Reading: Chap. 7, Sect. 7.3; Chap. 8, Sect. 8.2, Chap. 9, Sect. 9.3, 9.2, 9.4-9.5
Homework #5: available now - due Friday/Monday (Oct. 11, 14)
Public Lecture (extra LC credit) : Tuesday, Oct. 15, 8:15pm - MU Great Hall:
Dr. Chris Lintott: *"How to Find a Planet Without Leaving Your Couch"*

Last time: Overview of Solar System - outside and in

- Overview of our Solar System
  - Inner (Terrestrial) planets & Outer (Jovian)
  - Asteroids, Comets, KBOs, other small bodies
- Probes of planetary interiors
  - Density, rotation, magnetic fields

Today: **Planet interiors and surfaces**

- Planetary interiors: hot and stratified
- Processes affecting planetary surfaces
  - Impact cratering
  - Volcanism and melting
  - Weathering and Erosion

The Nobel Prize in Physics 2019

Ill. Niklas Elmedhed. © Nobel Media.
James Peebles
Prize share: 1/2

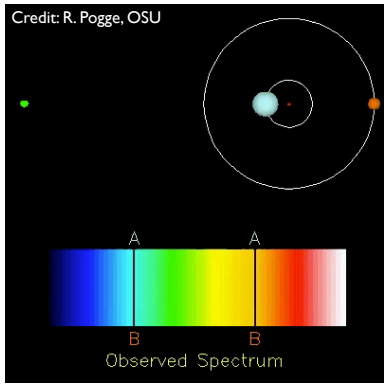
Ill. Niklas Elmedhed. © Nobel Media.
Michel Mayor
Prize share: 1/4

Ill. Niklas Elmedhed. © Nobel Media.
Didier Queloz
Prize share: 1/4

The Nobel Prize in Physics 2019 was awarded "for contributions to our understanding of the evolution of the universe and Earth's place in the cosmos" with one half to James Peebles "for theoretical discoveries in physical cosmology", the other half jointly to Michel Mayor and Didier Queloz "for the discovery of an exoplanet orbiting a solar-type star."

