Terrestrial Surfaces and Interiors

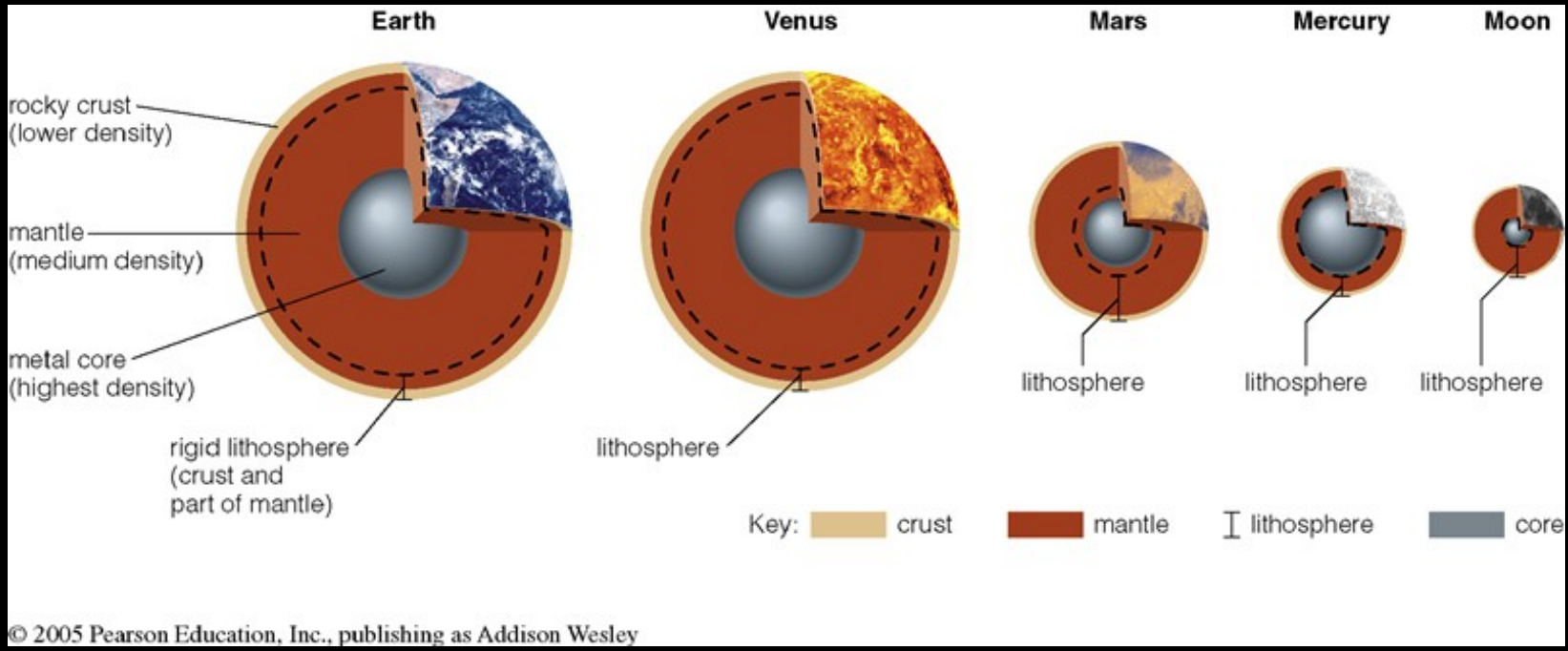
11/4/2009

Opening Discussion

- http://www.youtube.com/watch?v=iHQdHxq4S5s
- Have you seen anything interesting in the news?
- What did we talk about last class?

