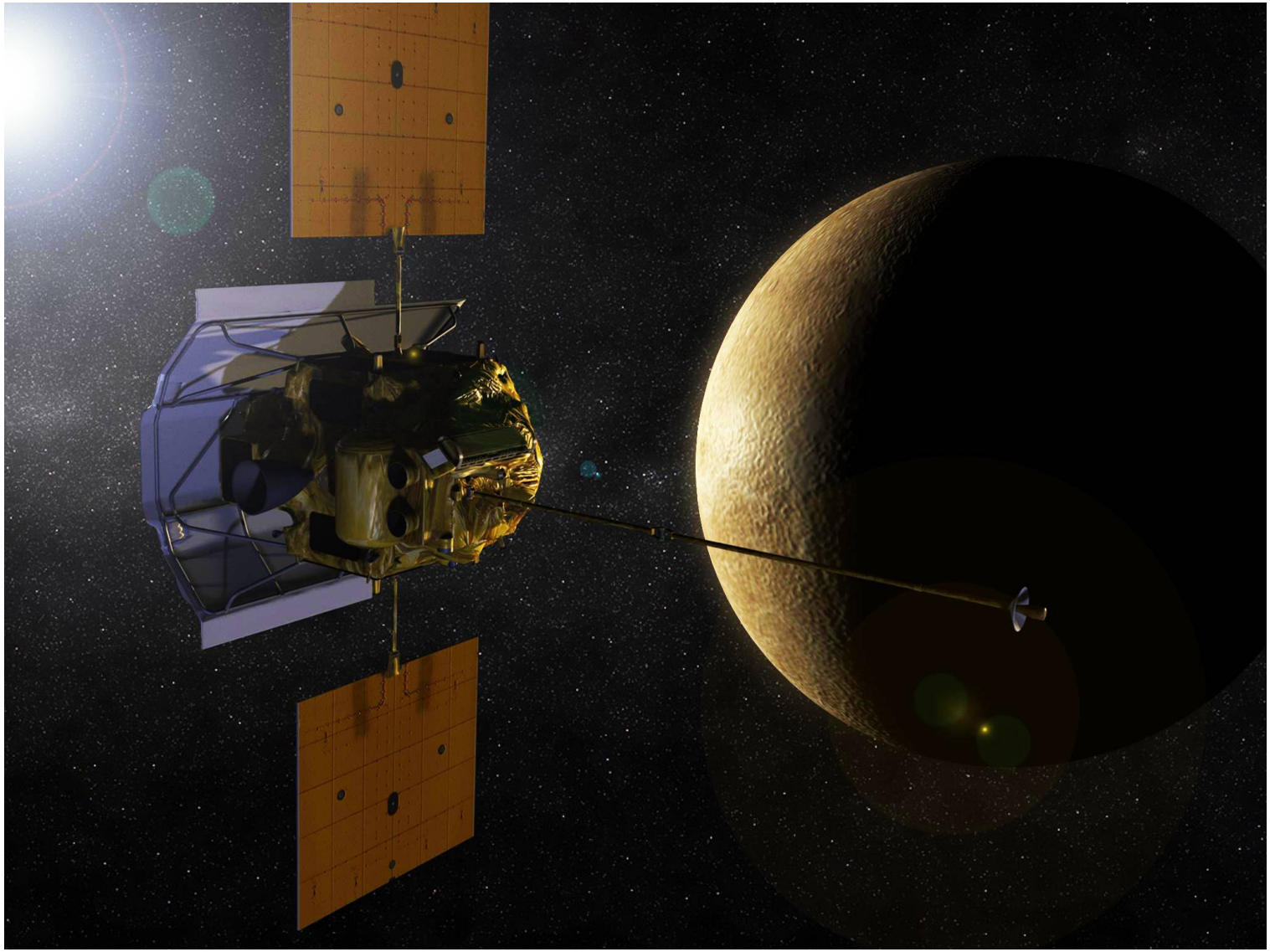
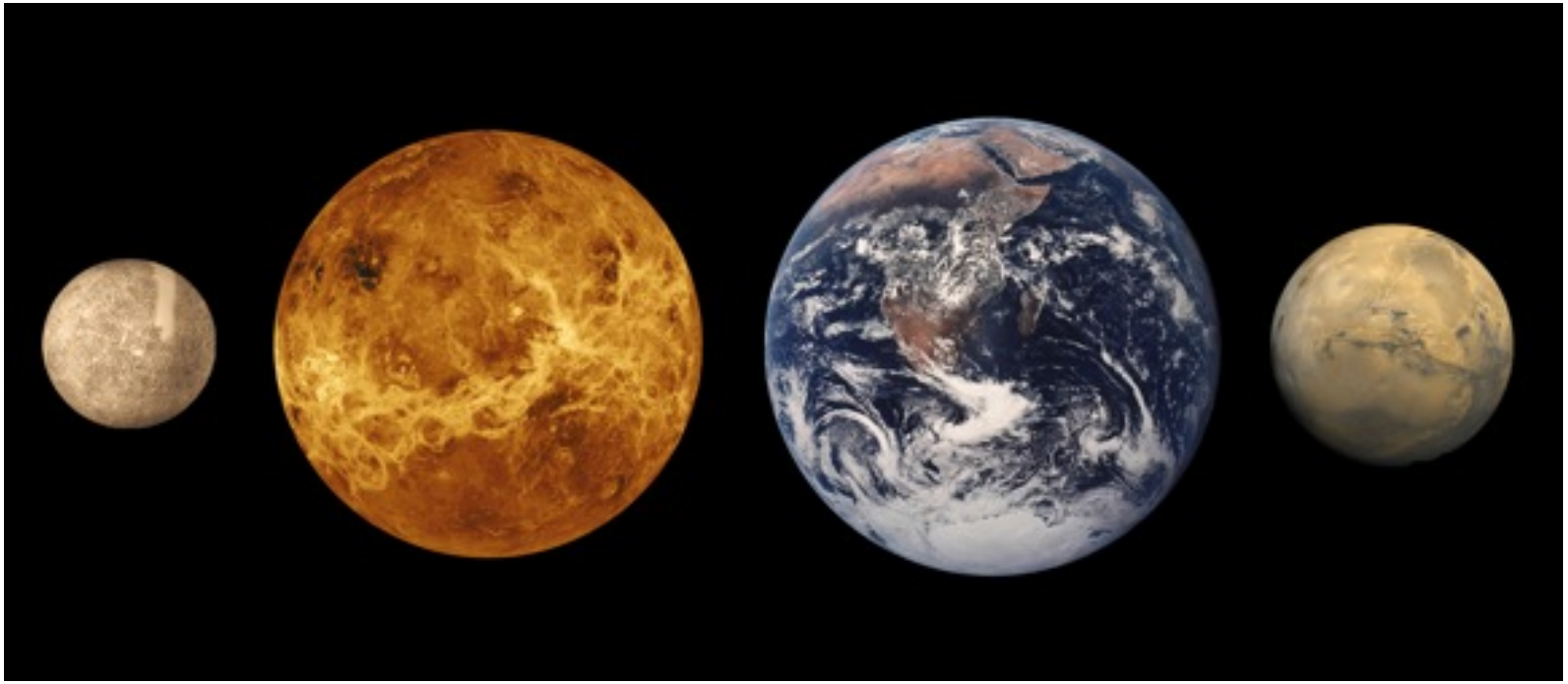
The Planets



Part 1: the terrestrial planets



Mercury and Venus in the night sky

- Mercury is always very close to the Sun in the sky, is small in diameter, and is farther away than Venus. This makes it a difficult object to see. The legend is that Copernicus never saw it.
- Venus at times is the brightest object in the sky after the Moon; you can't miss it.