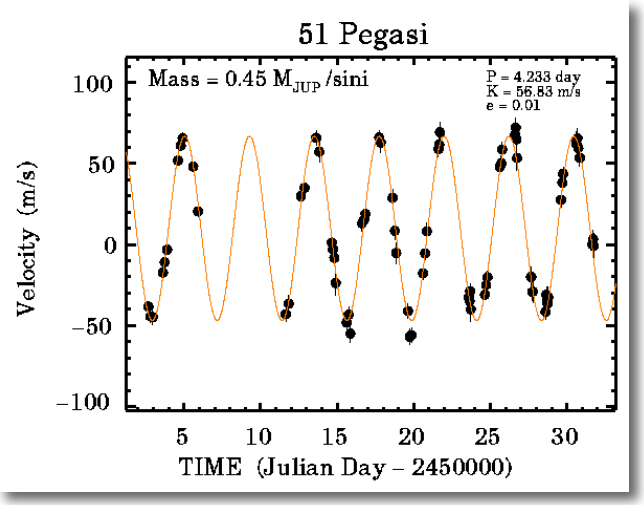
Reflex Orbital Motion

- via reflex orbital motion:
  precision spectroscopy

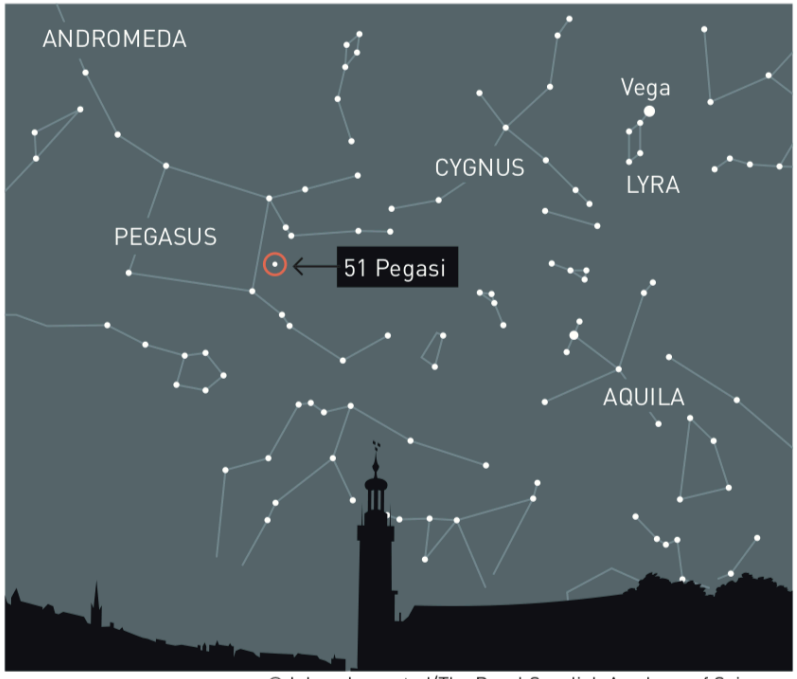


Credit: R. Pogge, OSU

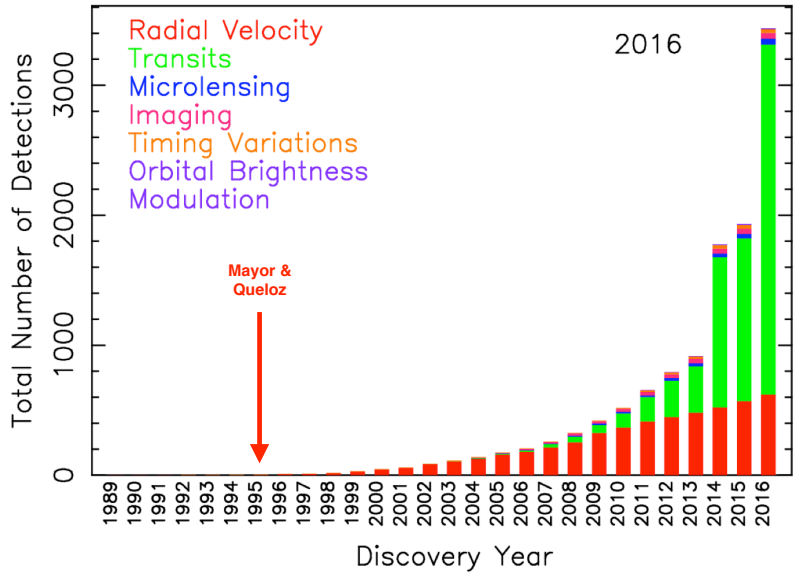
- pre-1995 - The Search is On
  - initial search for 'ordinary planets'
  - P_{orb} ~ months
- **1995 -first discovery - 51 Peg** (Mayor & Queloz)