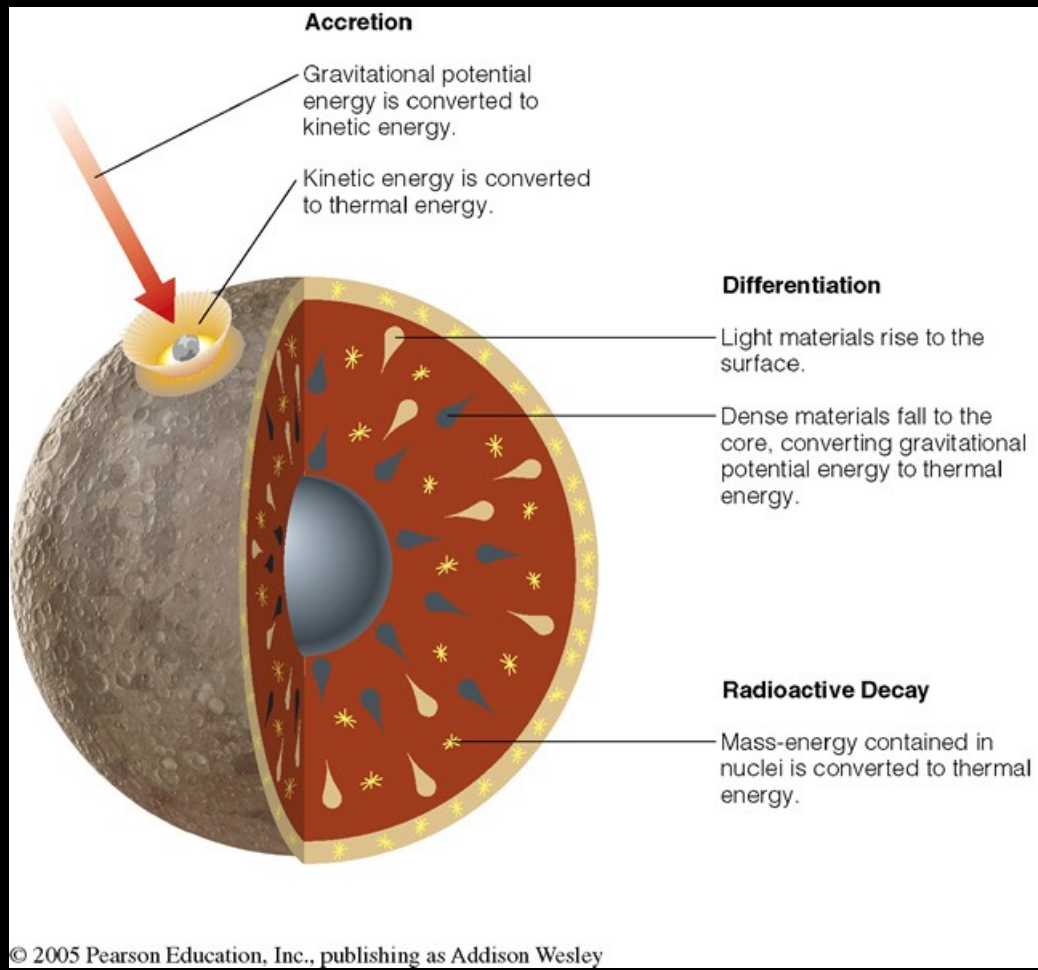
Planetary Interiors

- Terrestrial planets have crust, mantle, and core (sorted by density). We know about interior structure of Earth and Moon from quake data. Orbiters give us distribution information for other planets.

