Geology of the Moon, Mercury, and Mars

11/6/2009

Opening Discussion

- http://www.youtube.com/watch?v=zSgiXGELjbc&fe
- Have you seen anything interesting in the news?
- Surface heat vs. internal heat
- What is the geology of a 2 Earth mass planet likely to be like?
  - Volcanism
  - Tectonics
  - Erosion
  - Cratering

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.

Erosion

- Normal erosion breaks down material at high altitude and deposits it at lower altitudes. That is how sedimentary rocks form.
- These types of erosion require that the planet have a reasonable atmosphere and weather of some type.

More Erosion

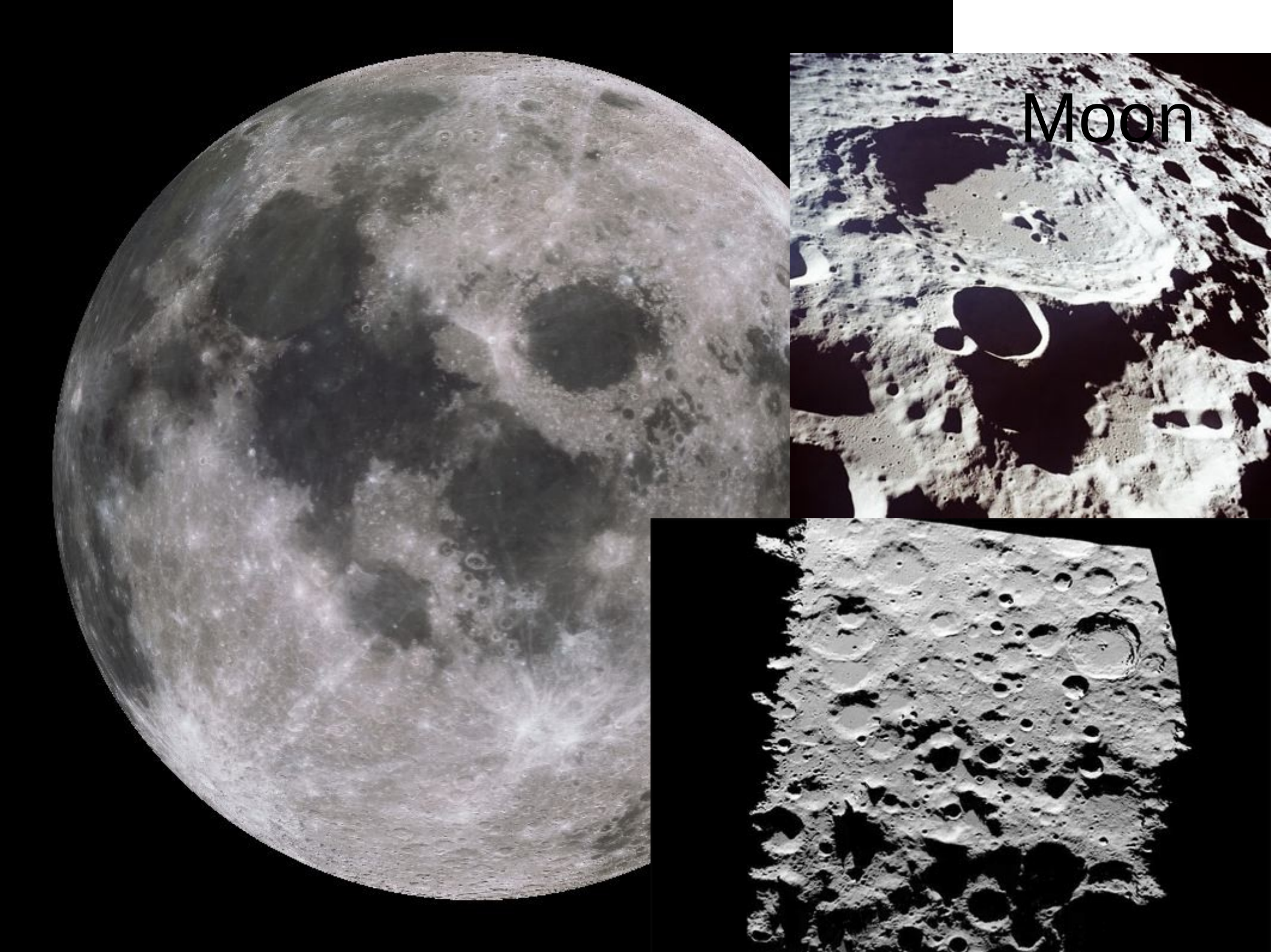
- Whether a planet has an atmosphere with weather depends on the size of the planet, its distance from the star, and its rotation rate. You don't expect much erosion on planets that are too small, too close to or too far from the star, or that don't spin enough to keep winds moving.
- A source of erosion you might not normally consider comes from micrometeorite impacts. This is a smaller effect and doesn't matter at all if there is an atmosphere.