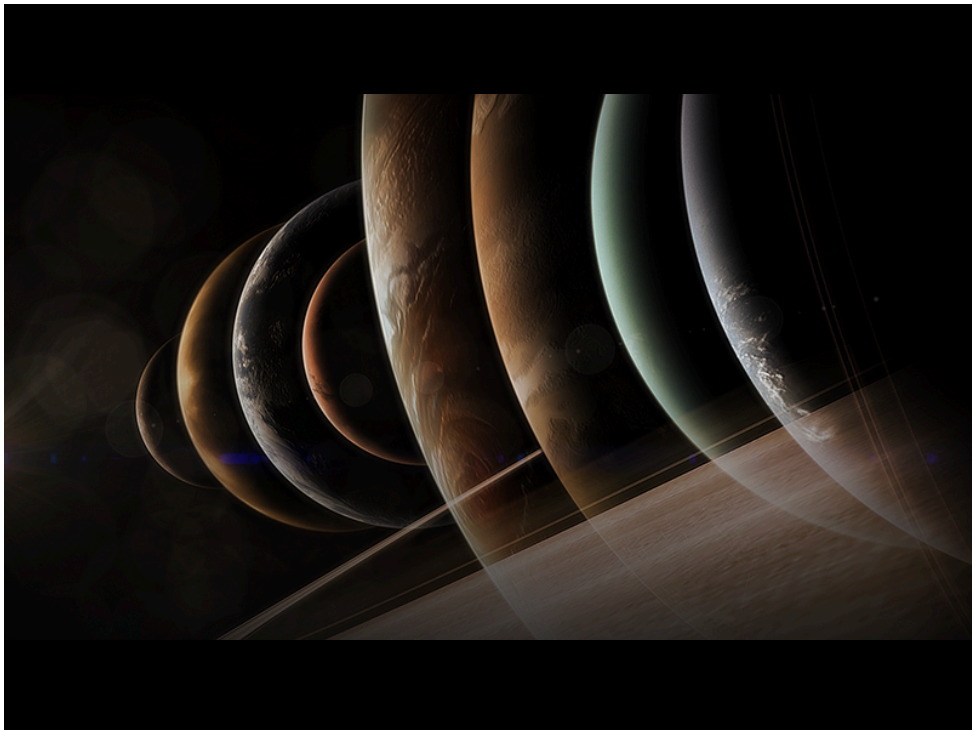


P_{orb} = 4.233 days
M_{planet} = 0.45 $M_{Jupiter}$



©Johan Jarnestad/The Royal Swedish Academy of Sciences

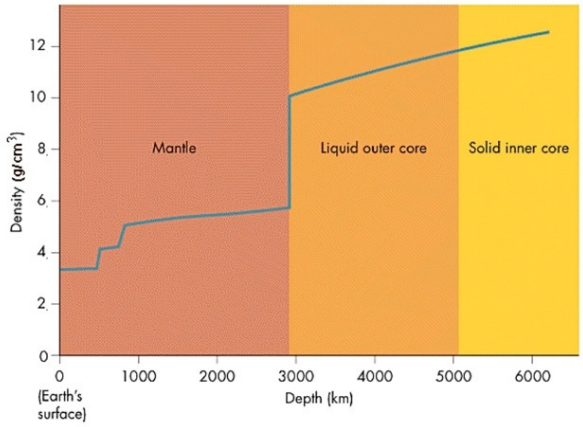




The Earth's Interior

- Dense molten iron **core** (density, magnetic field)
- Rocky but elastic **mantle** (oblateness)
- thin, light surface **crust** (density)

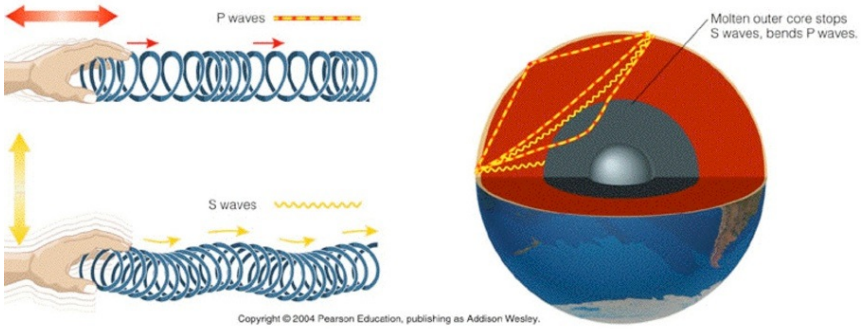
With some simple physics, compute what the inside of the Earth might be like

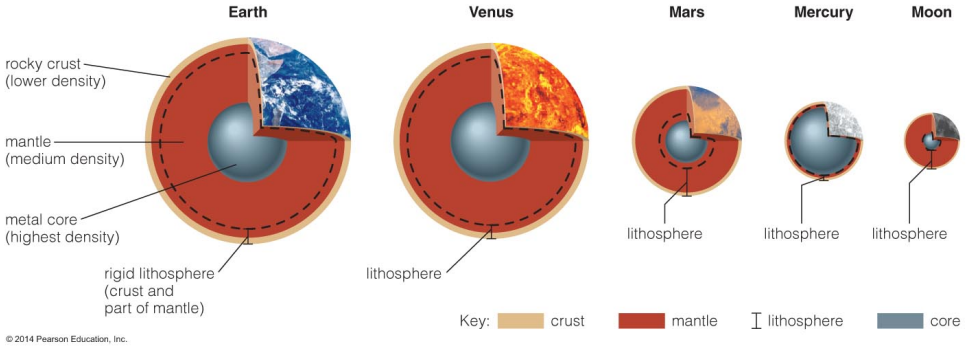


Testing the Model Directly: Seismology

- earthquakes send vibrations through the Earth
- speed of various kinds of waves depends on
  - density
  - temperature
  - phase (liquid or solid)