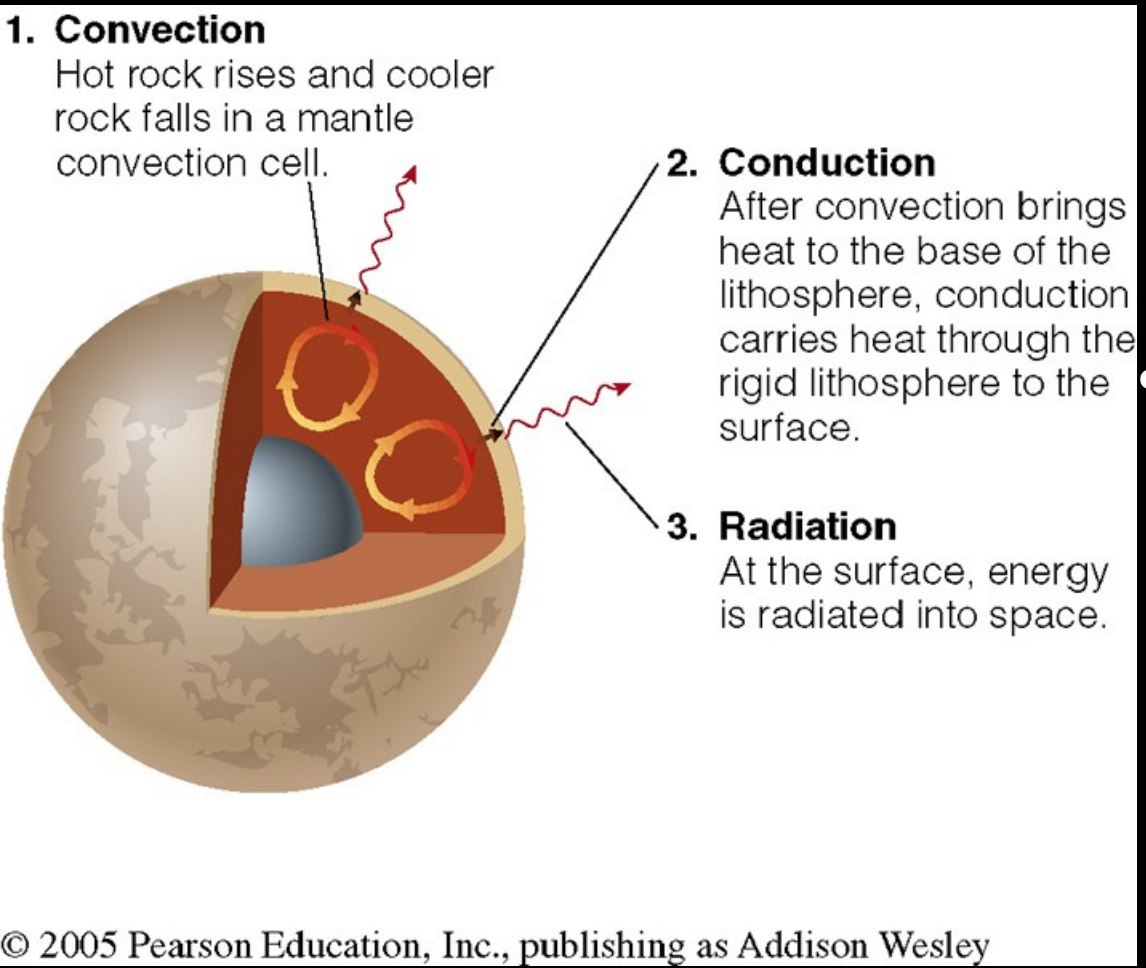


Sources of Heat

- Geology is driven by internal heat. This heat comes from accretion, differentiation, and radioactive decay.
- The first two are basically converting gravitational potential energy to thermal energy. The third converts mass energy to thermal energy.
- All three of these are greater for bigger planets.



Dissipating Heat



- Energy is constantly escaping from the surface of the planet through thermal emission. This keeps the surface layers cooler and heat moves outward over time.
- In fluid material convection does the moving of heat. In solid material it moves through conduction. Dissipating heat drives a lot of geology. Big planets cool more slowly.

Cooling Rates

- Surface area to volume ratio impacts the cooling rate. Thermal radiation is per unit area.
- Radiative cooling scales as surface area.

