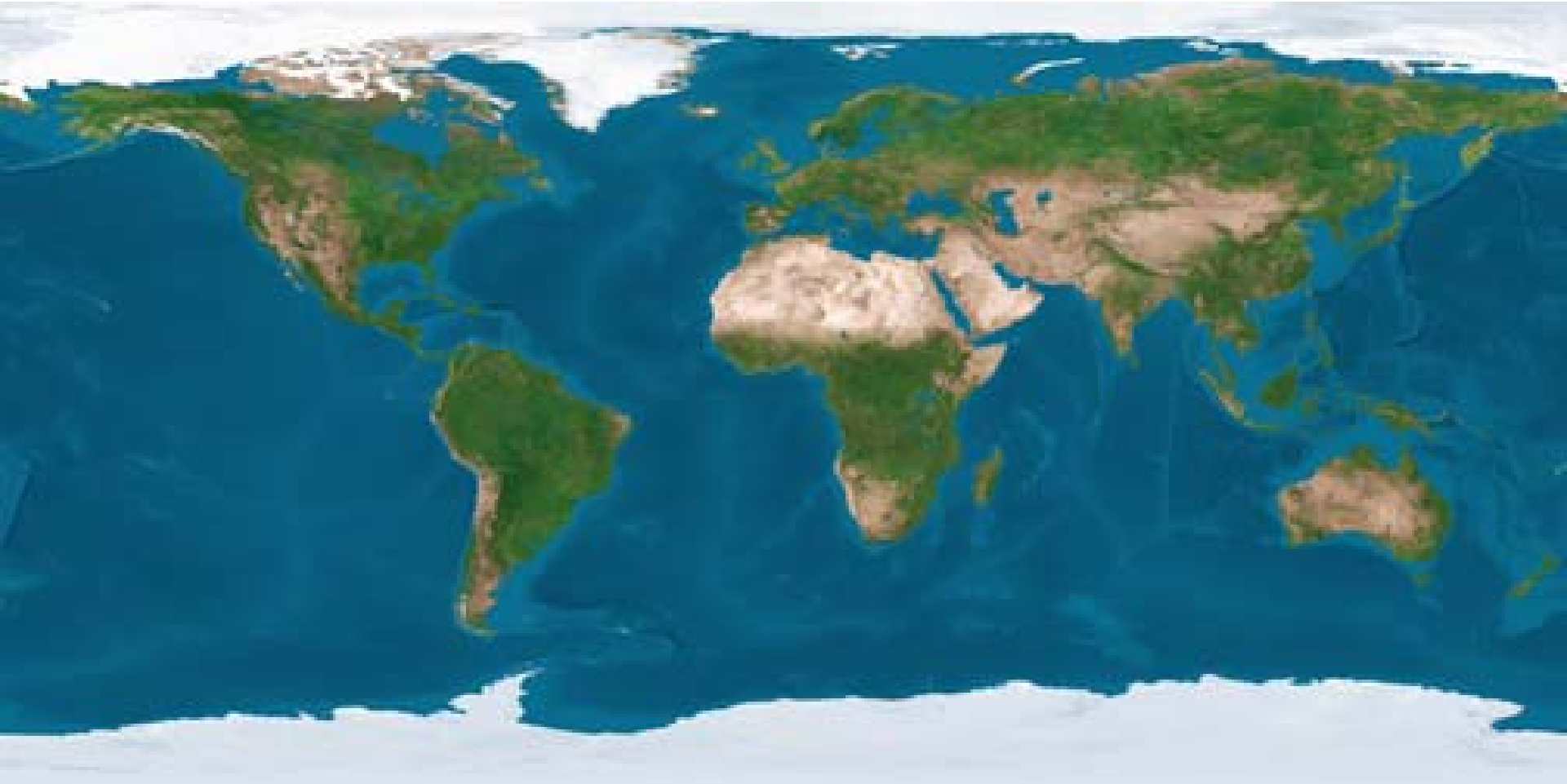


e A mantle plume probably created the round corona, which is surrounded by tectonic stress marks.