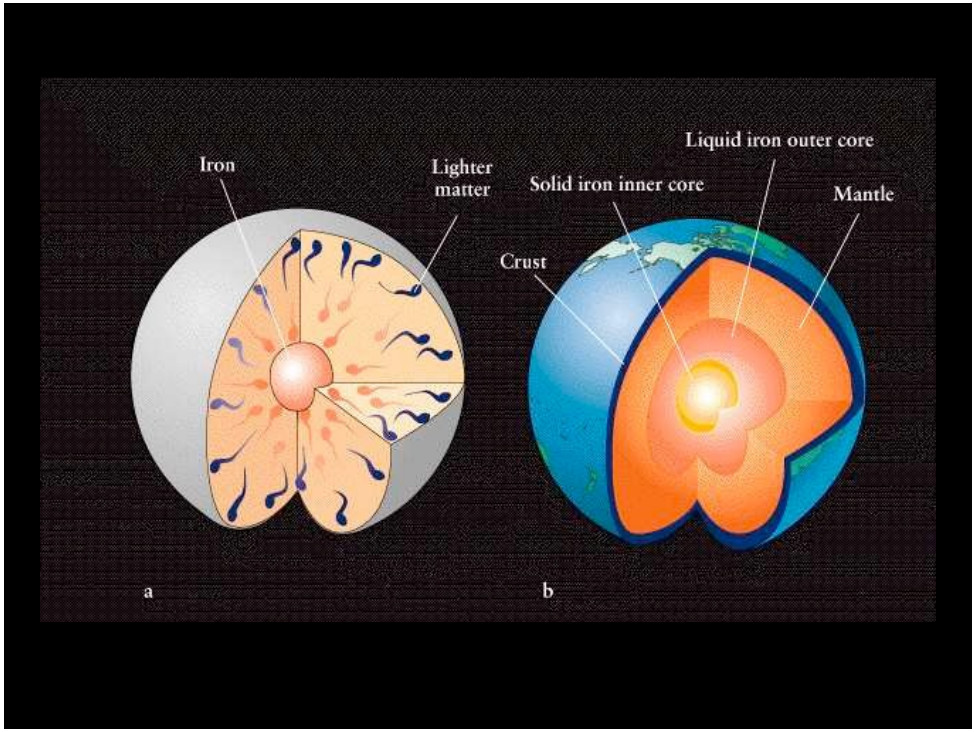
can map out structure of Earth (or planet) interior





Planetary Interiors

- **Why are planetary interiors so hot?**
  - accretion heating – residual heat from formation
  - radioactive decay of elements in rocks
  - tidal heating (moons, Mercury)
- **Why are planetary interiors stratified?**
  - initially fully mixed (at formation)
  - accretional heating
  - differentiation: heavy stuff sinks, light stuff floats
    - crustal material is less dense (in terrestrials)
    - iron is densest (in terrestrials)