Magnetic Fields

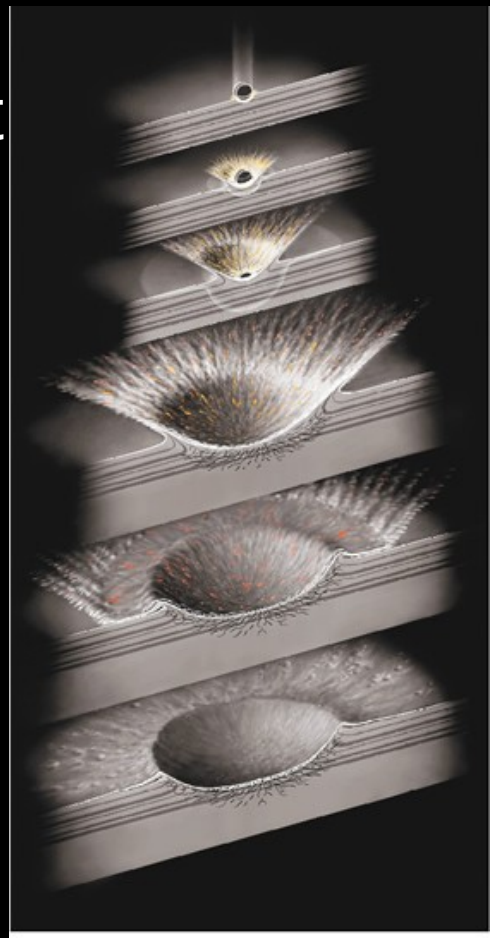
- Moving charges produce magnetic fields.
- This is found in the interiors of planets when:
  - They contain an electrically conductive fluid.
  - There is convection in that fluid.
  - The planet has a moderate spin rate.
- Of the terrestrial bodies, only the Earth clearly has these.
- Mercury is unclear. Has a significant magnetic field.

Four Geological Processes

- What we see of planets is just their exteriors. There are a lot of features that can be formed on planetary surfaces, but they all come about because of four basic processes:
  - Impact cratering
  - Volcanism
  - Tectonics
  - Erosion
- The interaction of these four is what determines the types of features that we see on the surface of a planet.