Moon and Mercury

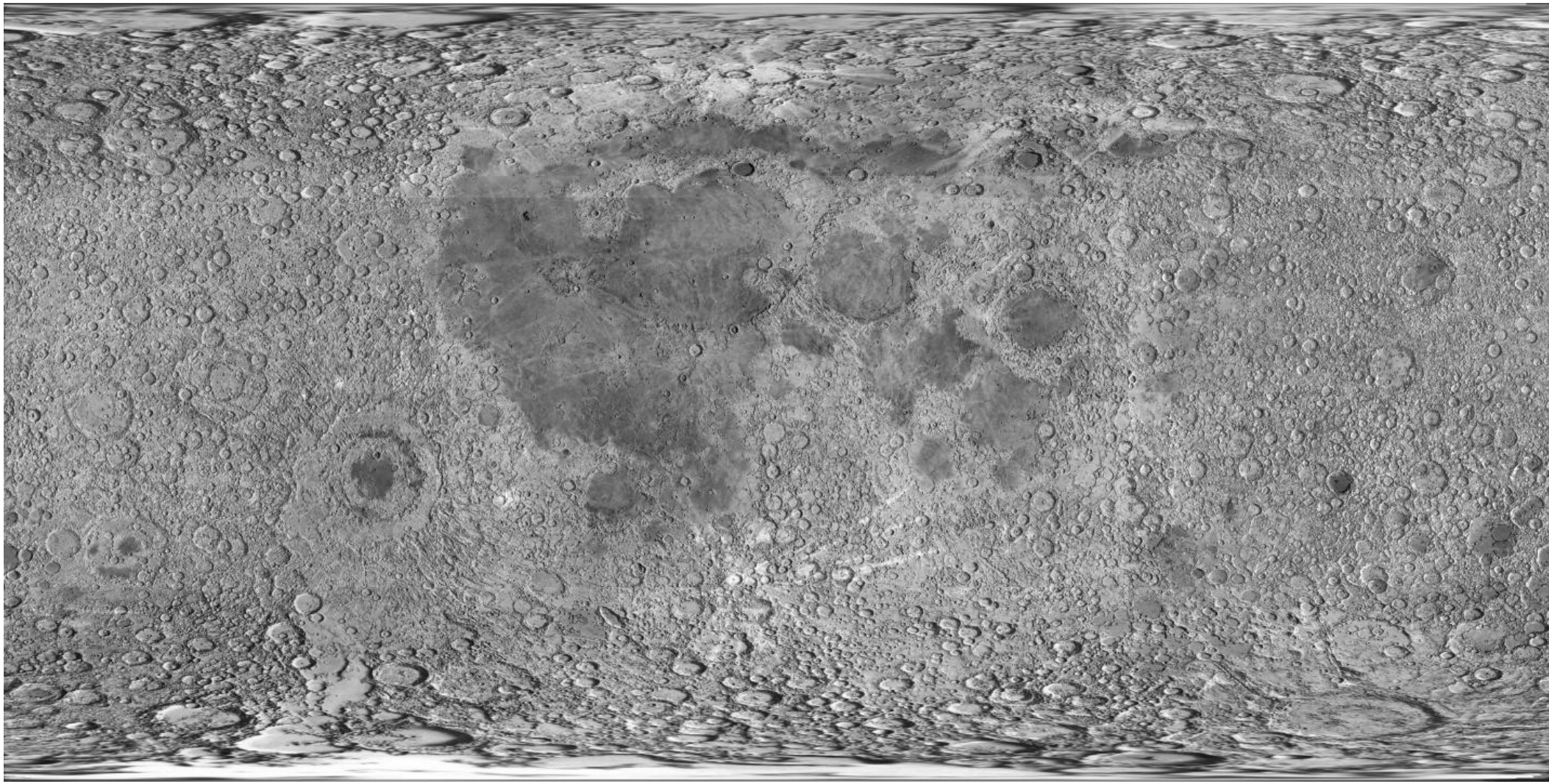
- We start off by looking at the two smallest terrestrial planets since size is the most significant influence on the geology of these bodies.
- Both bodies are very heavily cratered. Because they are small, neither has active volcanism, nor do they have atmospheres and erosion.
- Volcanism and tectonics were active in the early history of both of these worlds. Since they cooled off, both have little geological activity other than the occasional impact.