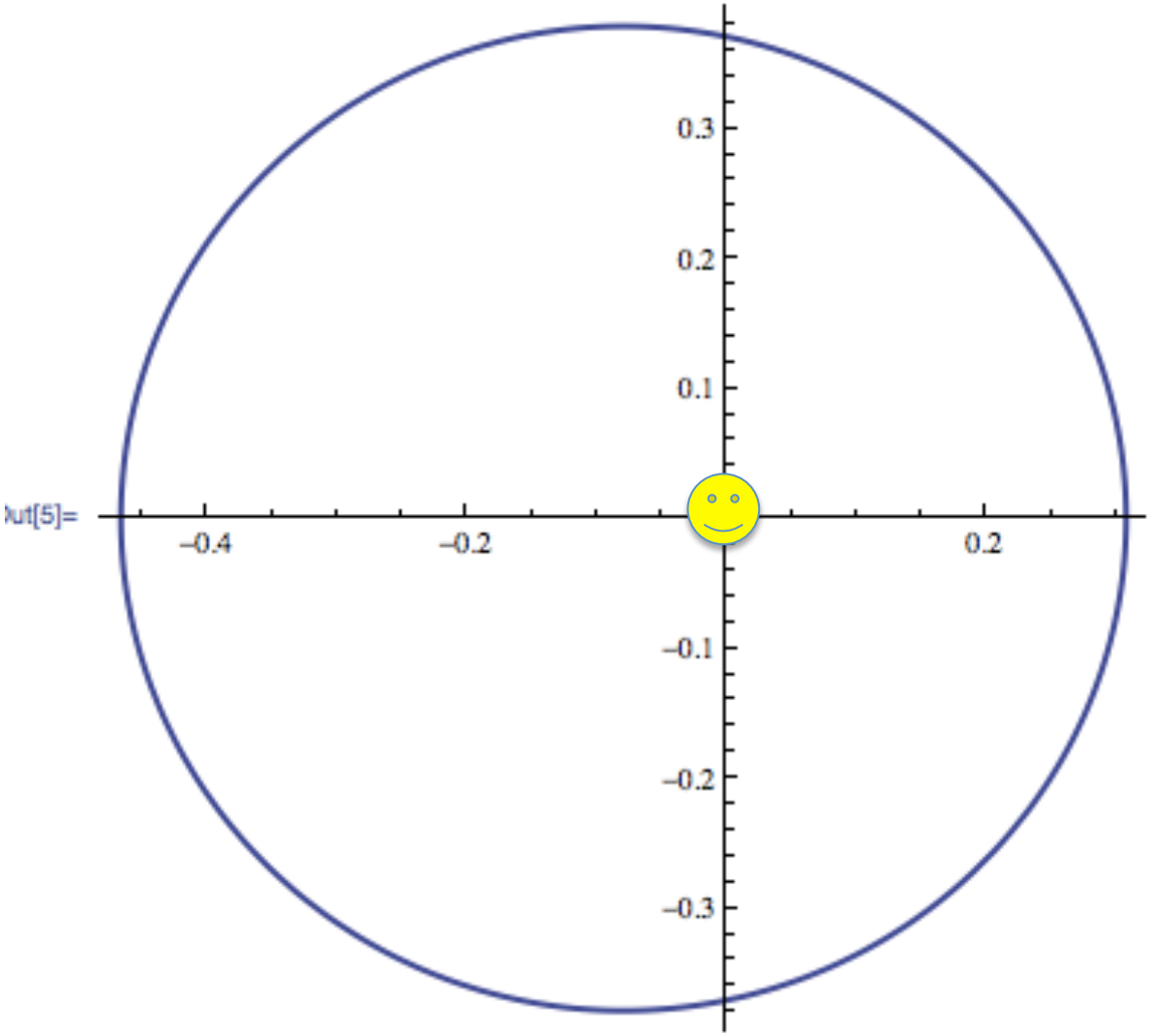
p. 46 God of Morning star

p. 46 God L lord of heliacal rise

Basic facts of Mercury

- Semimajor axis of orbit: 0.3871 au
- Eccentricity of orbit: 0.206 (large for major planet)
- Inclination of orbit: 7.00 degrees
- Diameter: 4878 km (0.38 Earth diameters
- Mass: 0.055 Earth masses
- No atmosphere, surface heavily cratered

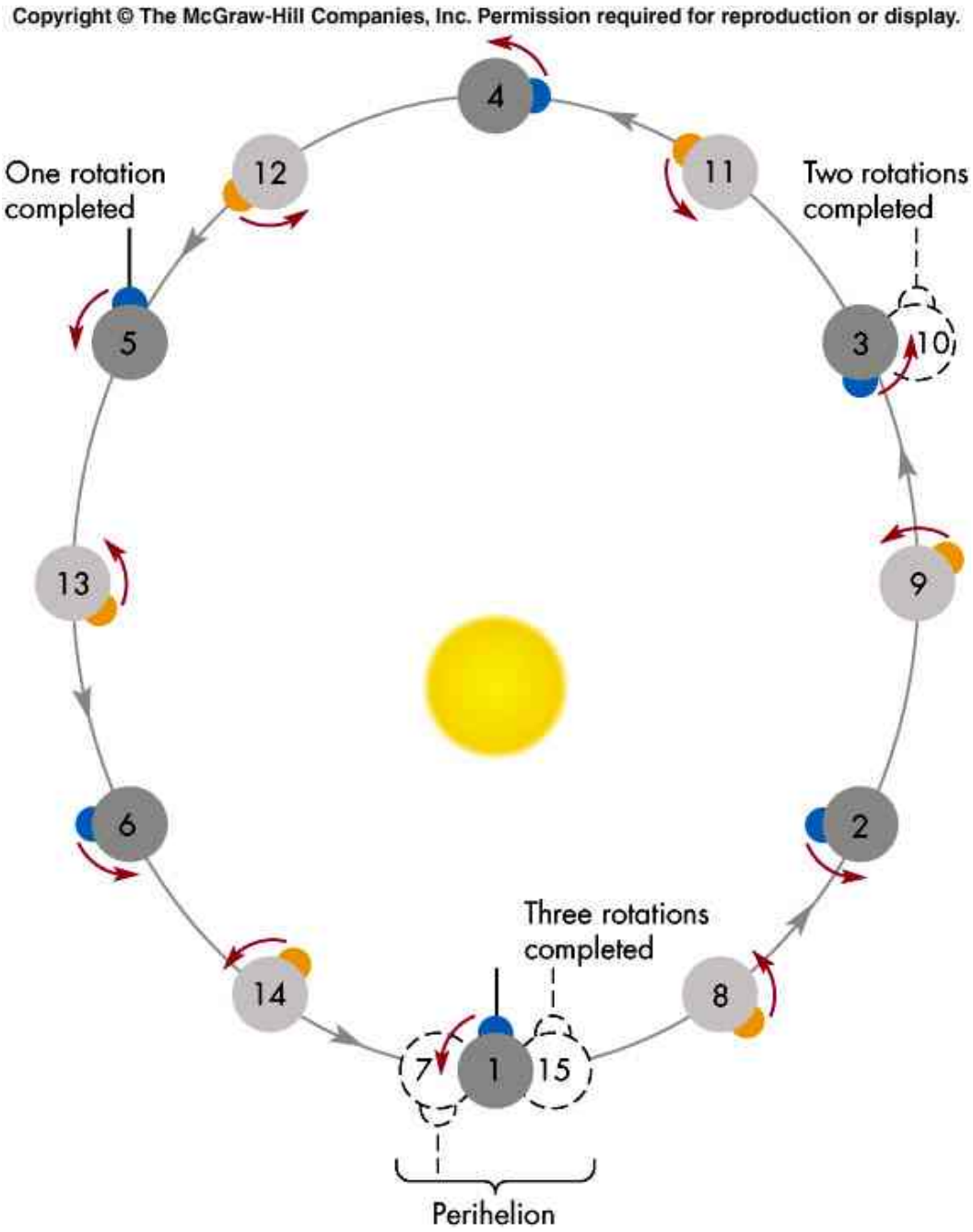
Mercury: Closest of the Major Planets



Interesting aspect of Mercury: the length of the day

Mercury is closest major planet to Sun, so tides are significant. For long time, it was believed to be synchronously rotating (like the Moon), with a rotation period equal to the revolution period of 88 days (87.97 days). In 1967 this was found not to be true. Mercury is in "2/3" resonance" (rotation period 58.65 days), meaning it undergoes 3 rotations for 2 revolutions

3/2 synchronous rotation and the weird day of Mercury



The weird day on Mercury

- Weirdness is due to the fact that the rotation period is comparable to period of revolution, and that they are related by the ratio of 2/3 (see figure 10.3)
- An apparent solar day lasts 2 years!
- Only 2 longitudes have the noon when the planet is at *perihelion* (“hot poles”)
- Only 2 other longitudes have noon at *aphelion* (“warm poles”)
- From one of the hot poles, the Sun would rise quickly, linger around noon, then set fast

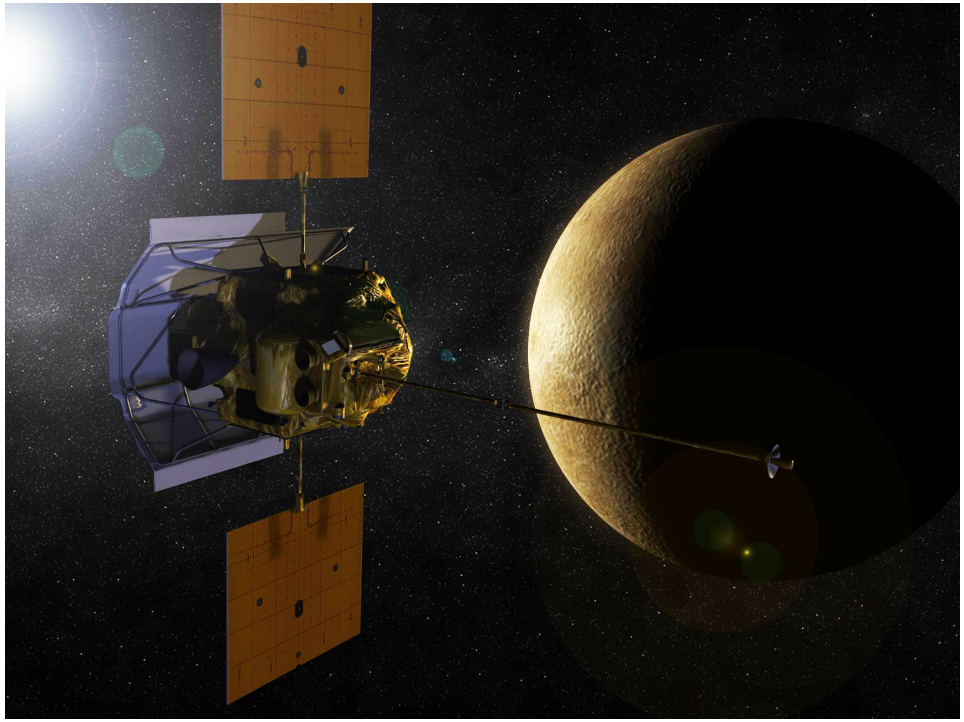
Surface temperature on Mercury

Mercury is much closer to the Sun than the Earth, so the amount of solar heating is much larger (technically, the flux of solar radiation is larger by the square of the distances of the planets, which is $\frac{1.00}{0.387}^2 = 6.7$ times higher. In addition, daytime (when the Sun is above the horizon) lasts 88 days. As a result, the daytime temperature of Mercury is unbelievably hot. Surface temperatures can reach 700 K (700 degrees Kelvin), which is about 770 degrees Fahrenheit. Read the textbook about the Kelvin temperature scale. We will be using it the rest of the course.