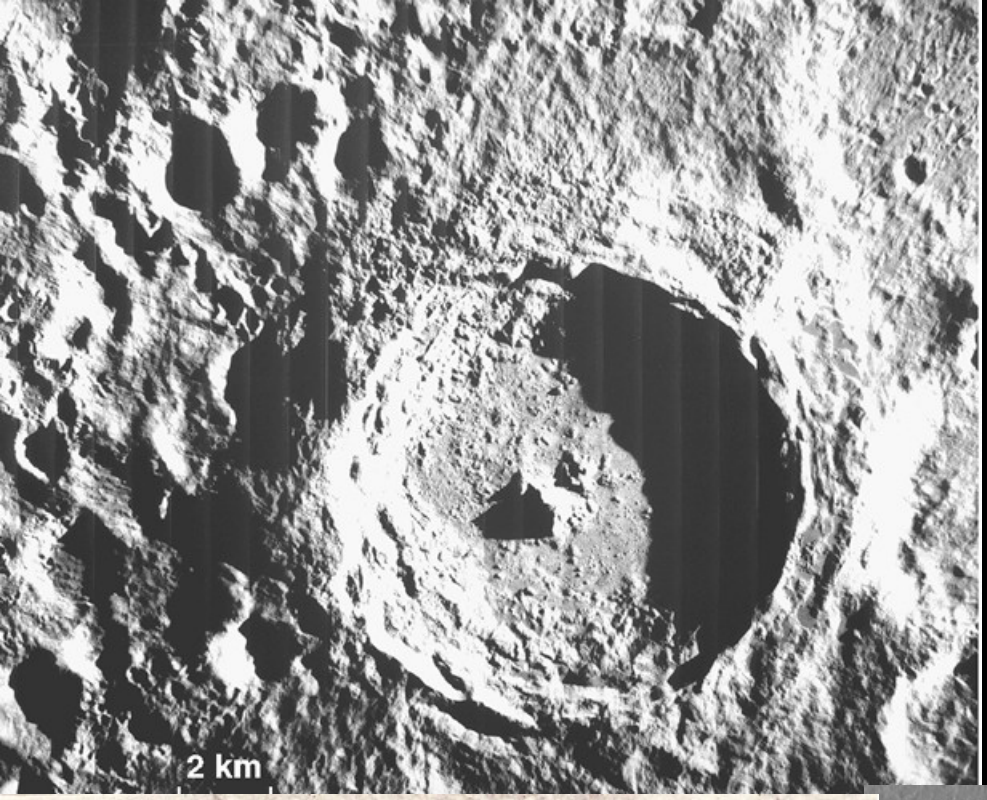
Impact Cratering

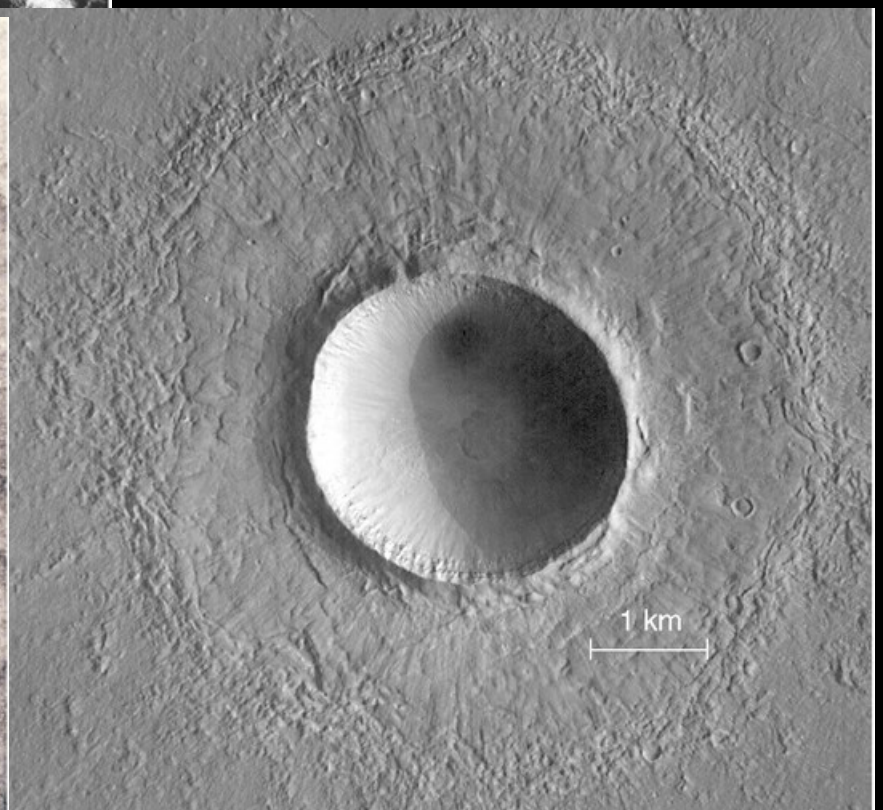
- During the heavy bombardment, the terrestrial bodies were being pelted with debris, large and small, on a regular basis. Since that time the rate of impacts has decreased, but it is not zero.
- Impact speeds are typically in the tens of thousands of km/hr. Impactors typically make craters 10 times larger across than the impactor and 1-2 times as deep.
- The number of craters we see on a surface tells us about the age of the surface. All terrestrial bodies should have undergone the same cratering history. The question is whether that history has been removed.



Example Craters

- Structure of craters can tell us about the local geology.



