GLG 101 – CHAPTER 24 - PLANETARY GEOLOGY

- Planetary bodies in our solar system can be divided into three types: 1) terrestrial or "rocky" bodies including Mercury, Venus, Earth, our Moon, Mars, and many asteroids and moons of the outer planets; 2) Jovian or "gas giant" planets including Jupiter, Saturn, Uranus, and Neptune; and 3) Icy bodies composed of frozen water, carbon dioxide, methane, ammonia and even nitrogen and carbon monoxide, with some rocky component mixed in – these bodies include Pluto, numerous moons of the outer planets, the outer asteroids and cometary bodies at the outer reaches of the solar system.
- The **Nebular Hypothesis** gives an explanation for how the Sun and planets formed from a contracting cloud of gas and dust particles. As the contracting nebula began spinning faster, it flattened out into a disk and gravitational forces clumped the gases and dust together to form the Sun and planets. The heat from the early sun drove easily volatilized compounds like water and other gases out of the inner solar system, leaving behind metallic and rocky particles that formed the terrestrial planets. The icy and gaseous planetary bodies occupy the outer solar system.
- There are four primary types of geologic processes that occur on the terrestrial planets and moons, with varying degrees of activity depending on the internal heat of the planet/moon. These processes are **impact cratering**, **volcanism**, **tectonism** (faulting and folding), and **gradation** (erosion by all processes except crater formation).
- Impact cratering occurs when a meteoroid (a chunk of asteroid or comet) strikes the surface of a planetary body at extremely high speeds (typically tens of kilometers per second!). The huge amount of energy released compresses the ground and the rebound blows out lots of material in an explosion that leaves a round central crater surrounded by a layer of the ejected material (an "ejecta" blanket).
- The smaller rocky bodies have long since become inactive volcanically and tectonically, whereas larger bodies like Venus and Earth are still active. Mars, being of intermediate size was fairly active in the past and may still be slightly active today.
- Io, the innermost large moon of Jupiter, defies the normal pattern of size vs. activity in the solar system. Although it is only slightly larger than Earth's Moon, it is the most volcanically active body in the solar system. This activity is due to an unusual but powerful internal heat source – tidal friction from an unequal pull in its elliptical orbit around the massive Jupiter.
- Gradation (other than by simple mass wasting) can only occur on planets with atmospheres. Hence, it is active on Mars (primarily wind today, but water was important

in the past), Venus (mass wasting and wind), and Earth (primarily liquid water, but also wind, ice and mass wasting). Atmosphereless bodies such as Mercury, our Moon, and the outer moons and asteroids have little to no gradation, other than minor mass wasting.

- Small fragments of meteoroids enter the Earth's atmosphere and are heated to glowing – theseforms the familiar "shooting stars" we sometimes see at night. When fragments larger than sand grains enter the atmosphere, they will likely reach the surface before vaporizing, becoming **meteorites** – rocks that fell to the Earth from outer space. Meteorites are made of the same types of materials in the planets, silicate minerals, ices (which may vaporize during the short but hot trip through the atmosphere), and even some organic compounds (though probably not produced by living creatures!).
- The search for life (present or past) beyond Earth now centers on the two other places in the solar system where water in liquid form is known to exist near the surface of planets – Mars and Jupiter's moon Europa. Recent discoveries suggest that liquid water may reach the surface of Mars still today, only to vaporize and freeze rapidly as it flows down ravines that look similar to those seen in deserts on Earth. Recent evidence suggests that Europa may have a global ocean under kilometers of ice that contains up to three times the water volume of all Earth's oceans combined.
- Whether or not life could have evolved in either of these two environments is uncertain, but the basic elements for life - liquid water, carbon compounds, and an energy source/sources – are present. It is possible that the first evidence for life in the solar system beyond Earth could be found during our lifetimes!