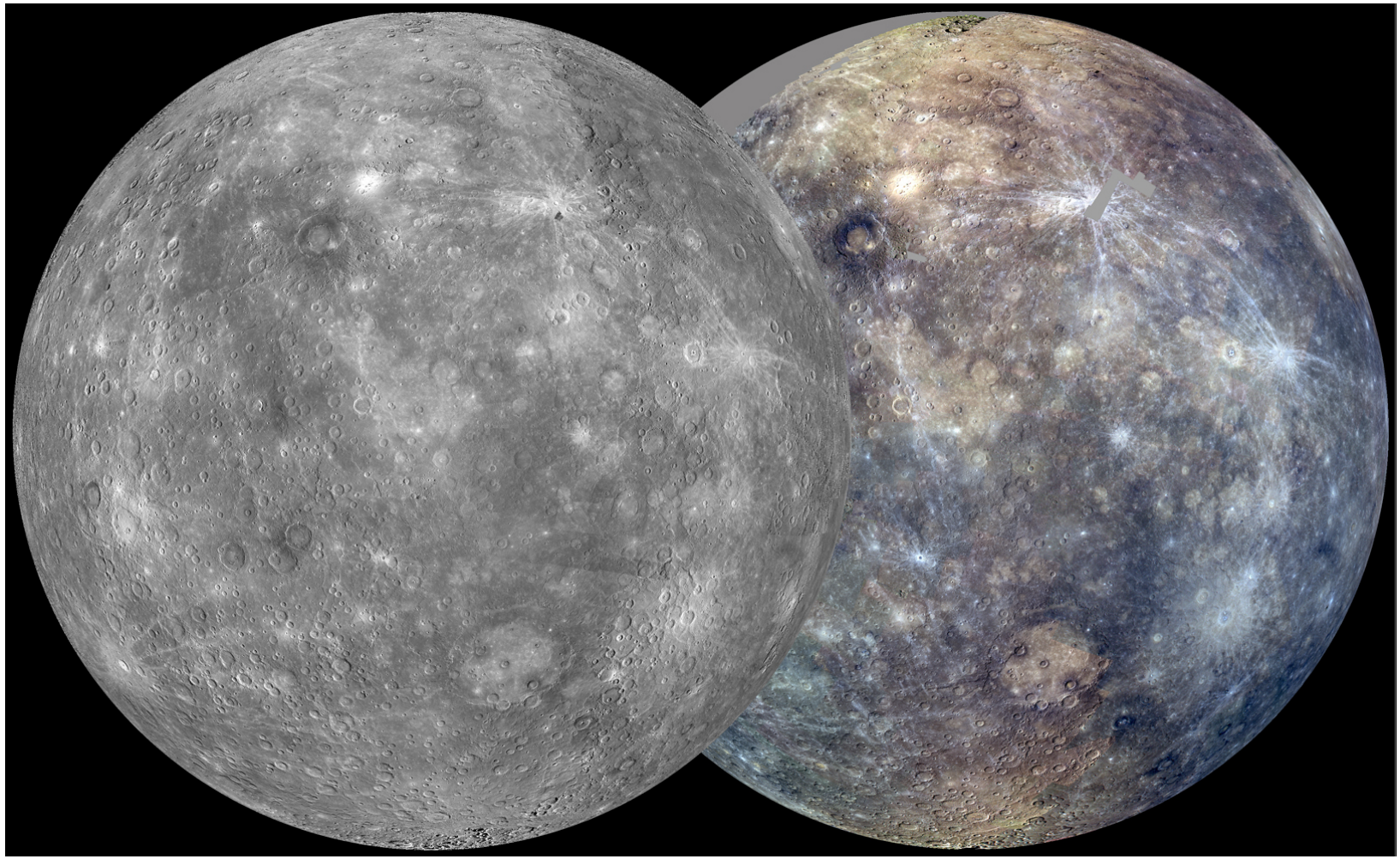
At nighttime, the Sun is absent from the sky for a revolution period of 88 degrees, so there is plenty of time for the surface of Mercury to cool off. Furthermore, *Mercury has no atmosphere to help retain the heat.* On the nighttime side, the temperature drops to 100 K, which is similar to temperatures in the outer solar system far from the Sun. The Kelvin temperature scale is described on p134 of your textbook. Read it.

The Messenger mission to Mercury

- Launch: Aug. 3, 2004
- 1st Mercury flyby: Jan. 2008
- 2nd Mercury flyby: Oct. 2008
- 3rd Mercury flyby: Sept. 2009
- Orbital insertion: Mar. 2011



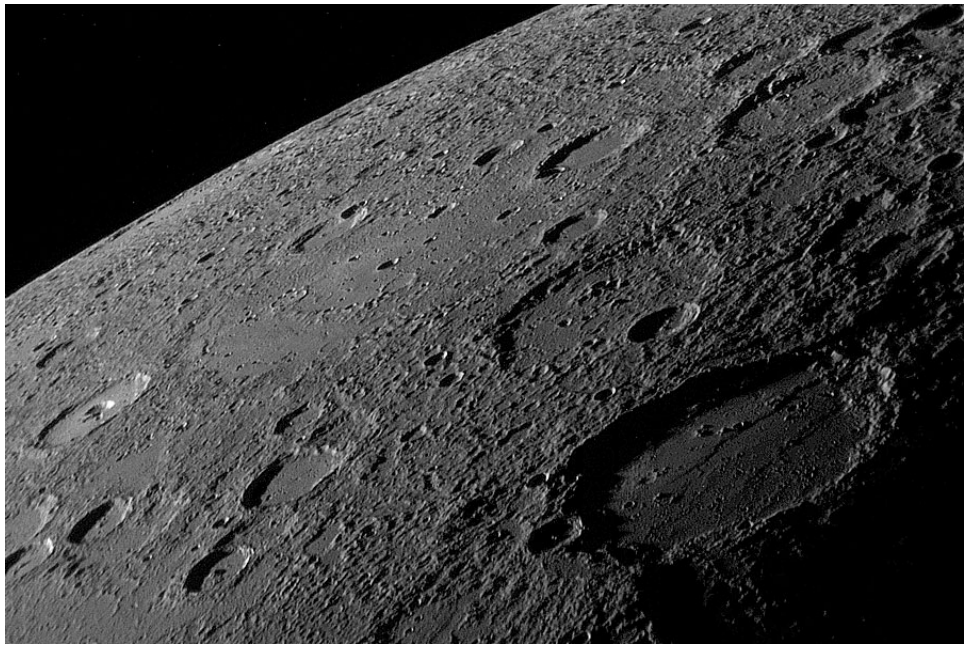
A new age in the study of the planet Mercury



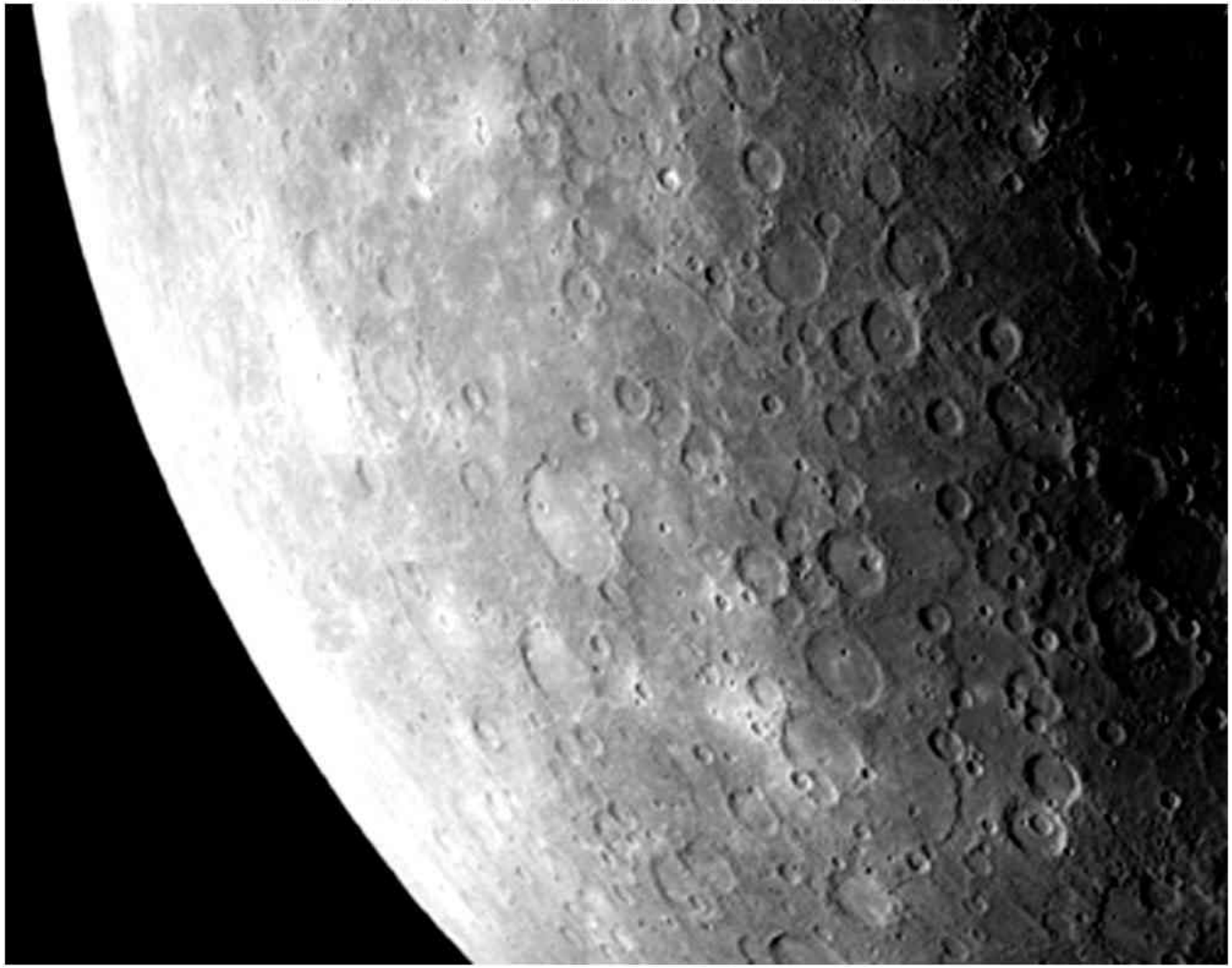
the Messenger spacecraft: a base at Mercury