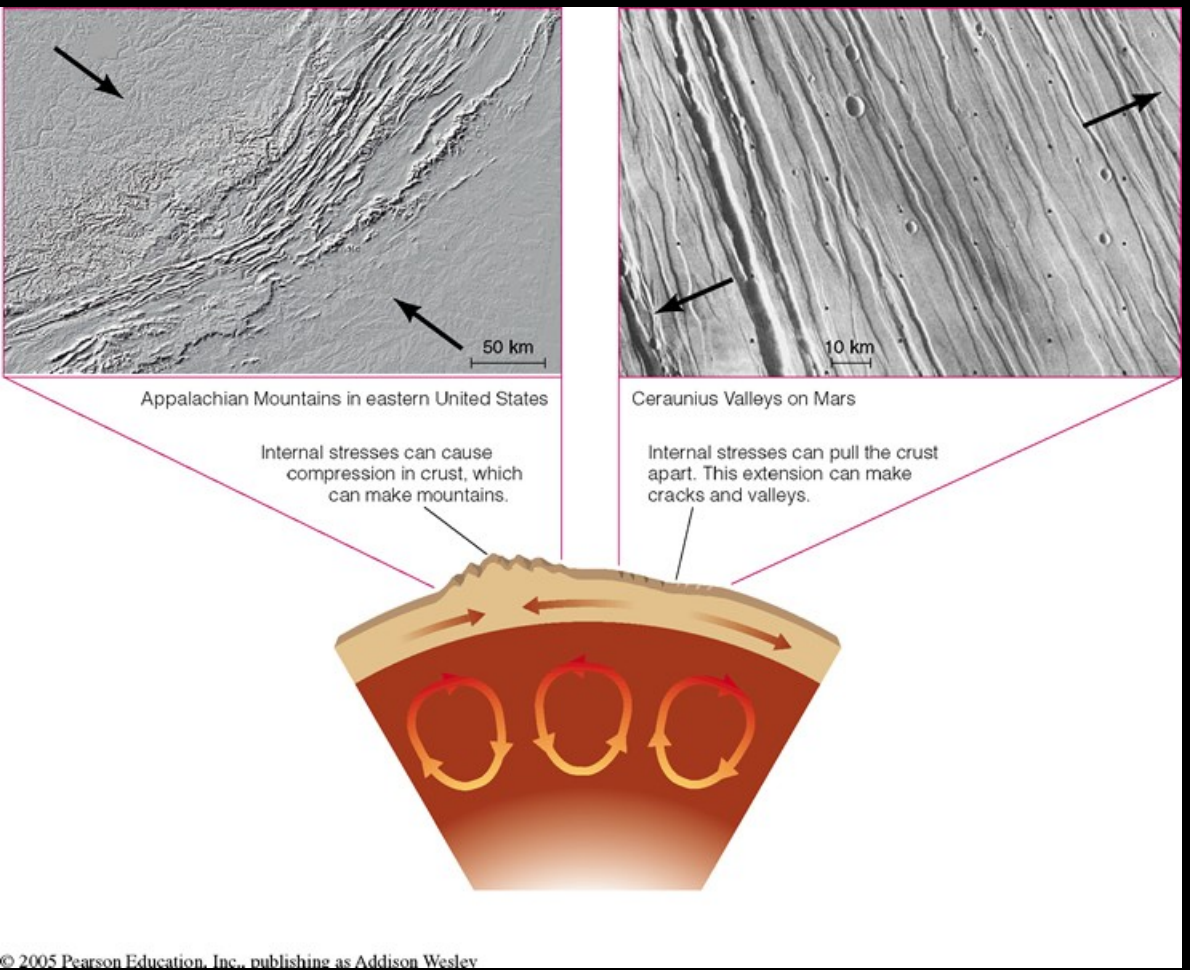


Volcanism

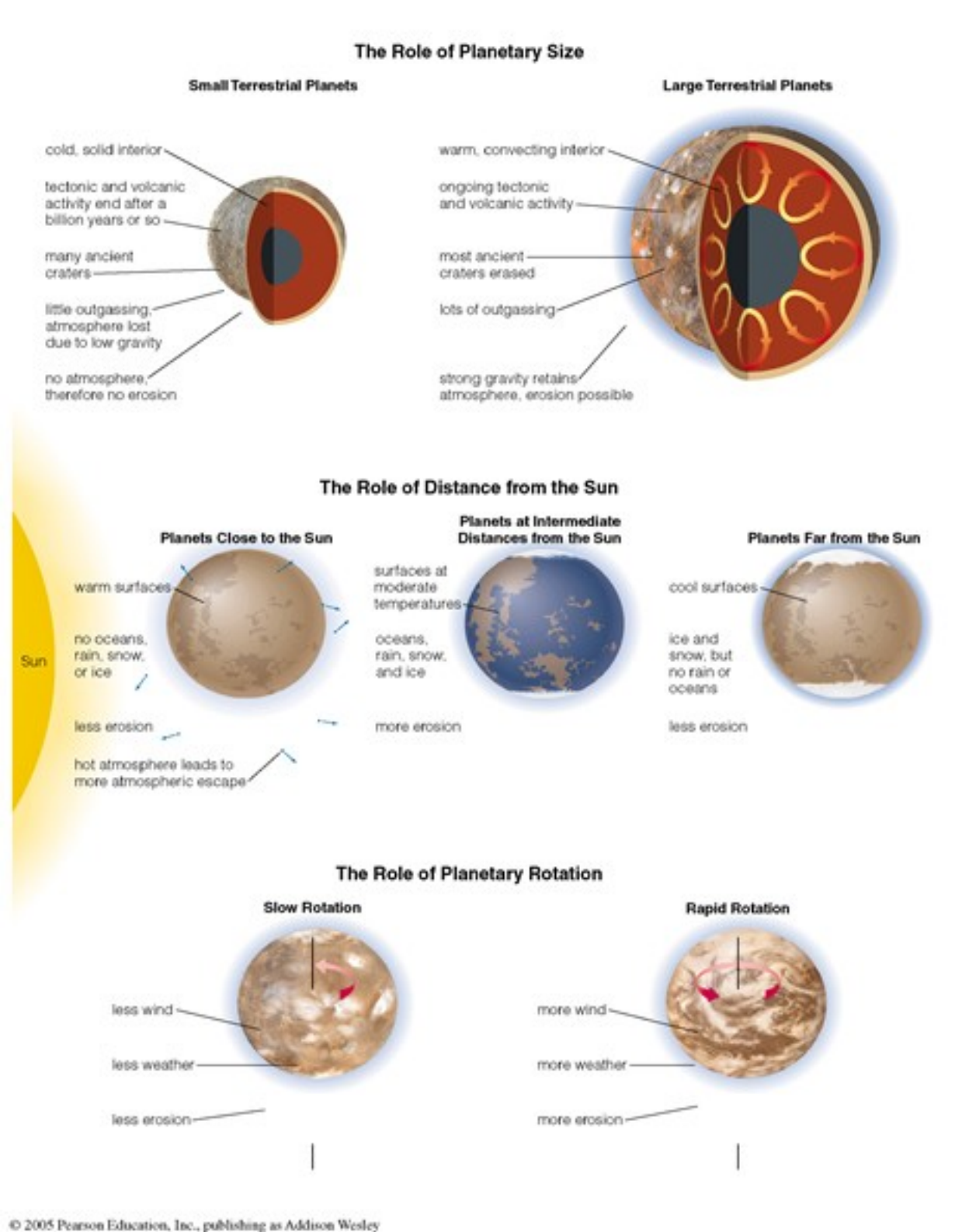
- Volcanism is the process of magma rising to the surface of a planet and flowing out as lava.
- Depending on the viscosity of the material, you get basins, shield volcanoes, or stratovolcanoes.
- Outgassing from eruptions is also significant for planets as it provides volatiles to the surface. These become oceans and atmospheres.

Tectonics

- Mantle convection drives tectonic activity by pushing the lithosphere around.



Erosion



Differences Between Bodies

Impact Craters and Age

- The number of impact craters on a surface tells us about the geological age of that surface.
- Radiometric dating of lunar rocks has given us a direct comparison between crater densities and ages.
- Large planets have few visible craters because geological activity has erased the older ones. Small planets retain even very old craters on their surfaces.

Minute Essay

- The next round of extrasolar planets we discover will likely be a terrestrial bodies a few times larger than the Earth. What would you expect the geology of these bodies to be like?
- Remember the reading quiz will close tomorrow at 12:30pm.