Earth from Space

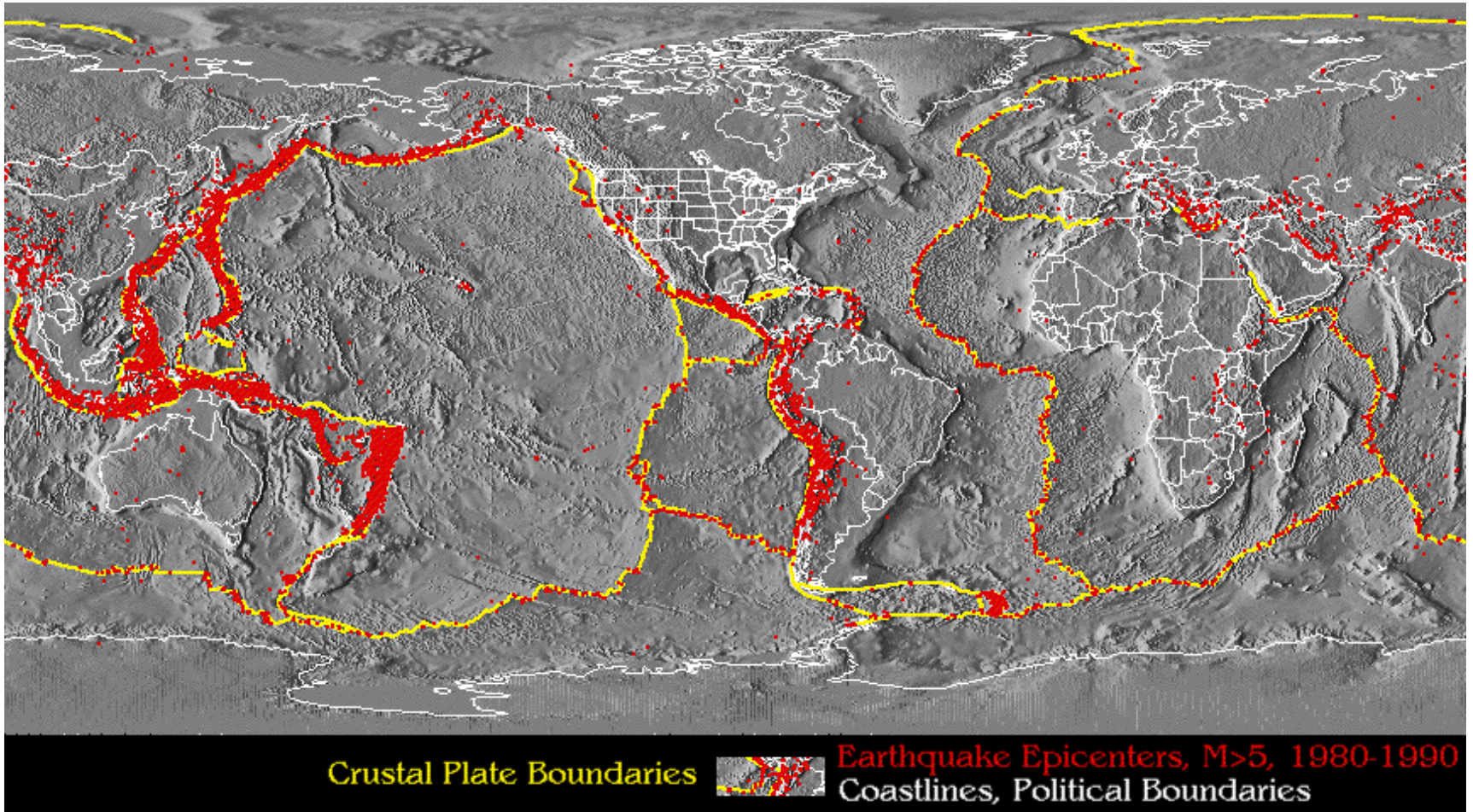


The Earth's Surface