The geology of Mercury

What we can learn from its high mean density, magnetic field, and surface photography from Mariner 10 and the Messenger spacecraft

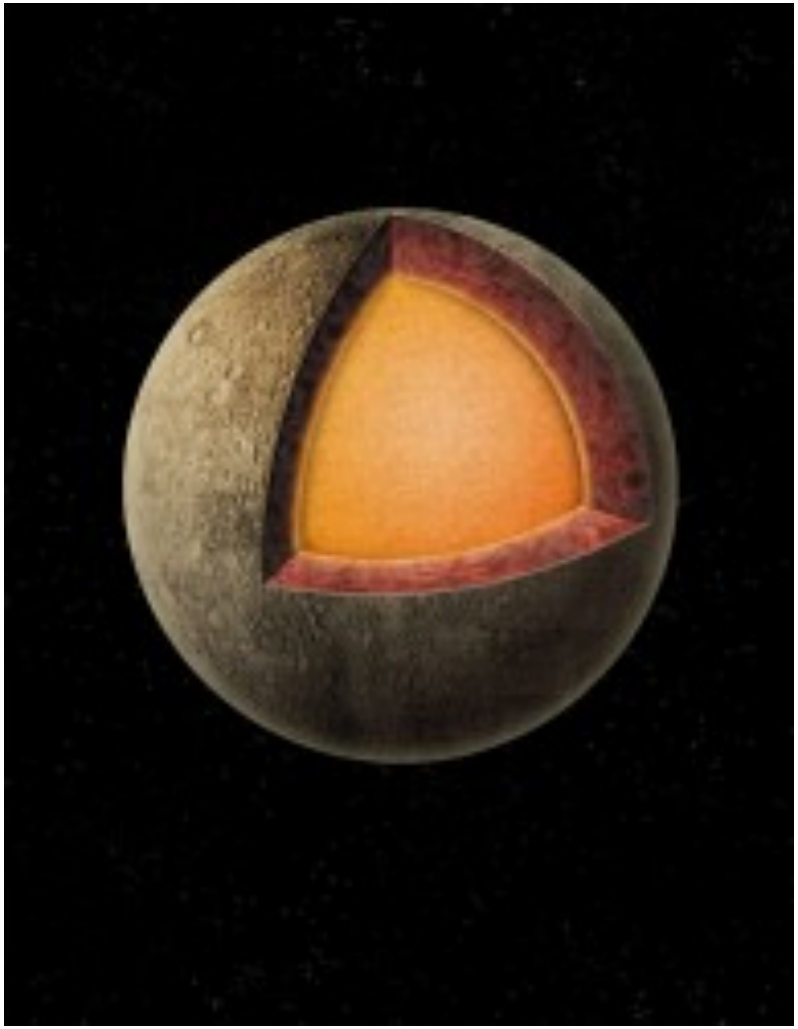


The surface of Mercury

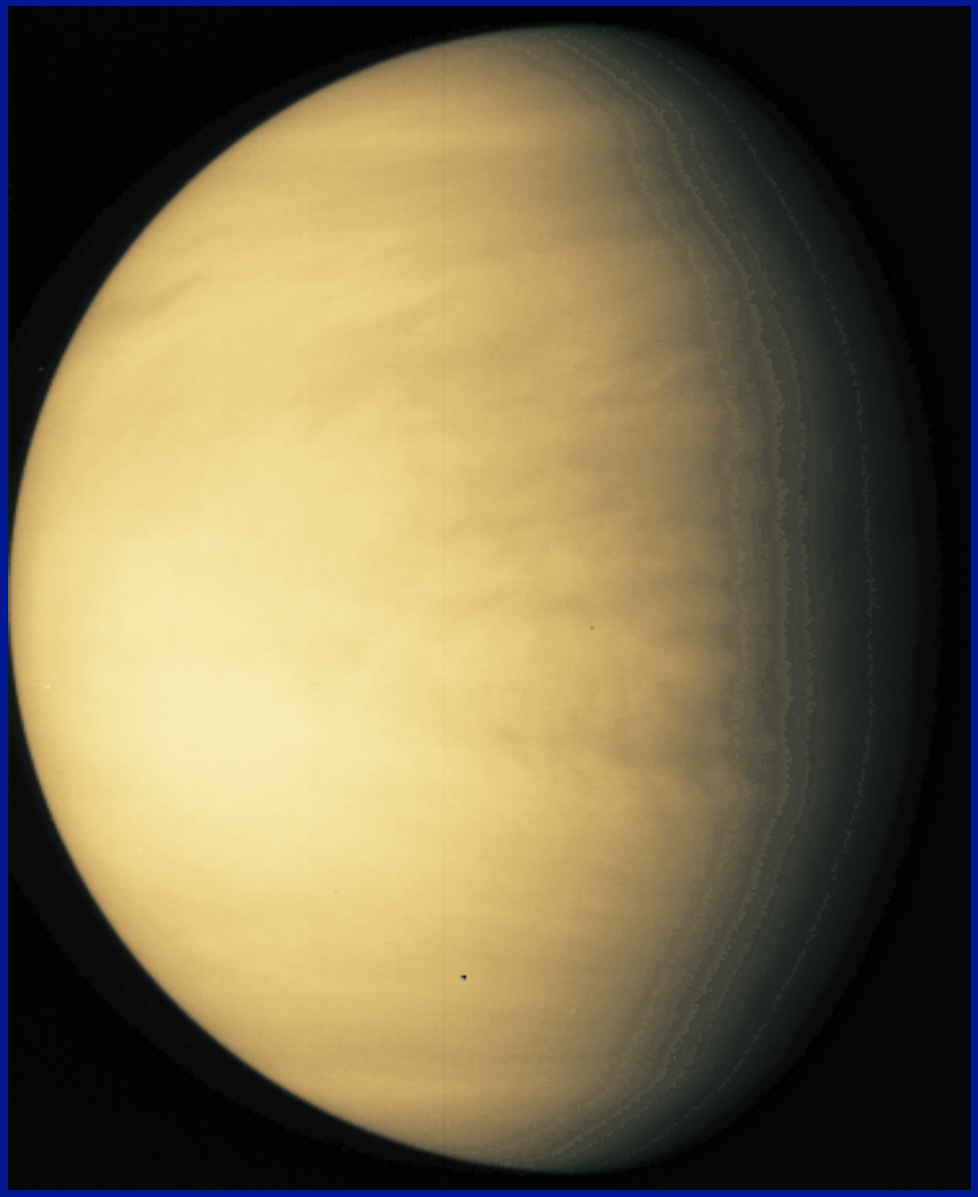


The large core of Mercury (result from Messenger)