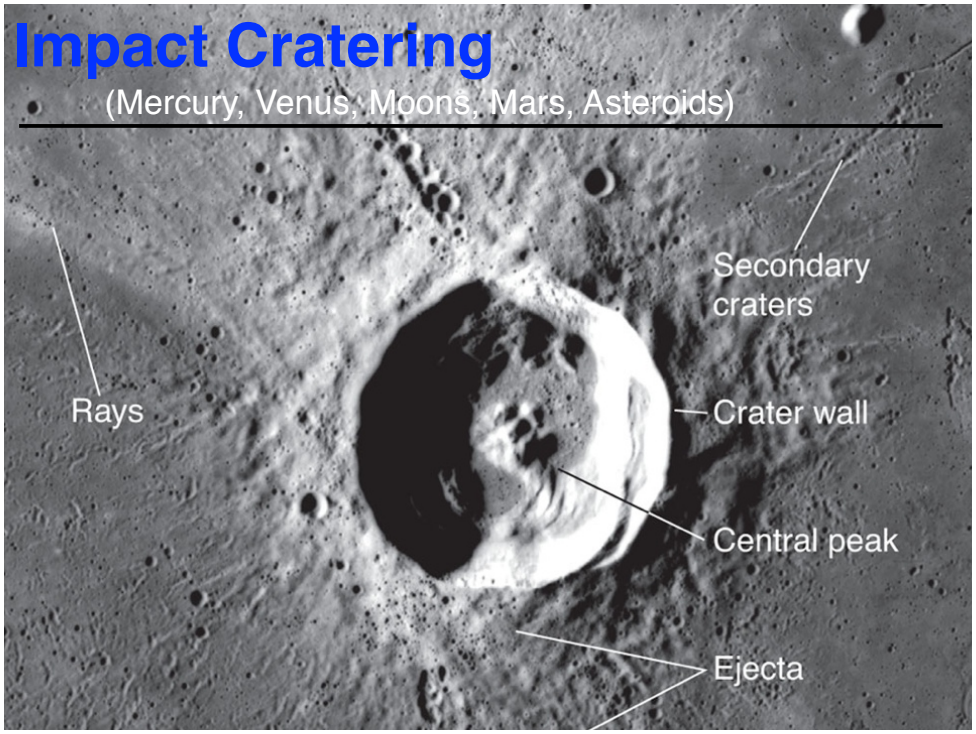


Planetary Surfaces

M,V,E,M, Moon(s), asteroids

Processes that Alter Planetary Surfaces

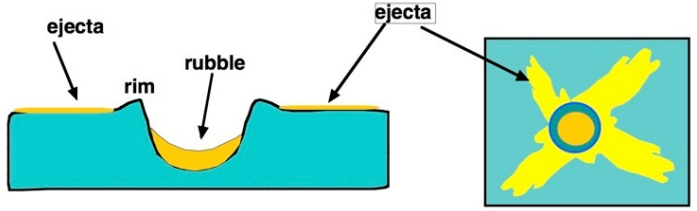
- Impact Cratering
- Volcanism and melting
- Weathering and chemical change
- Plate tectonics



Impact Cratering

(Mercury, Venus, Moons, Mars, Asteroids)

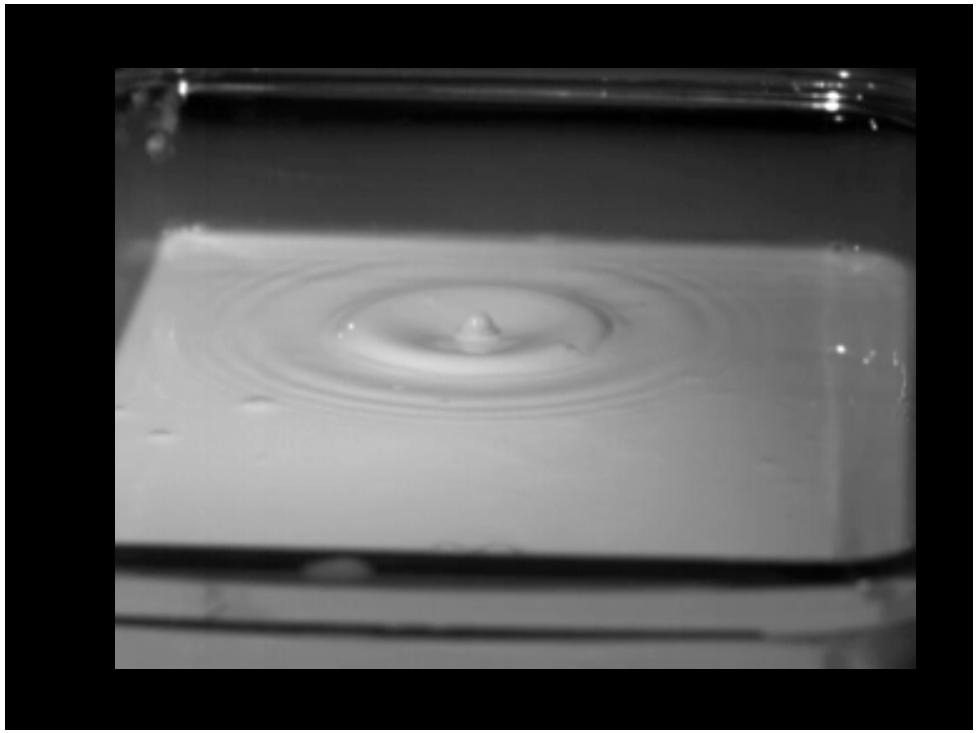
- Solar system has always contained “small” bodies
- these impact larger (planetary) bodies
- produces crater 5 – 10 times larger than impactor