<http://livingearth.com>

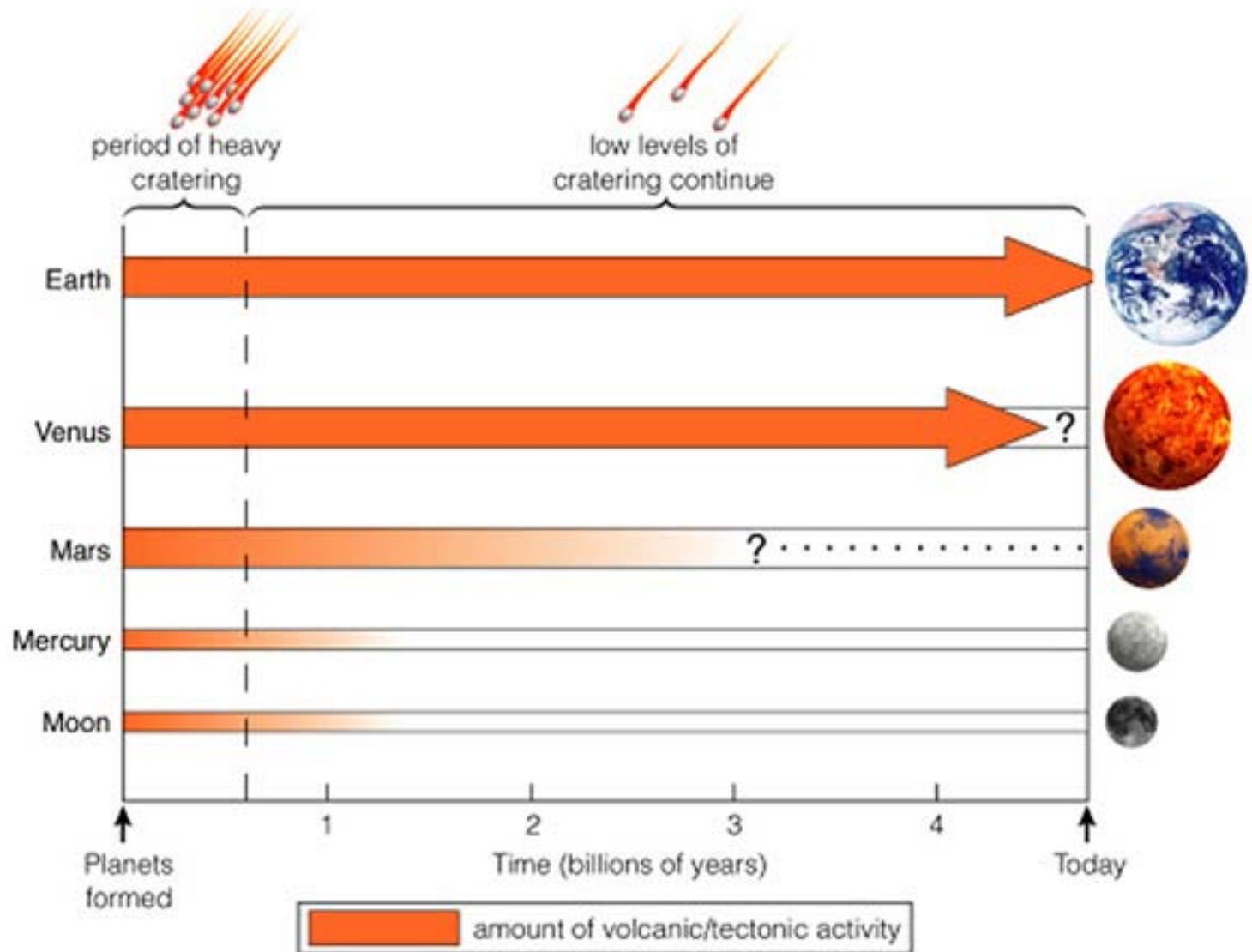
Earth's Tectonic Plates