Estimates are iron core extends 85 % of way to surface

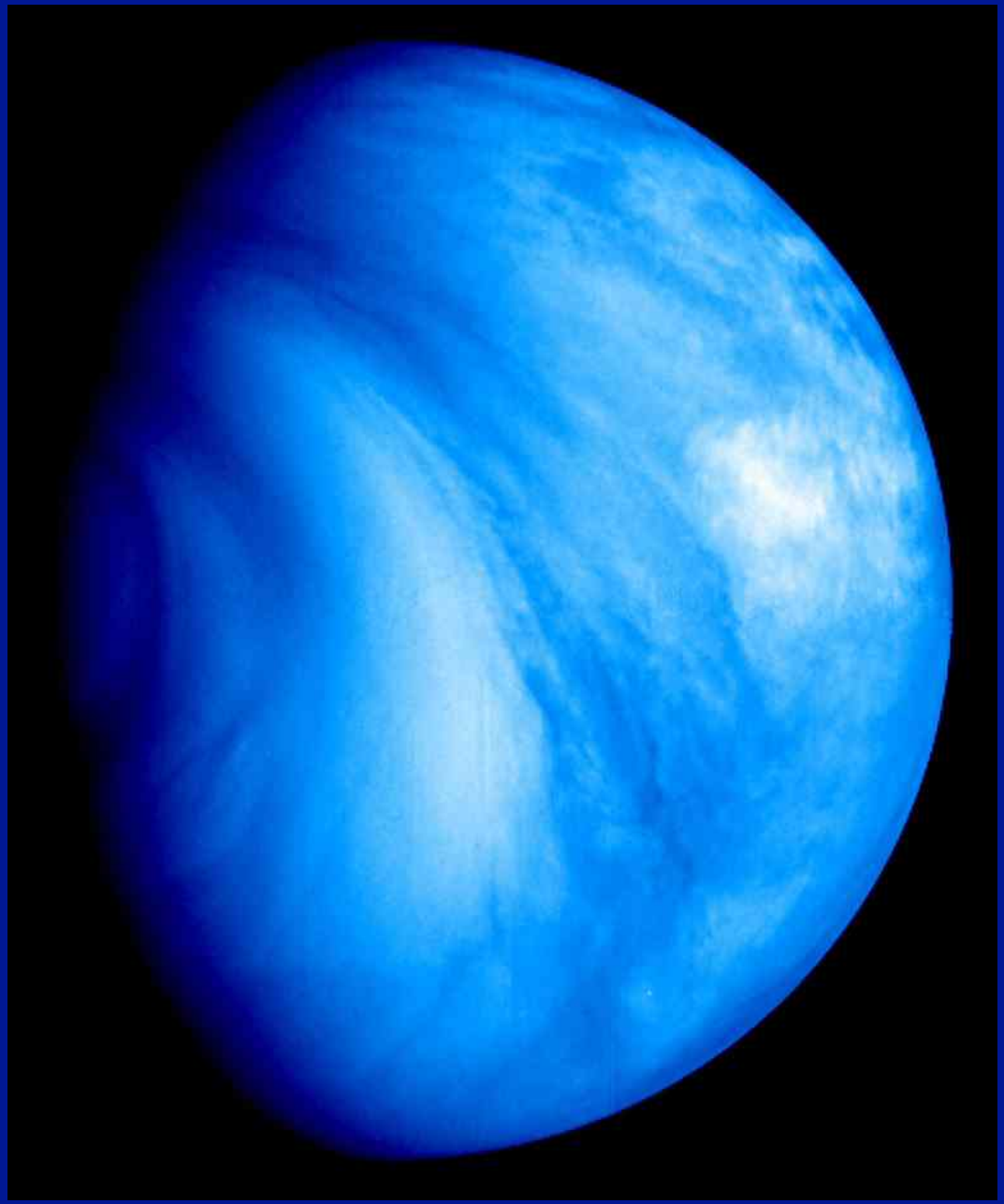


Venus…Earth’s twin

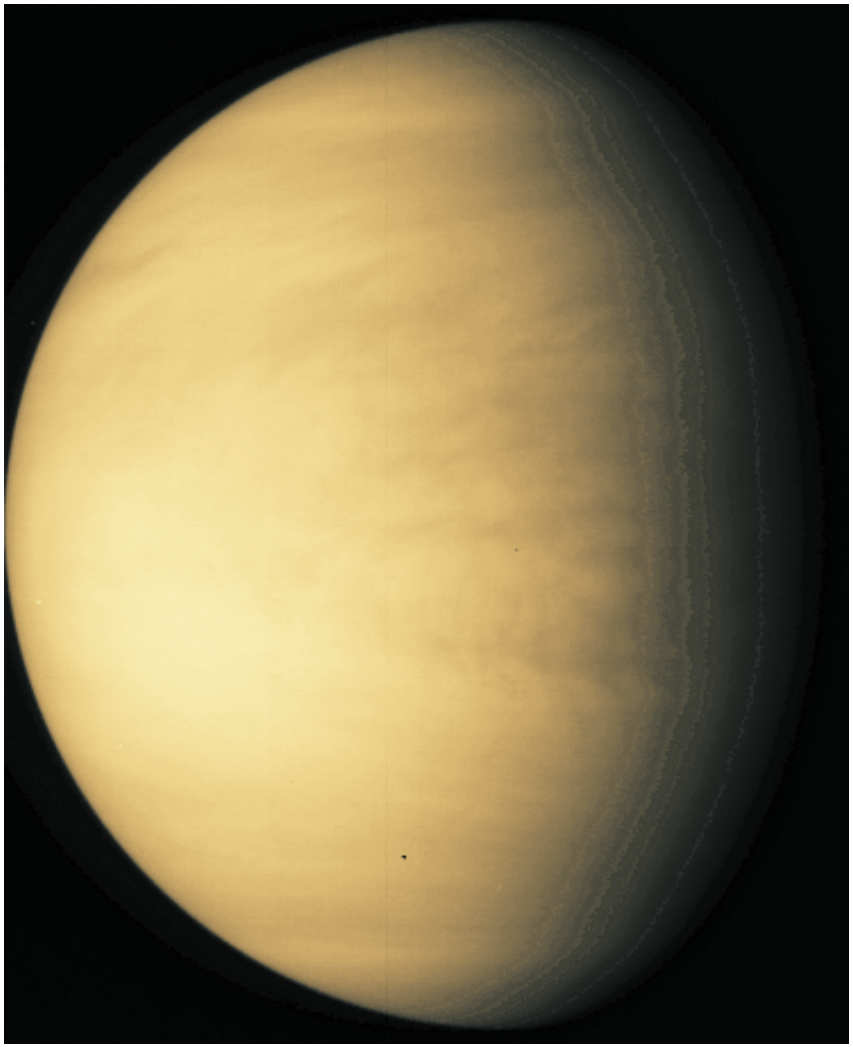


Venus in ultraviolet light

What is under
The clouds?



The planet Venus: the Earth's twin (in a limited sense)

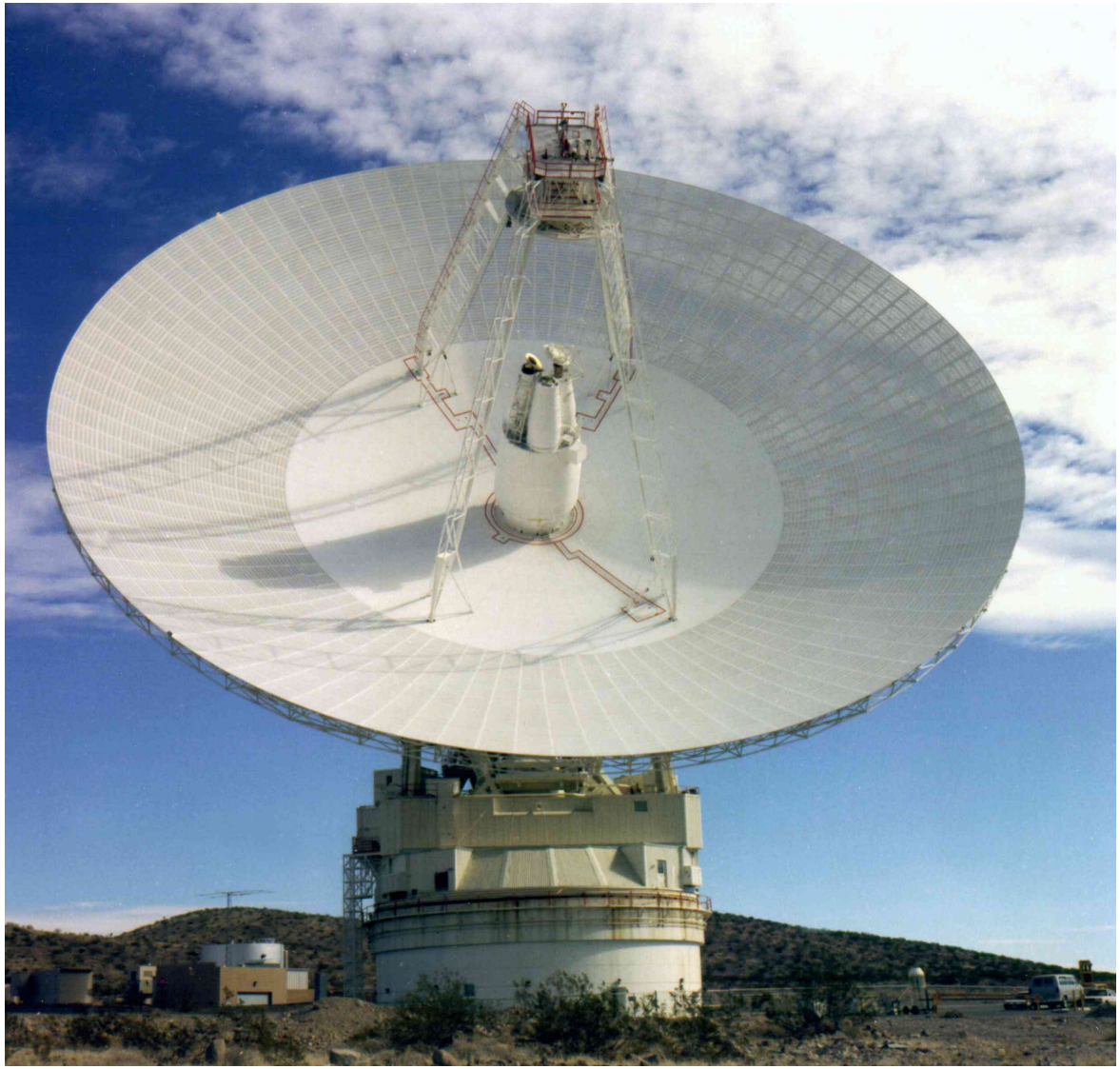


A comparison of Earth and Venus

- Semimajor axis of orbit: 0.7233 (V) 1.000 (E)
- Orbital eccentricity: 0.007 (V), 0.017 (E)
- Diameter: 12104 km (V) 12756 (E) !
- Mass: 0.815 Earth masses (V) 1.00 Earth masses (E) !!
- As spheres, Venus and Earth are very similar