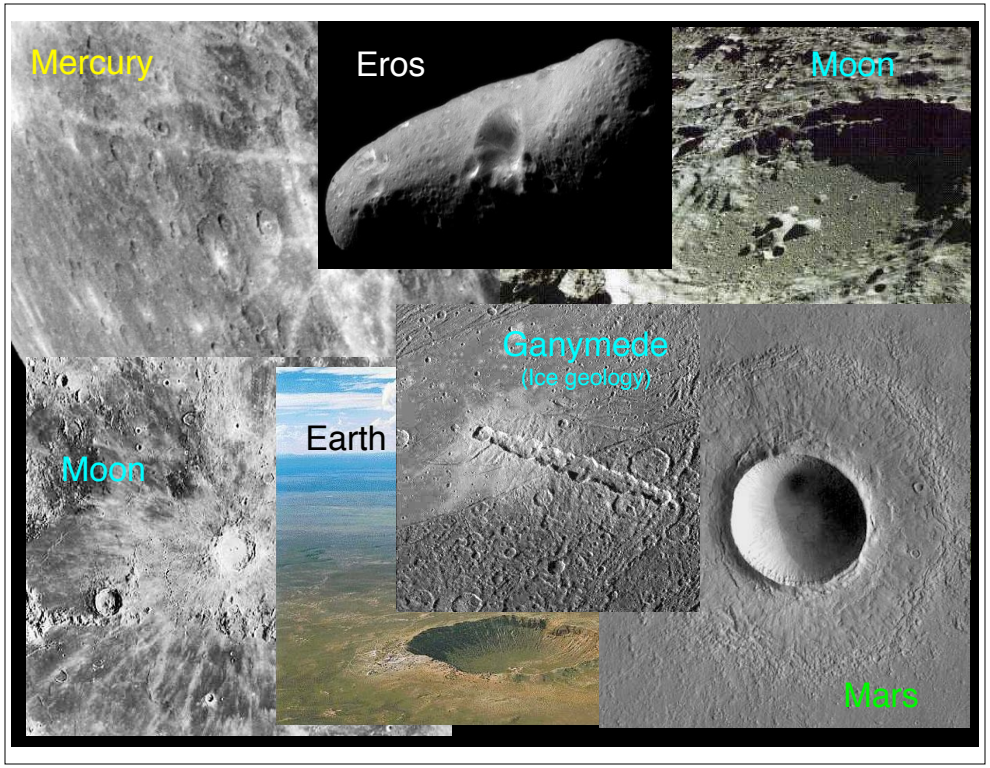


- impact sprays **ejecta** over a much larger area
- accumulated ejecta = **regolith**