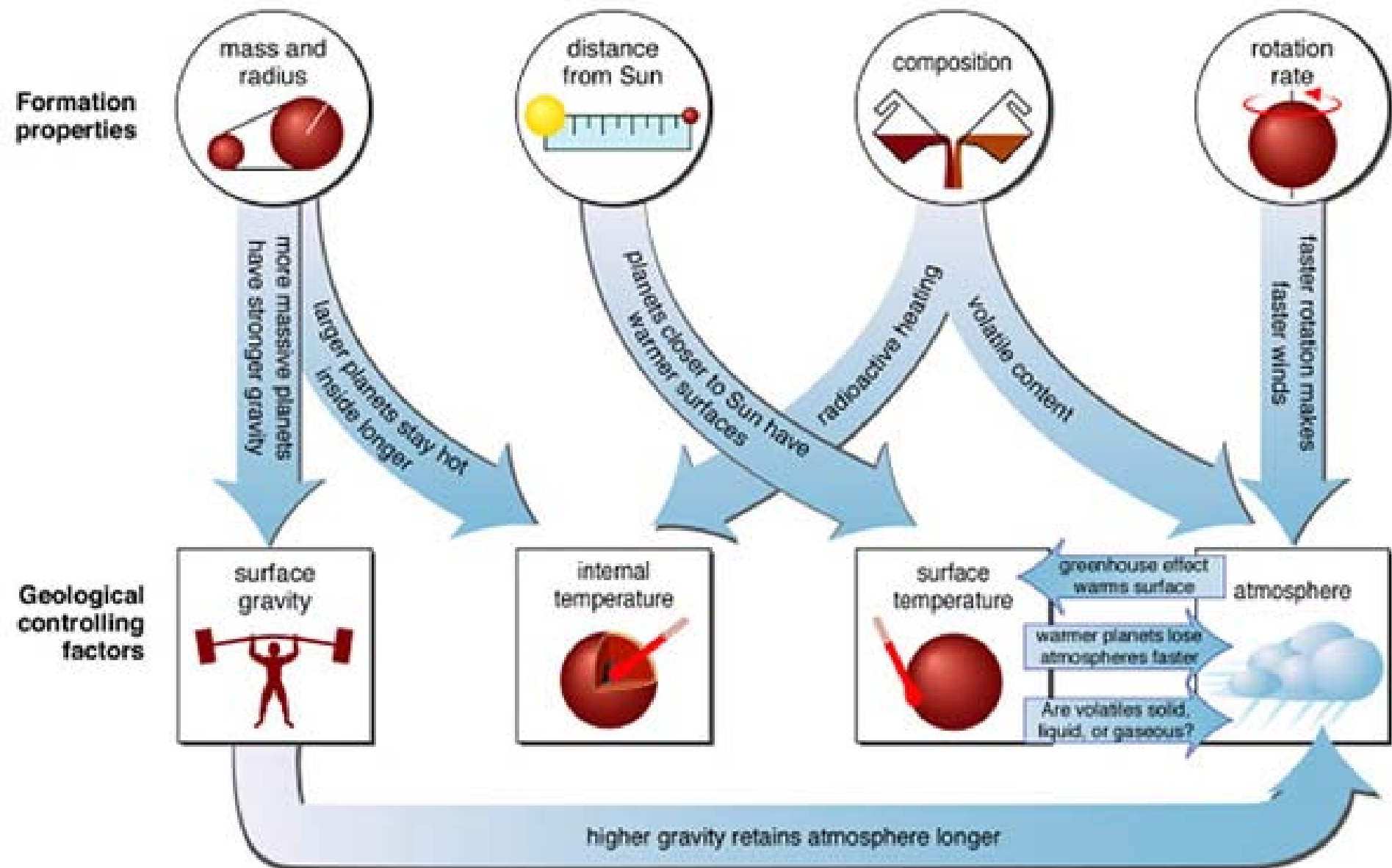
Vulcanism: Mt. Etna

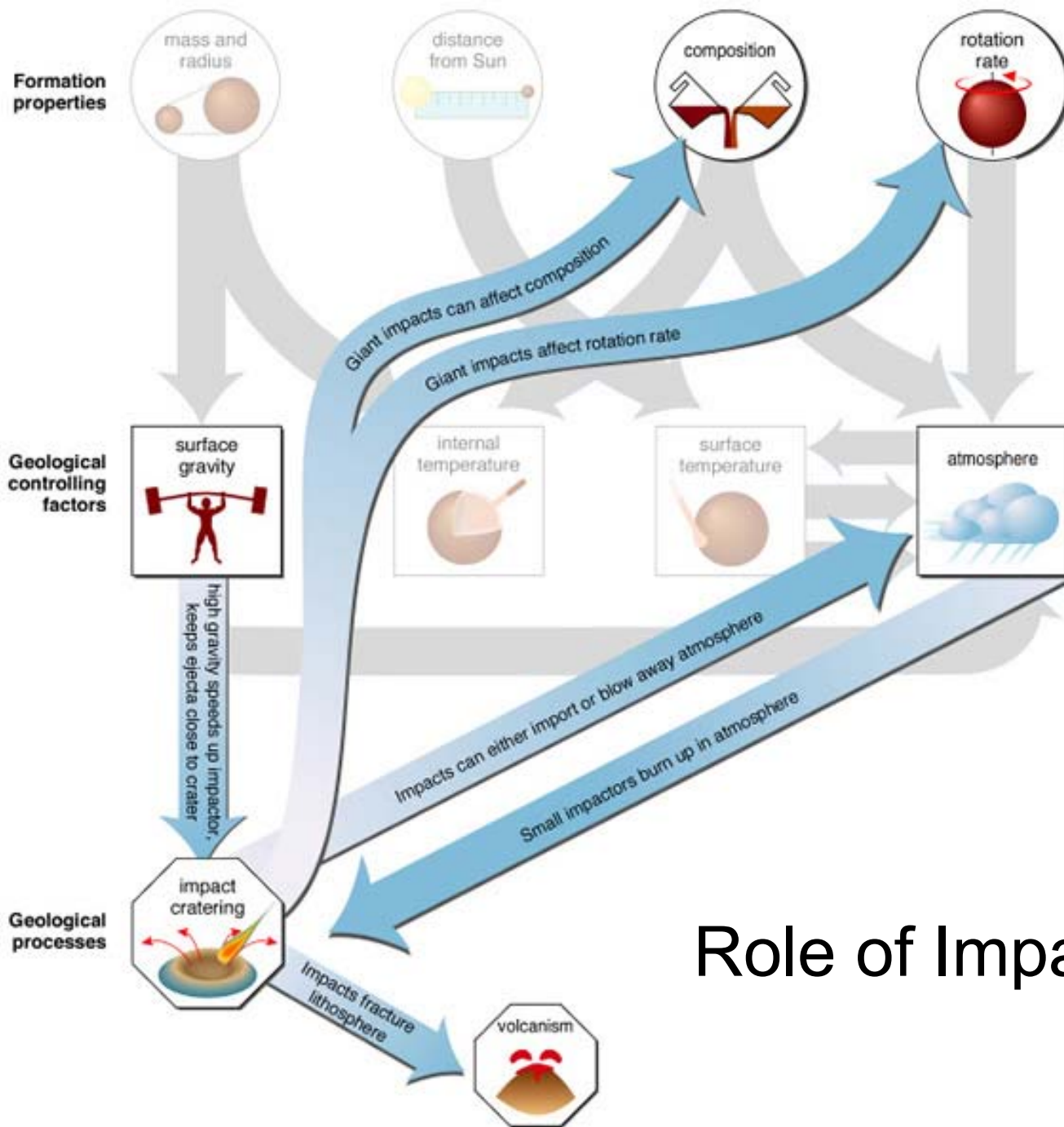