Seeing through the clouds of Venus with **Radio Astronomy!**

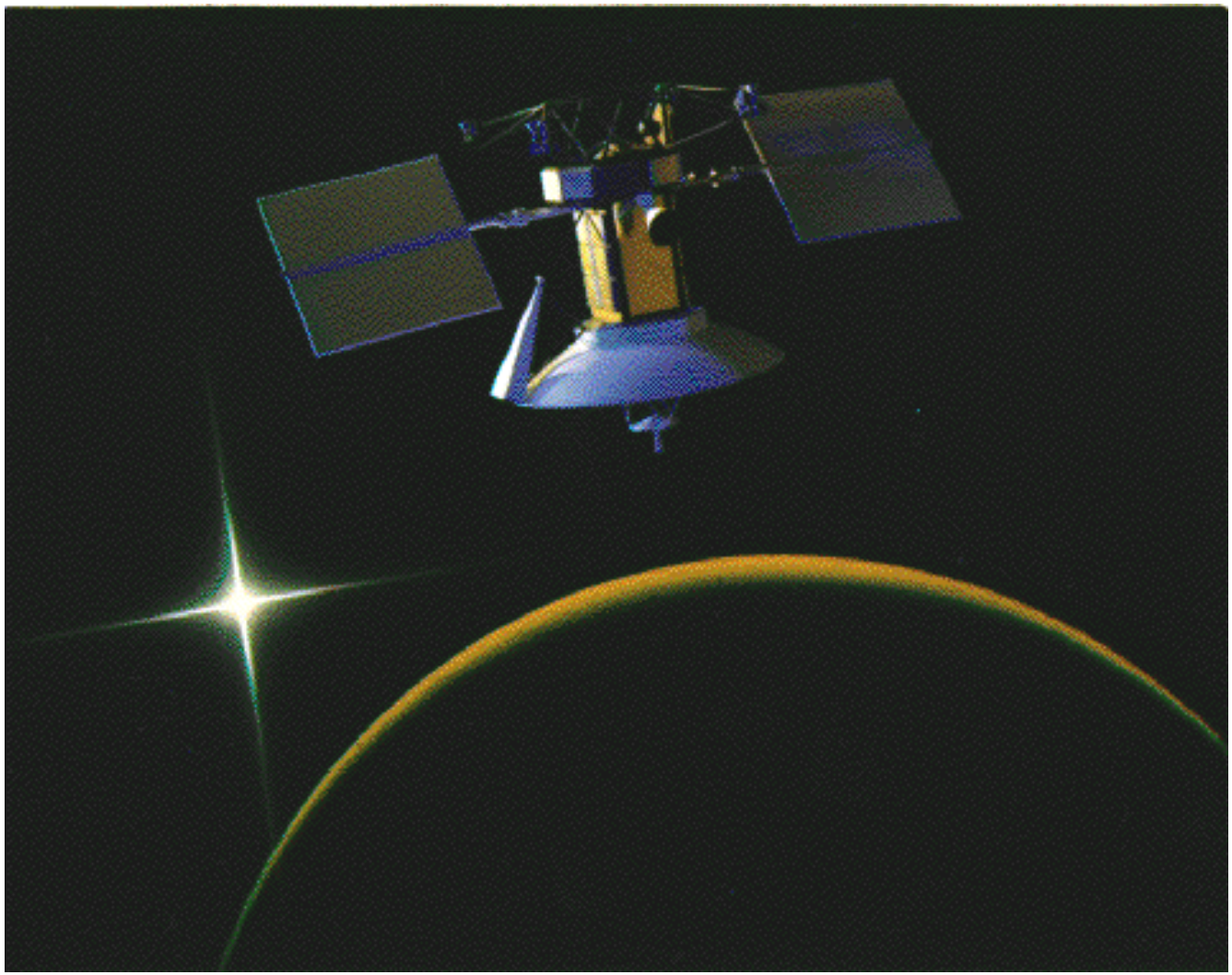
The Goldstone (California) tracking station and planetary radar



Radio astronomy and application of Kirchoff's Laws and Wien's Law allow us to measure the surface temperature of Venus (done first in the late 1950s)

- Surface temperature is 730K
- That corresponds to 855 degrees Fahrenheit
- What is responsible for this sort of temperature?
- The answer also lies in Kirchoff's Laws

The Magellan spacecraft explores the surface of Venus

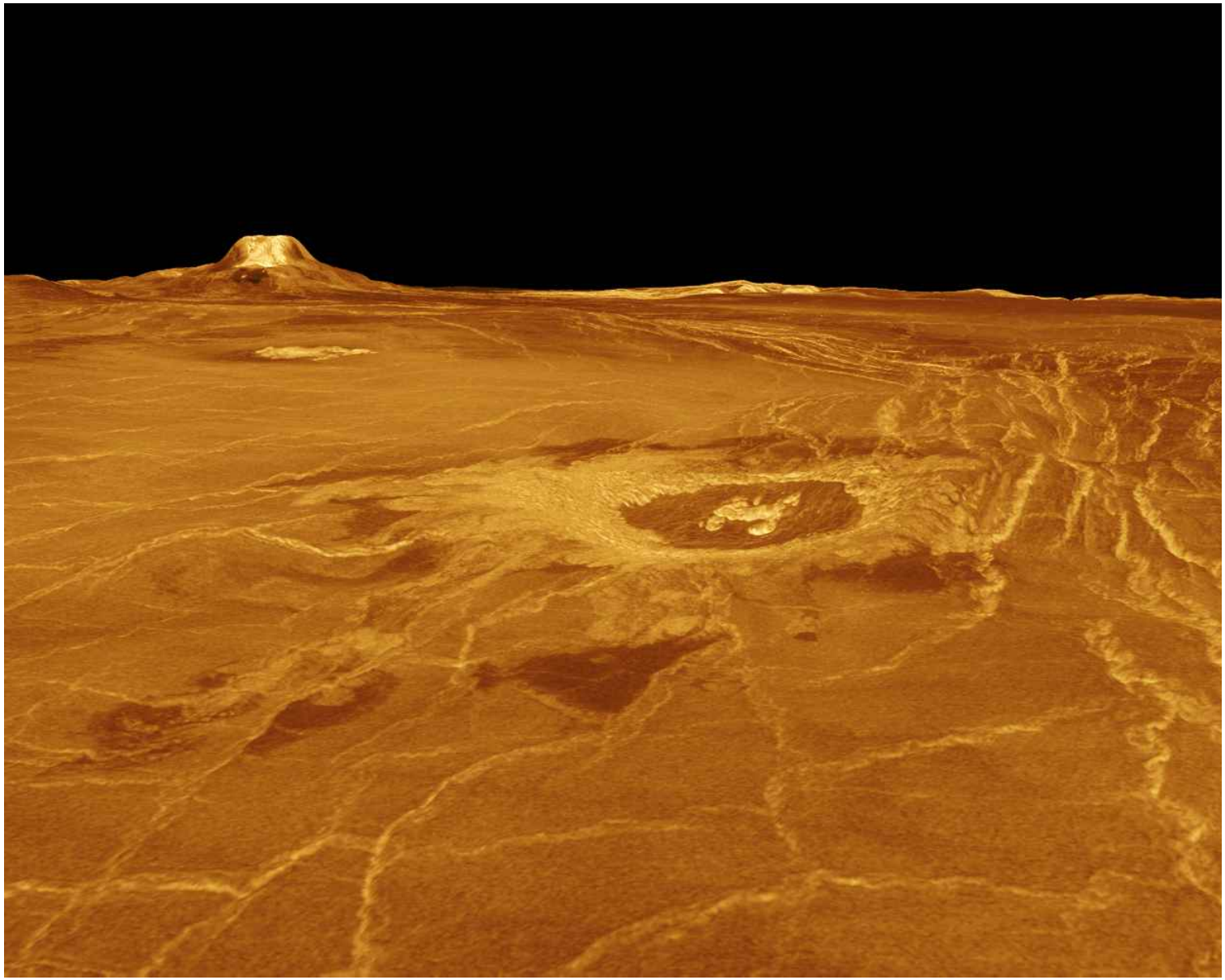


Radar signals (radio waves) transmitted from radars on Earth or the Magellan spacecraft travel unimpeded through the cloud layers of Venus, bounce off the surface, and come back to us. They can map the terrain. What do they see?

Radar signals can be used to measure the height of features on the surface of Venus, and the *radar reflectivity.* The radar reflectivity may be hard to interpret; it does not necessarily correlate with color, brightness or darkness, etc.