Moon

- The surface of the moon has records of ancient volcanism and minor tectonics. After the Moon formed and solidified, the heavy bombardment blasted the surface with numerous craters. Later, radioactivity heated the inside up to the melting point and low viscosity lava flows filled in the large regions we called the maria. Since then less frequent impacts have dotted the maria with some craters.
- There are wrinkles on the surface of the Moon that are the evidence of tectonics. They likely formed when material cooled and shrunk so some regions bunched up a bit.

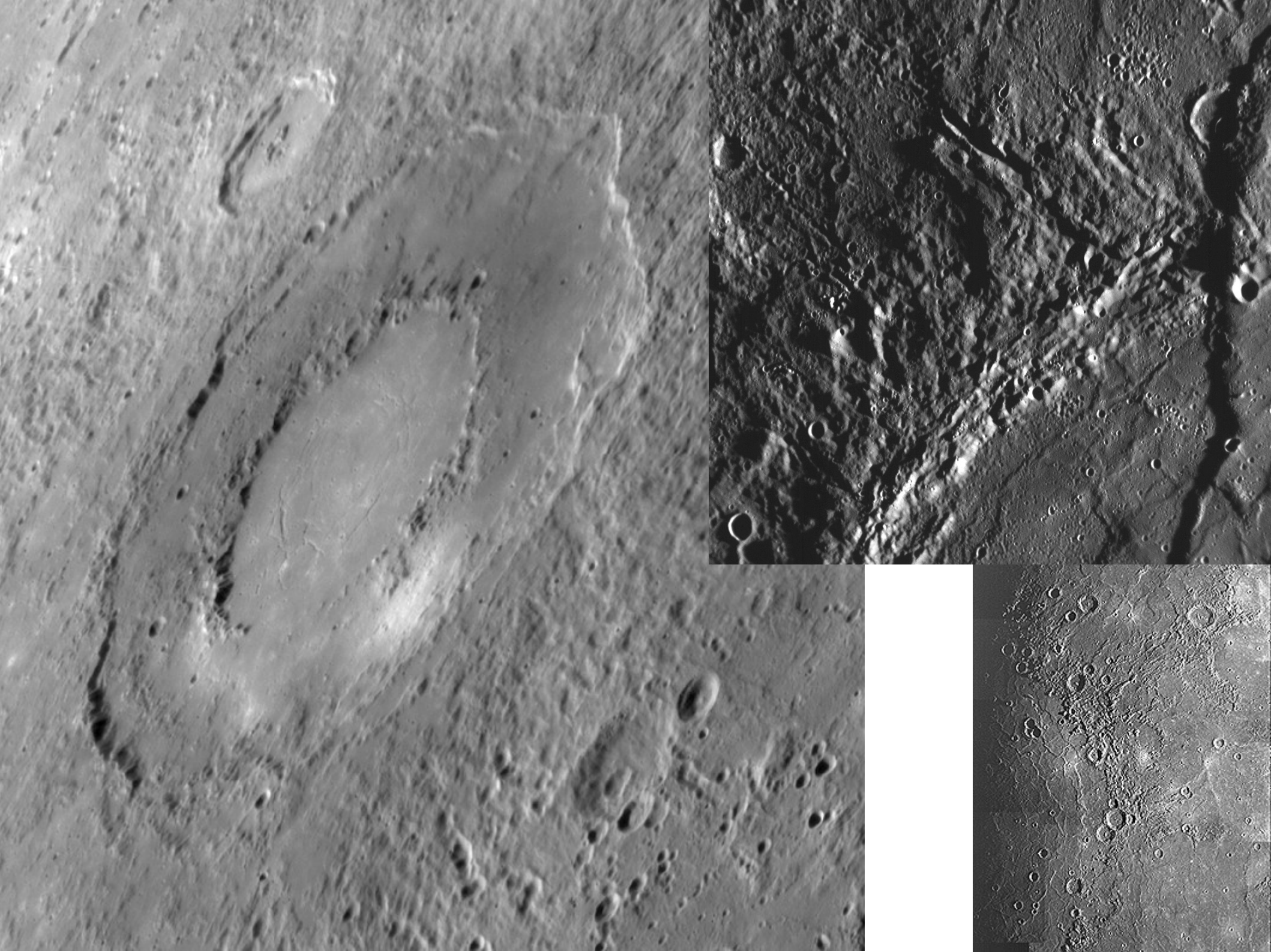

Moon

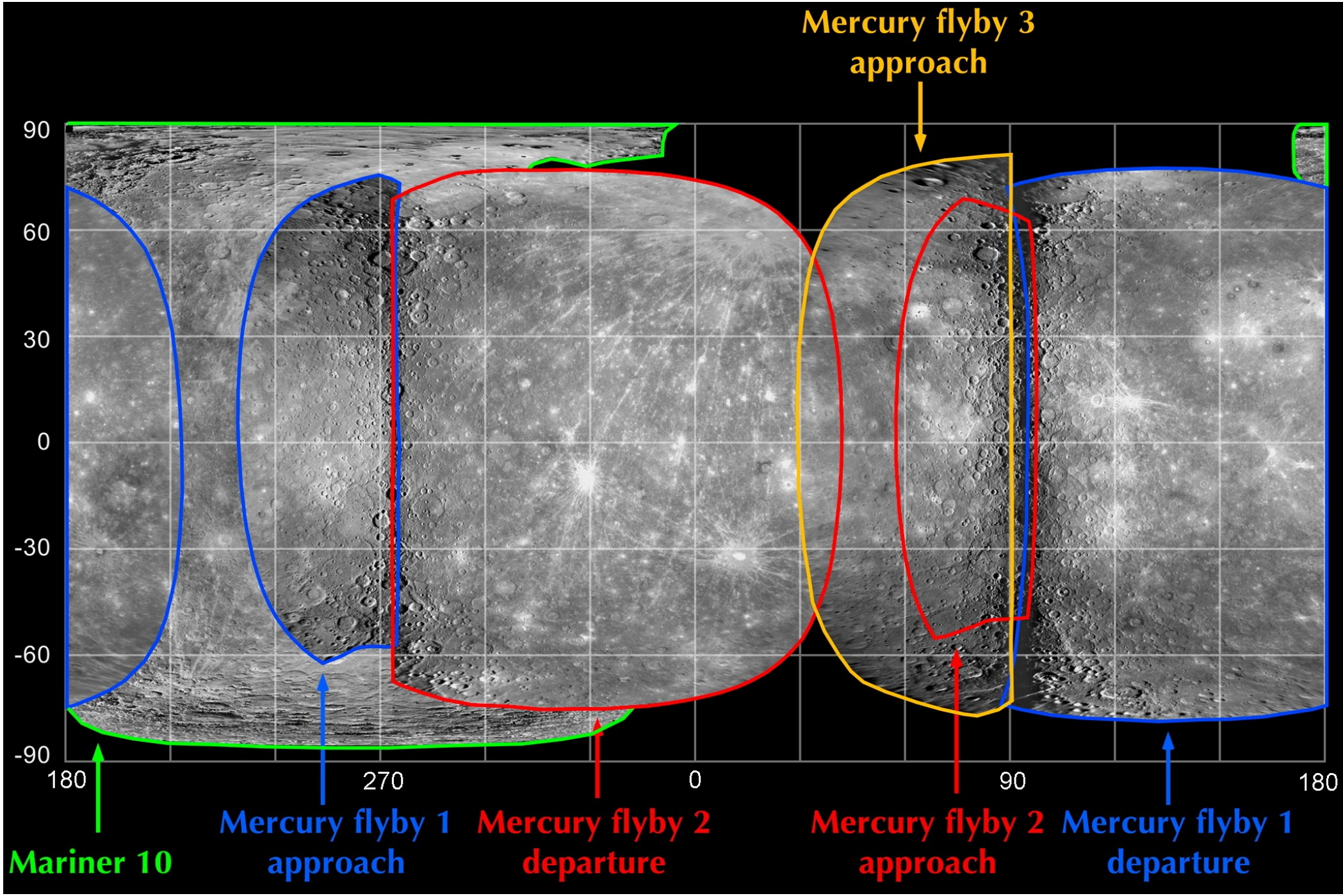
Moon Map



Mercury

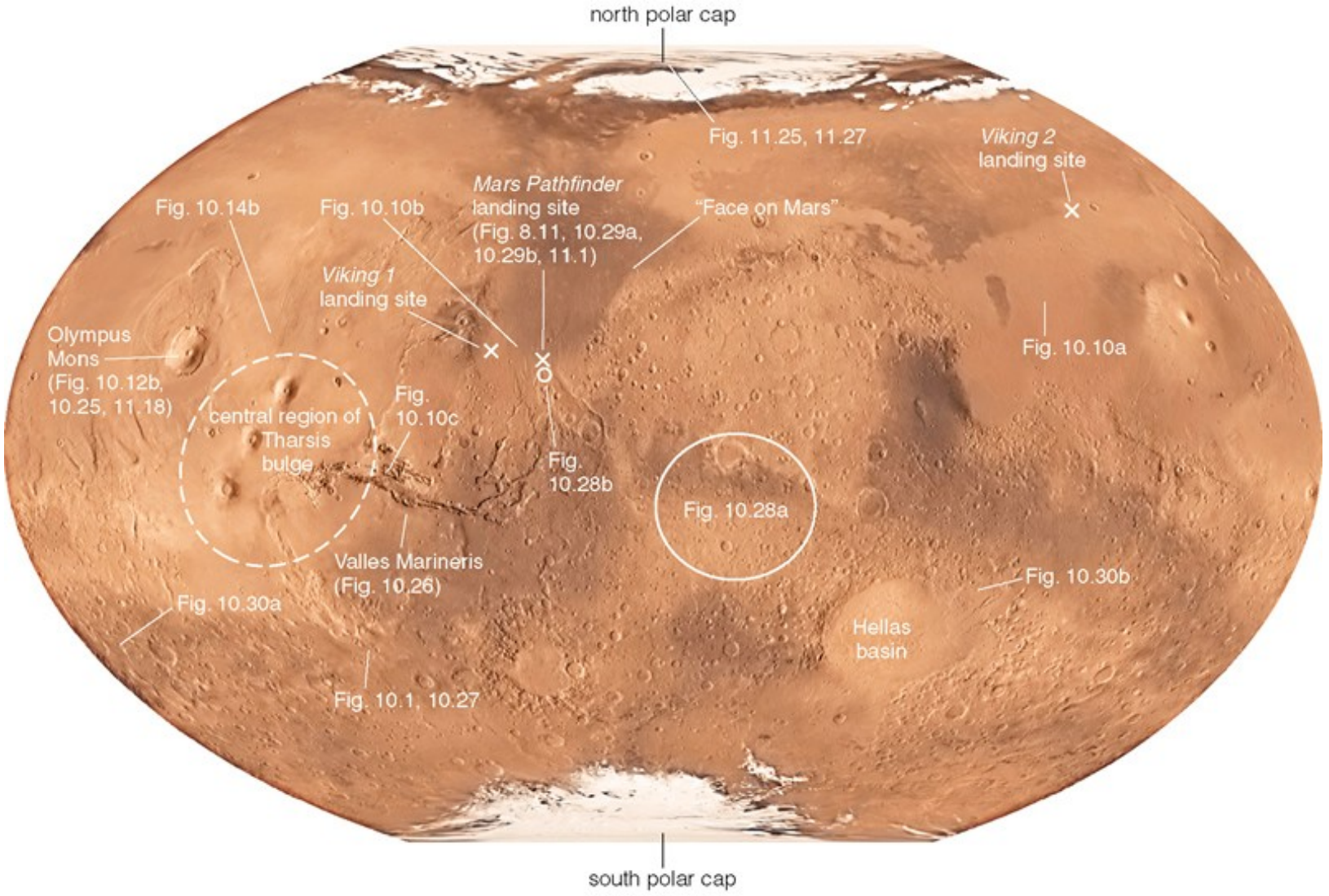
- Mercury's craters are less dense than the lunar highlands, indicating the they were resurfaced more recently.
- Mercury has one impact crater, the Caloris Basin, that spans more than half of the radius of the planet. The small number of craters in the basin tell us it happened late in the heavy bombardment.
- Mercury has many small lava plains.
- Mercury also has some remarkable cliffs (up to 3 km high, hundreds of km in length) that were formed by tectonics. These were likely formed by large scale shrinking as it cooled.