Inferred Geologic History of Terrestrial Worlds



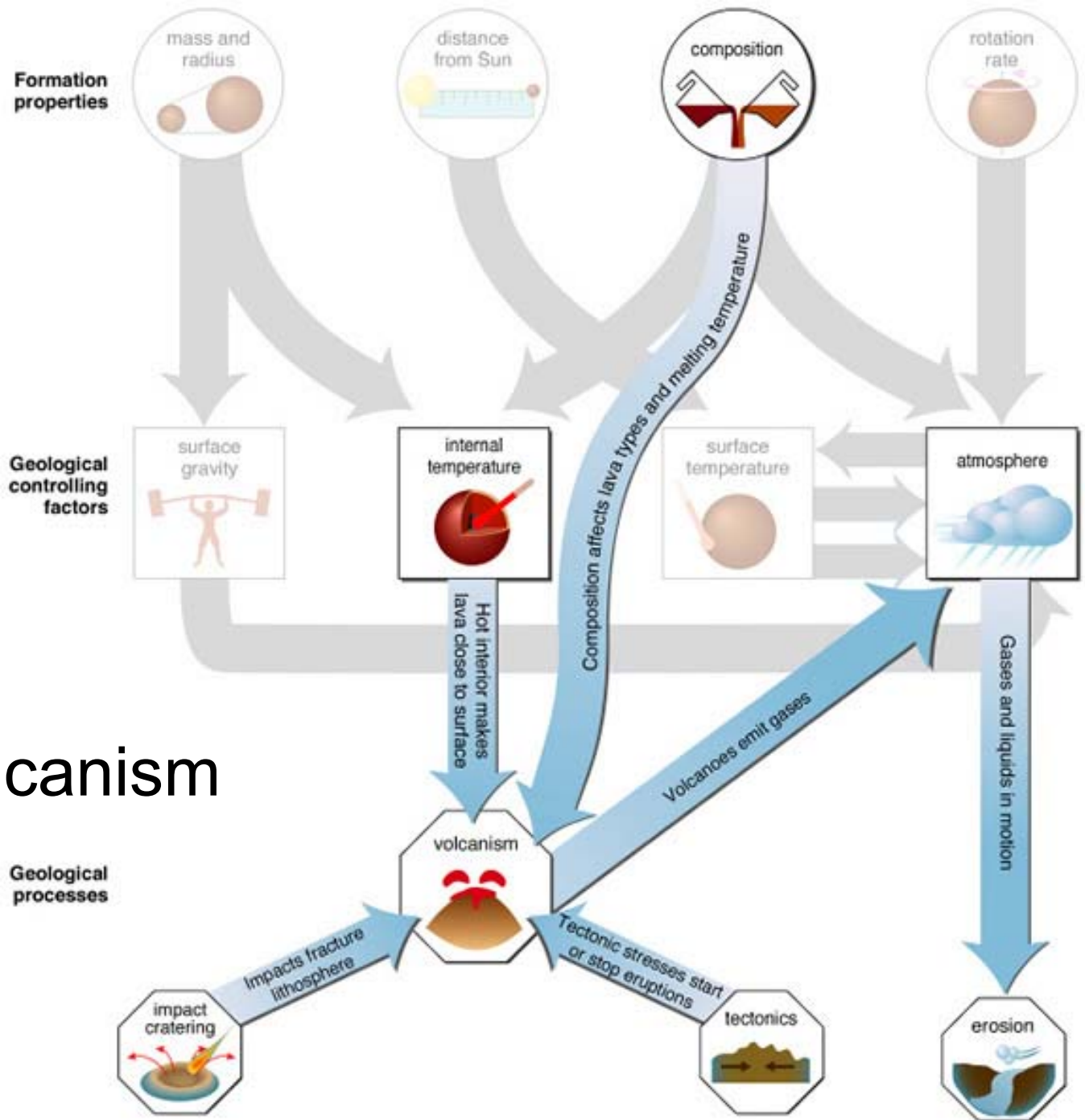