  dust to pebble sized rubble over entire surface

Lunar Regolith



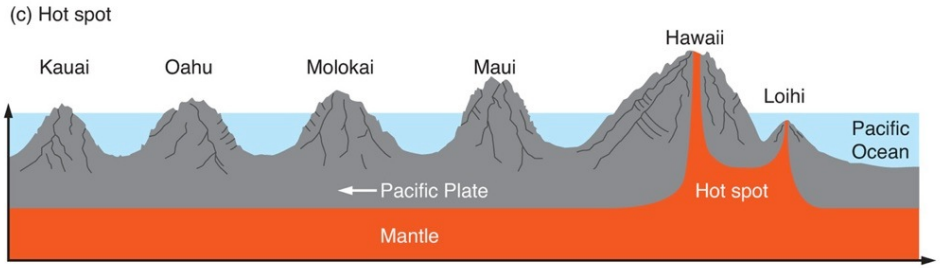


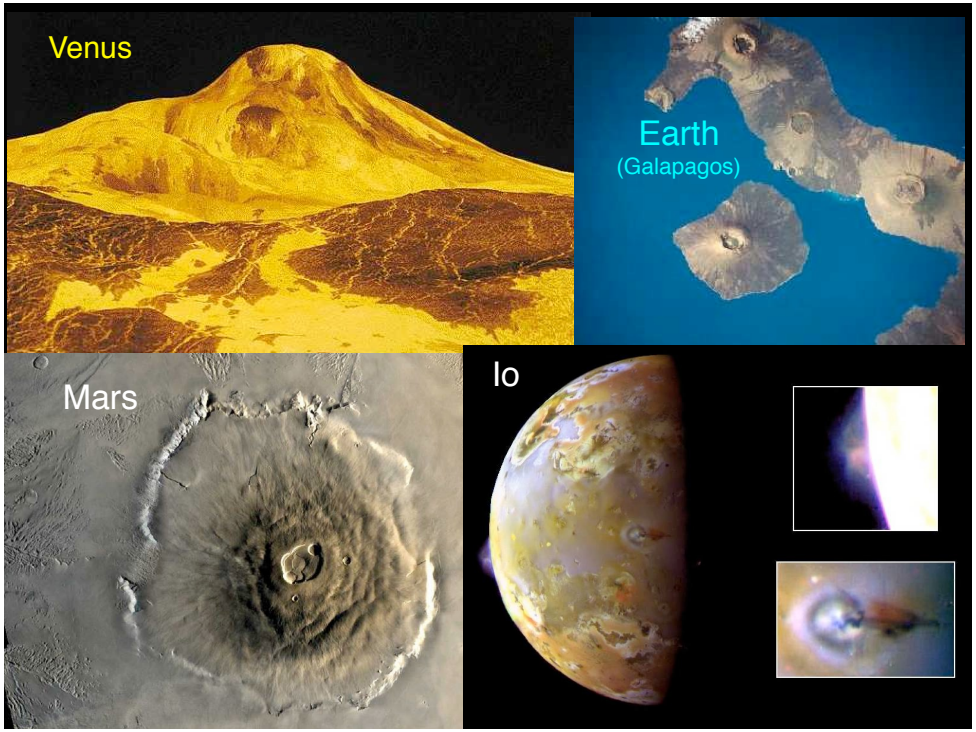
Volcanism

Mercury, Venus, Earth, Mars, Moon(s)

- Volcanoes: localized outlet for molten rock from interior
  - shield types (i.e. Hawaii) and
  - cone-shaped (Mt. Fuji, Vesuvius)

- Lava flows: large flows of lava from fissures and cracks
  - no mountain building
    (i.e. lunar maria, eastern Washington, western India)



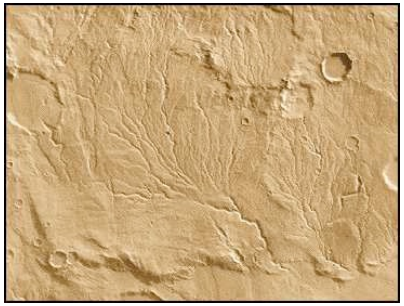


Erosion/Weathering

Venus, Earth, Mars

- Wind
- Running water
- freeze/thaw of water ice

} wear away impact, volcanic, and tectonic structures

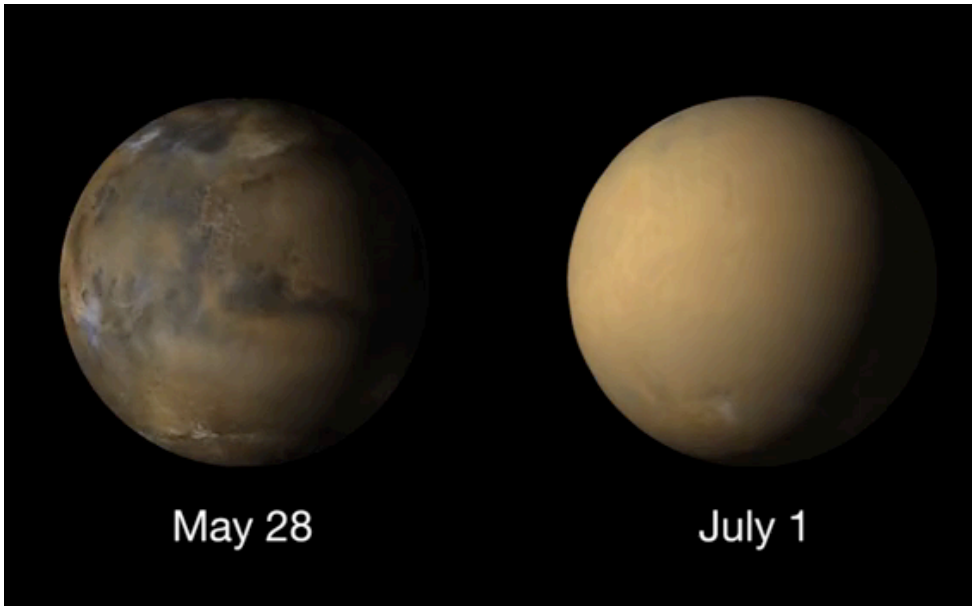


Ancient river network on Mars

A small dust storm on Mars

2018 Mars global dust storm

https://www.universetoday.com/140131/



Dust devils on Mars