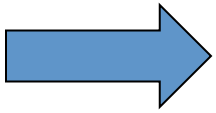
The Magellan spacecraft orbited Venus and carried out a radar mapping during the period 1990-1994. It is still the best overall view we have of the surface of "Earth's Twin"

What the surface of Venus looks like



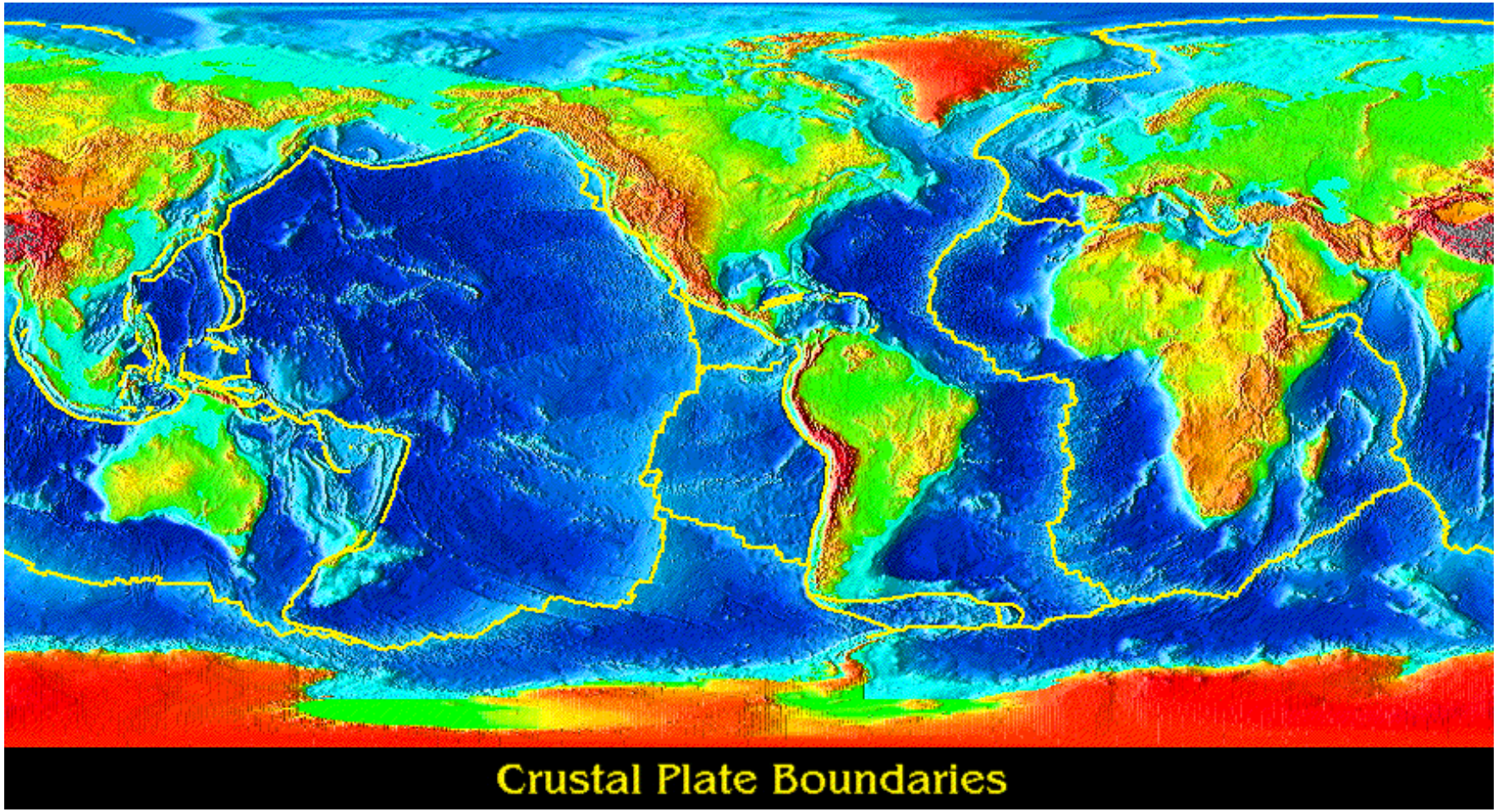
Let's begin with the Earth. What would it look like if your drained away the oceans?

- High, thick parts of the Earth's crust are the continental parts of the tectonic plates
- Lower, thinner parts of the crust are the ocean bottoms
- A striking feature would be the plate boundaries, where the plates are coming together or pulling apart

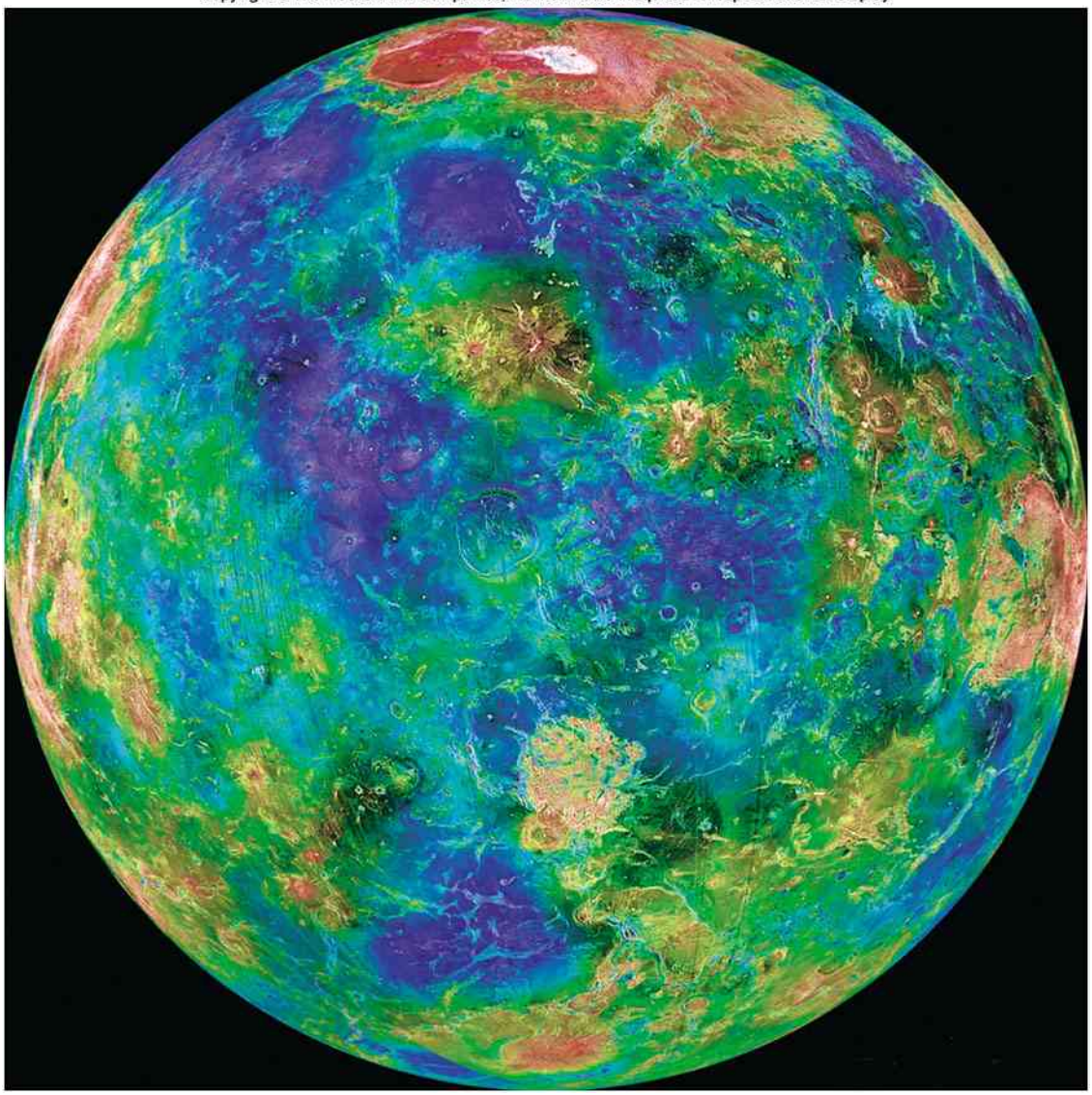


A picture is worth a thousand words

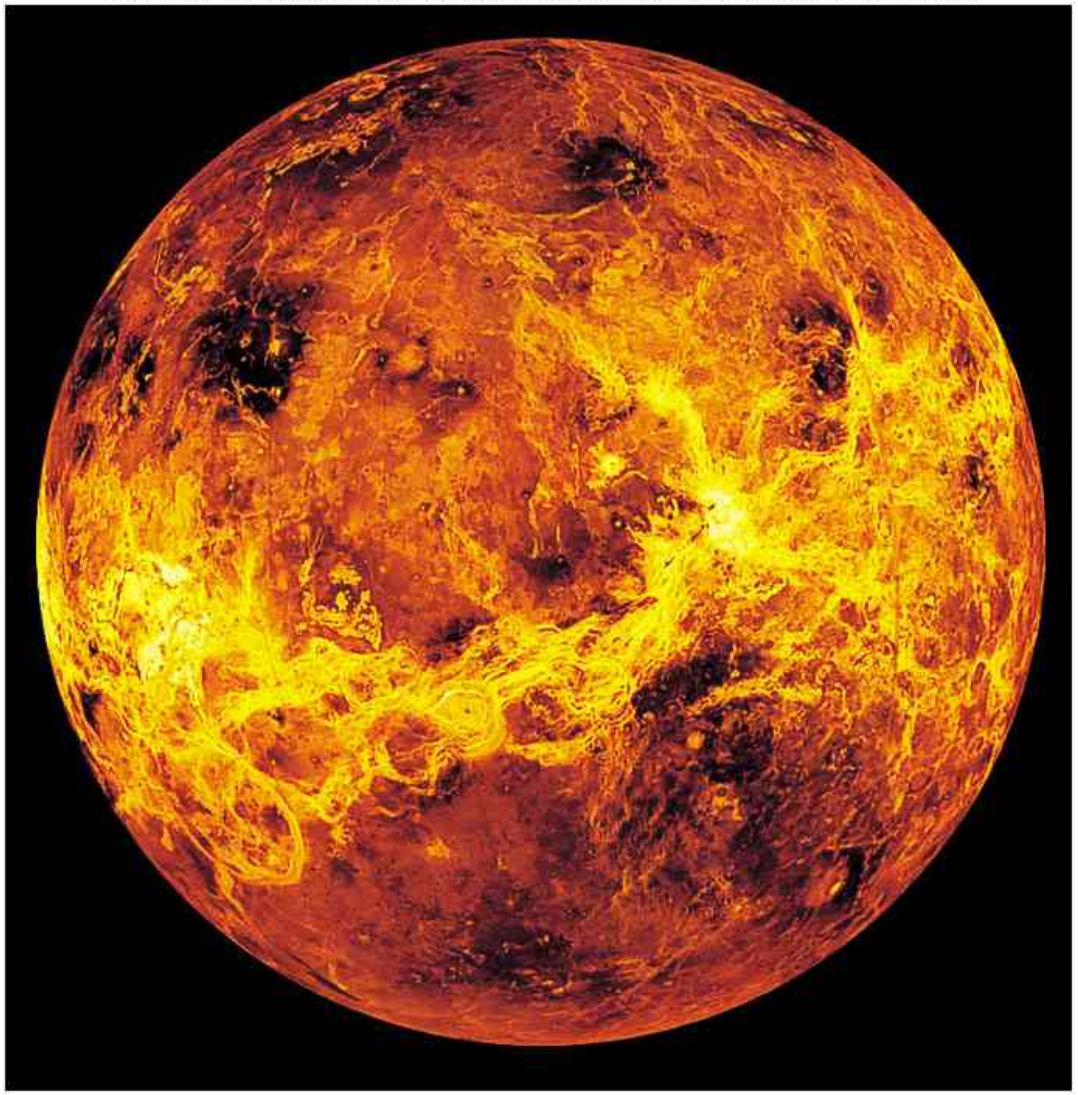
The surface of the Earth (with no water)