Planet Properties: Cause and Effect

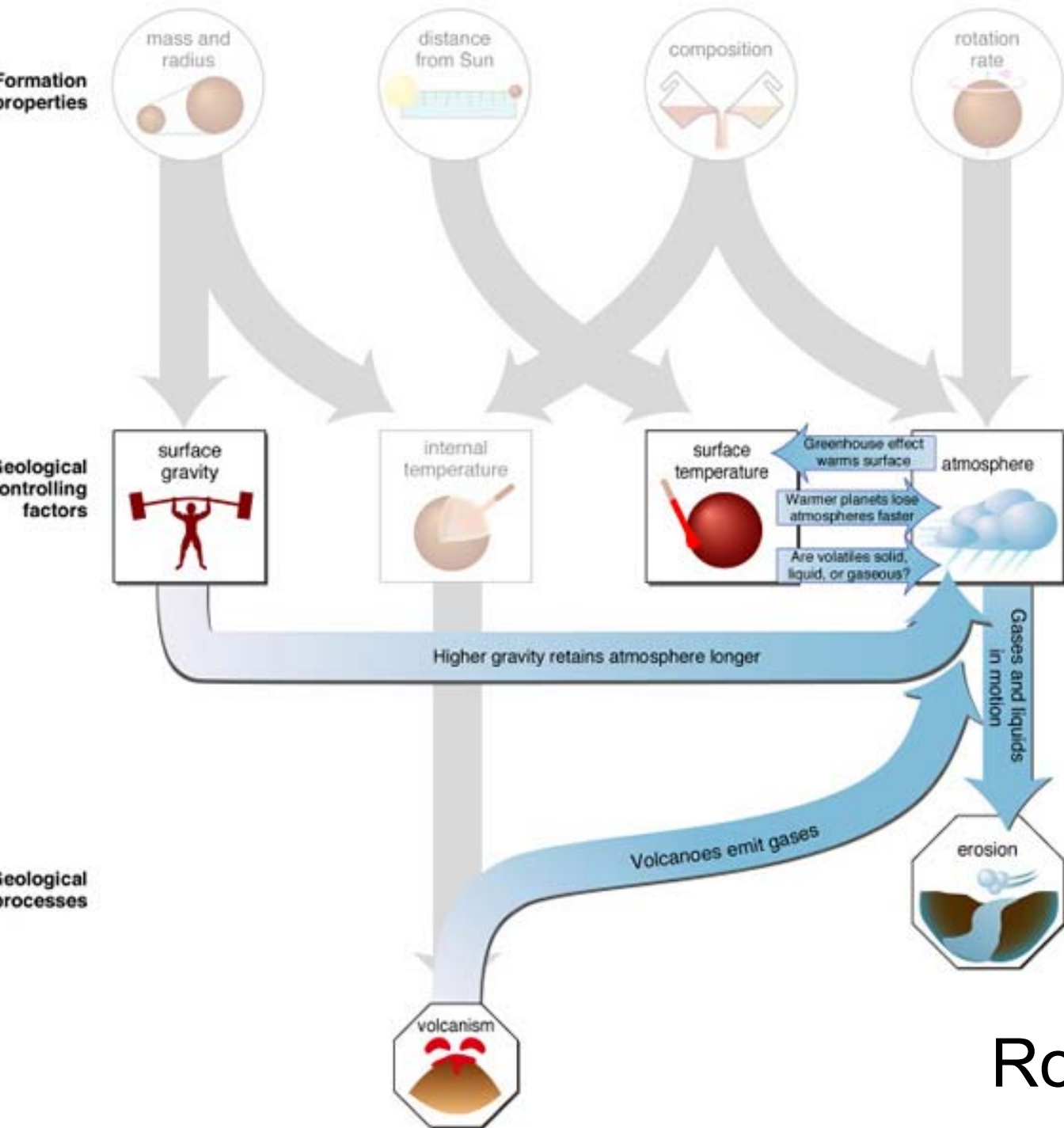




