Comparative planetology: studying planets by comparing them to one another

* Can compare semi-major axis, period, orbital velocity, mass, radius, density, rotation period, etc.

Terrestrial planet structure:

* Lithosphere (includes crust)
* Mantle
* Core (dense material)
* Differentiation in the early Earth: dense materials sink; low-density materials rise

How do we get this information?

* We model the Earth’s interior by studying earthquakes
* Seismic waves travel differently through different materials
  + Primary waves travel through solids and liquids
  + Secondary waves go through solids only

Gravitational Pull & Tides

* Something closer to an object experiences a stronger gravitational pull than something else further away
* The moon causes Earth to stretch, affecting tides
  + Earth’s oceans flow in response to the stretching of these tidal forces
  + The behavior is complicated by Earth’s landmasses and solar tides
* Tides can affect the solid part of Earth
  + The ground can rise under you by about 30 cm each day
* Results in friction, which generates heat
* Tidal heating is one of the important factors for a body’s internal heart
  + Can raise the internal temperature and melt solid material unless pressure is too high

Deep structures

* Deeper in a planet means hotter and more pressure
* Formation energy and radioactive material also help to heat the interior
* Smaller planets lose heat faster, large ones more slowly

Magnetic field

* Earth and Mercury are the only terrestrial planets with a substantial magnetic field
  + The moon had one long ago
* It is a puzzle why Venus and Mars do not have one

Surface

* Four processes have shaped Earth:
  + Impact cratering
    - Material falling from space on a planet’s surface would create impact craters
    - All terrestrial planets experience this
    - Large impacts can release huge amounts of energy
    - Venus and Earth have relatively few craters
    - Craters on Mars suggest it was once wetter
    - Mercury and the moon are covered in craters
    - The number of craters indicate the surface’s age
      * More craters = older surface and minimal geological activity
      * Rocks returned from Moon missions (1969 – 1976) give ages through radiometric dating
      * Almost all cratering happened in the first billion years of the Solar System
    - Tectonism and erosion can erase craters
  + Tectonism (moving crustal plates)
  + Volcanism
  + Erosion (wind or water)

Moon:

* Moon formed in large collision between Earth + Mars-sized protoplanet
* The material collected to form the Moon
  + Composition of the Moon is like that of Earth’s crust