Mercury flyby 3
approach
90
60
30
0
-30
-60
-90
180
270
0
90
180
Mariner 10
Mercury flyby 1
approach
Mercury flyby 2
departure
Mercury flyby 2
approach
Mercury flyby 1
departure

Mars

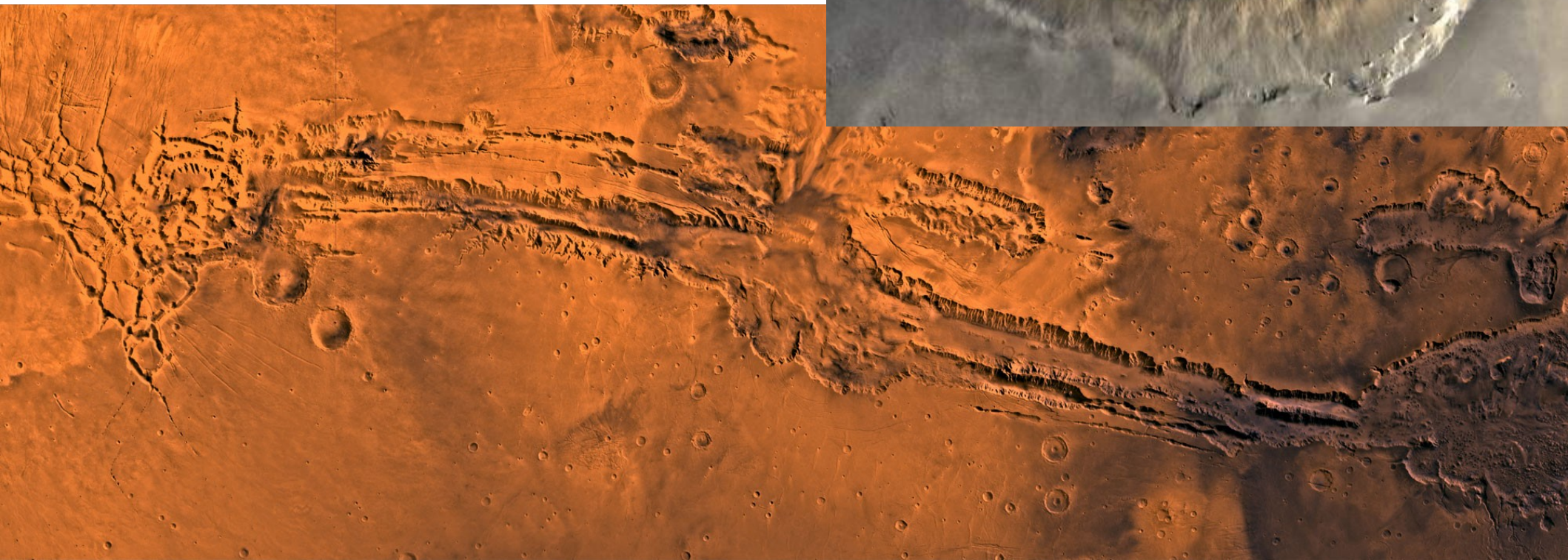
- The next terrestrial planet up in size is Mars. Mars is roughly 1/10th the mass of the Earth.



Features on Mars

- Mars has many similarities to Earth when viewed through a telescope. Most of these disappear when you get closer to the planet.
- The southern hemisphere of Mars is mostly covered in craters.
- The northern hemisphere was resurfaced by volcanism and has a number of very large volcanoes on it. Because of its small size, Mars is no longer very active if it is active at all.
- Valles Marineris is the most prominent tectonic feature on Mars.