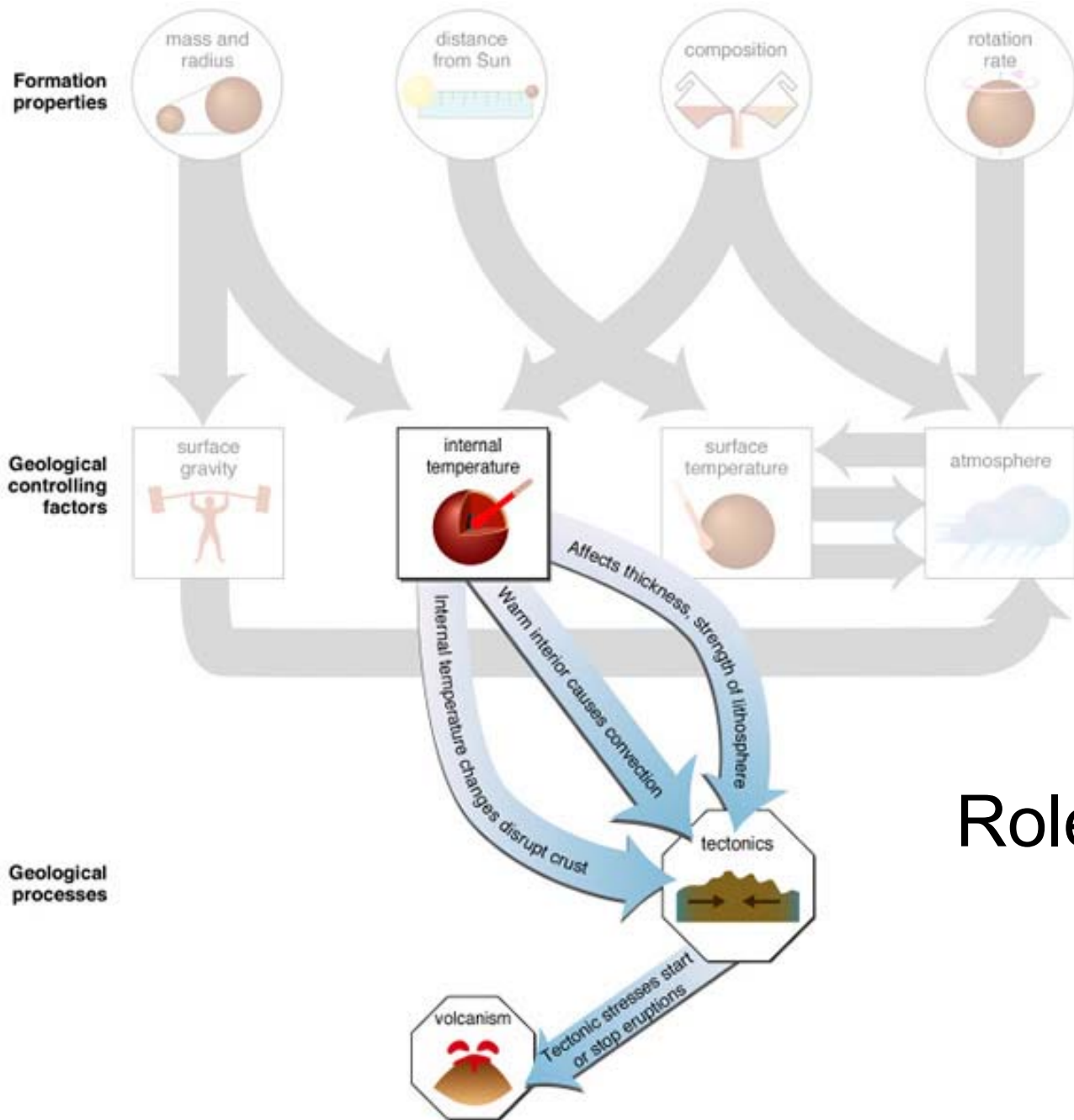
Role of Impact Cratering

Role of Vulcanism





Role of Erosion



Role of Tectonics

A Diversity of Worlds

Mercury



Venus