Volcanism and Tectonics

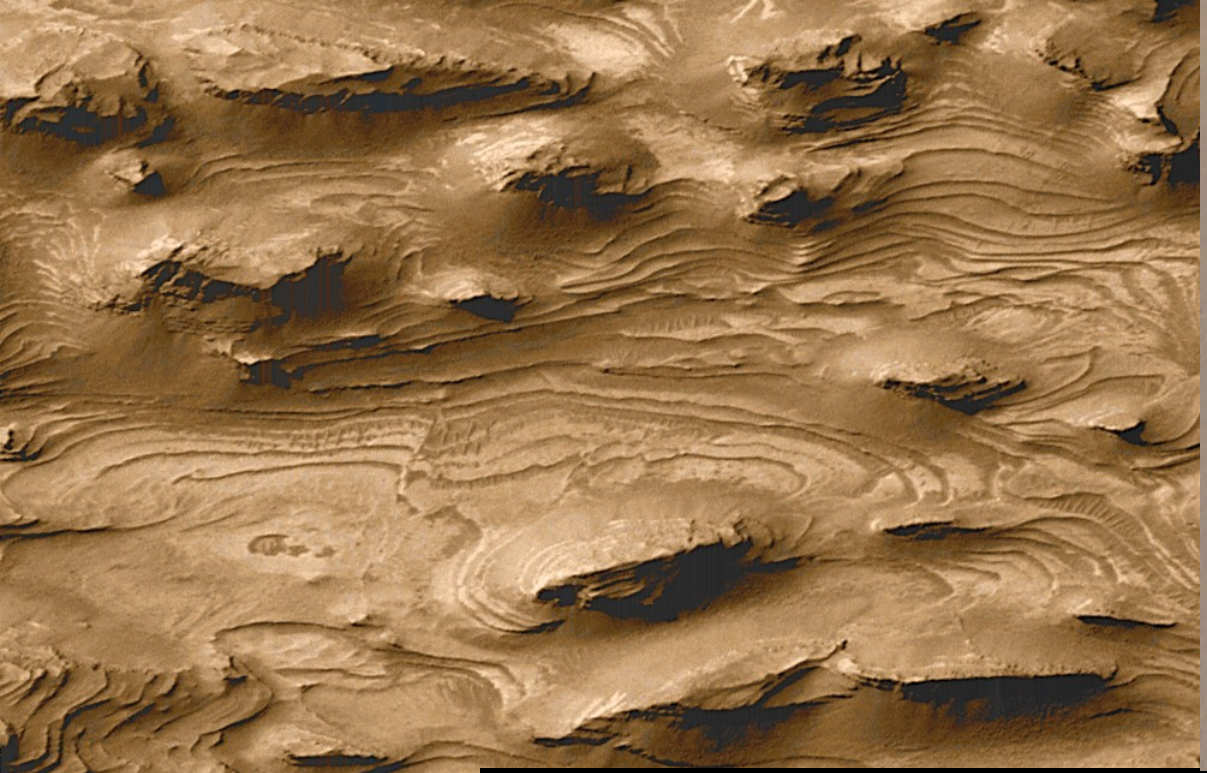


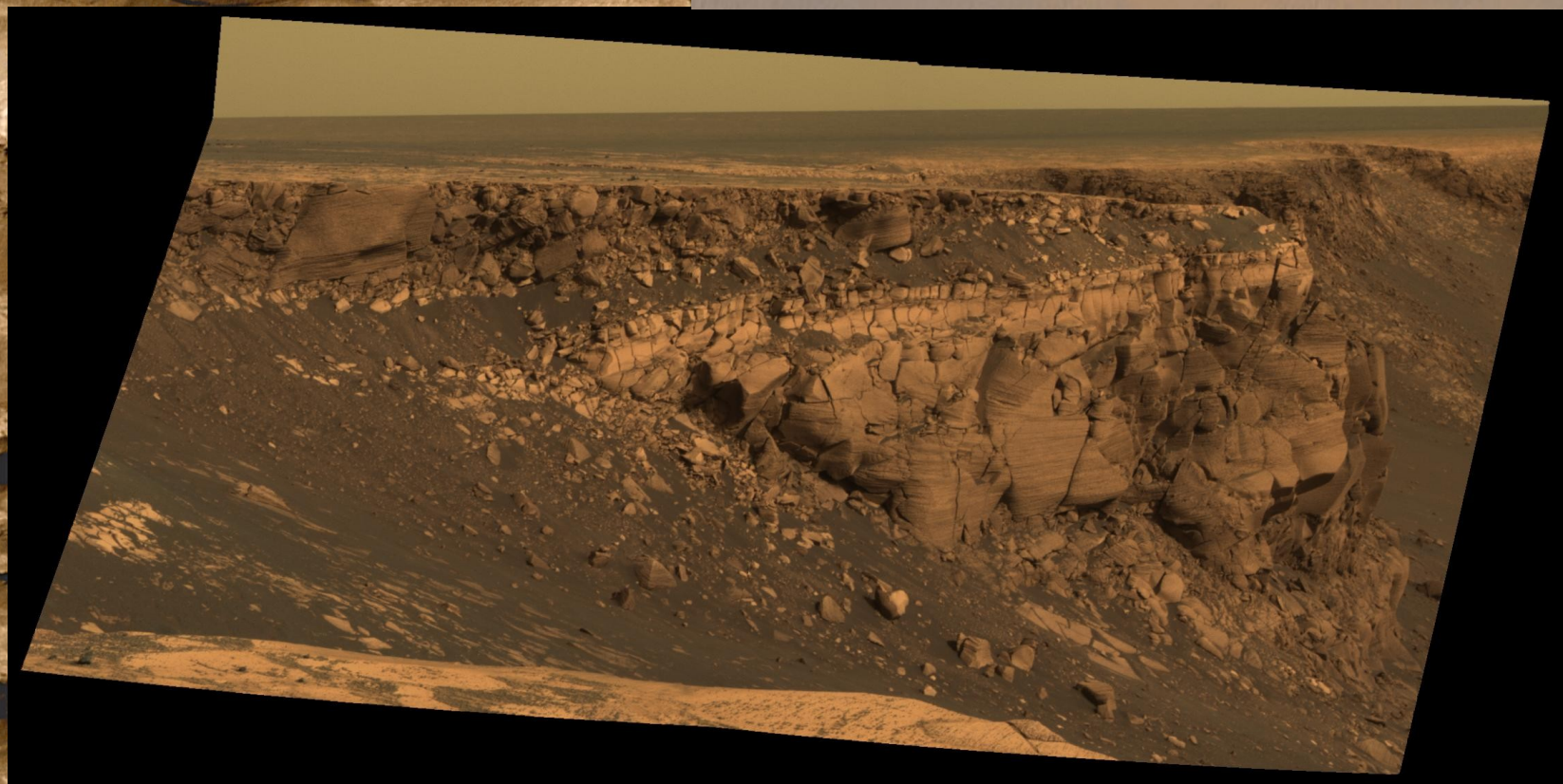
Erosion on Mars

- Mars has a thin carbon dioxide atmosphere and we have seen images of dust devils in it. The wind is constantly changing the look of the surface and contributing to minor erosion.
- There are also many features on Mars that indicate that there had at one time been significant water on the planet. It is possible Mars was warm and wet during the first 1.5 billion years of its life. About 3 billion years ago it dried up.
- http://marsprogram.jpl.nasa.gov/mgs/msss/camera/

Water?

- A major question is that of whether there is currently water on Mars. The atmosphere is too thin to support liquid water today. That doesn't mean there is no water, it just isn't liquid.
- There are many features that indicate the sudden release of large underground repositories of water more recent than 3 billion years ago.
- MGS has also returned images that indicate that there is underground water on Mars today. Mars Odyssey has shown other evidence of underground water.





109 yd
100 m
1.5 aspect ratio

Mars Reconnaissance Orbiter (MRO)

- This is the web site for the mission.
- http://marsprogram.jpl.nasa.gov/mro/
- The HiRISE camera takes remarkably high resolution images.

Minute Essay

- As of right now, do you think that life existed on Mars in the past? What about the present? Briefly explain.
- Enjoy your weekend.