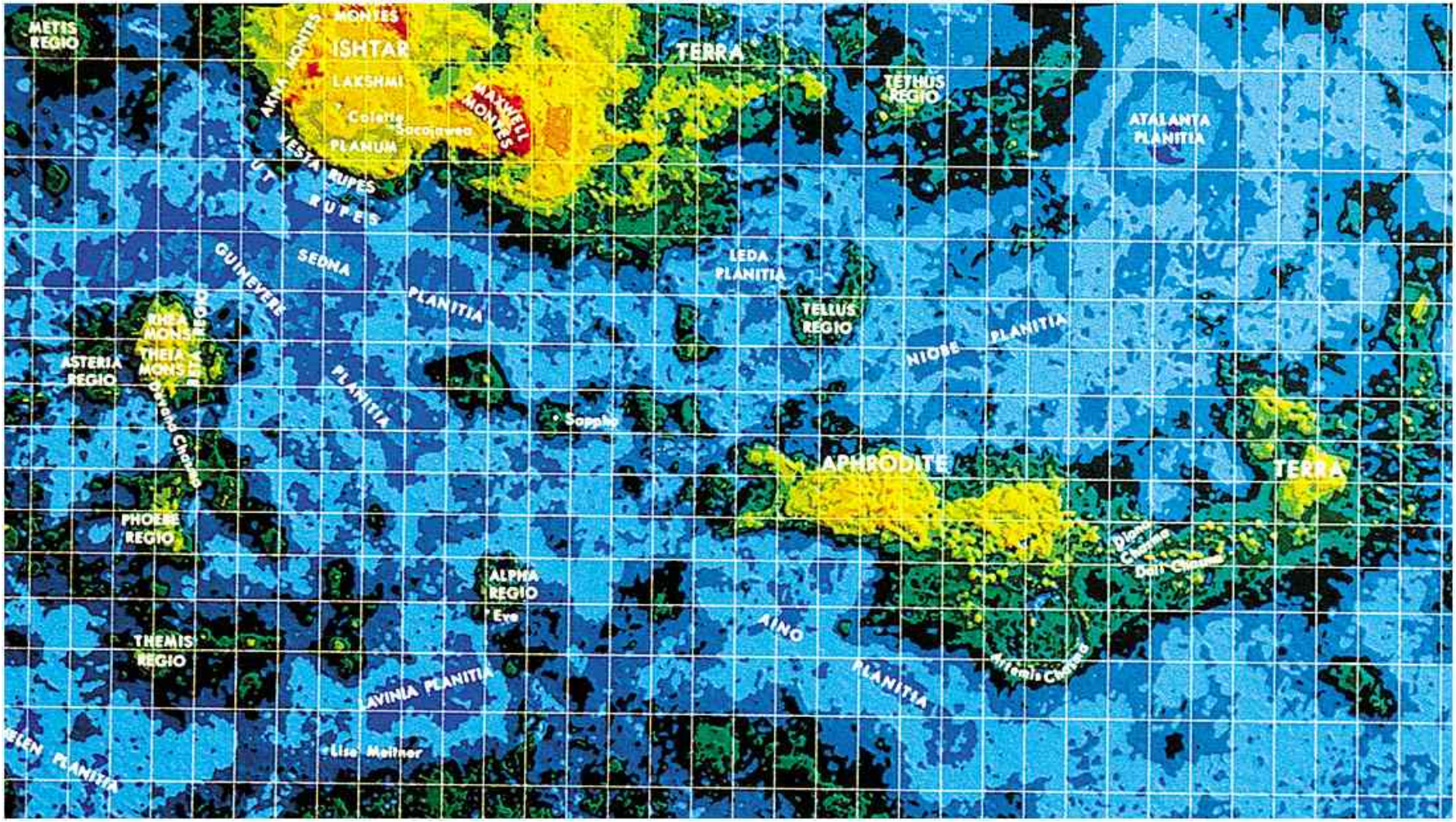
And now, a similar view of Venus, thanks to the Magellan orbiter



Radar reflectivity: the terrain of Venus



Another way to look at things: a topographical map of Venus



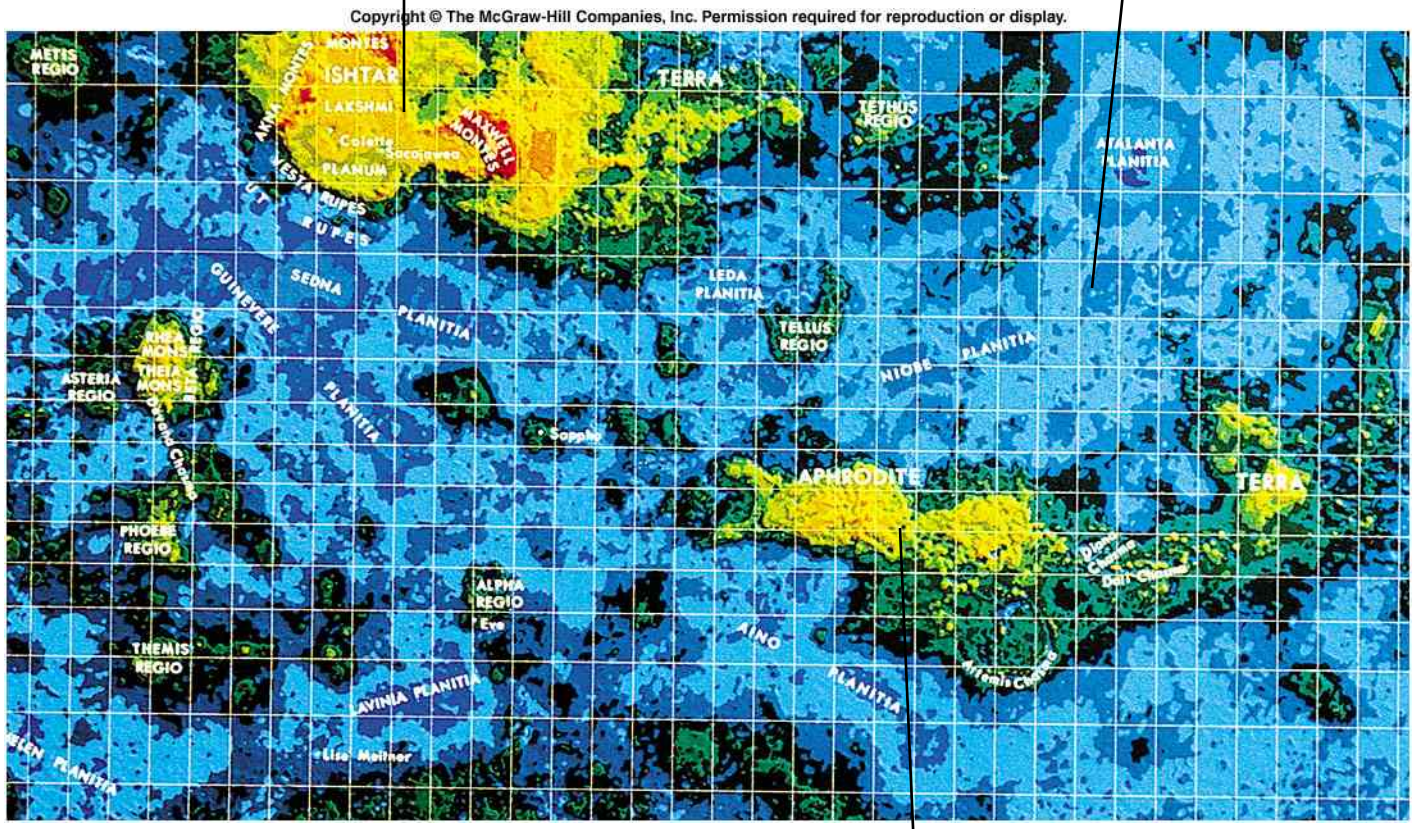
What have we learned from our exploration of the surface of Venus?

- Some similarities: low flat areas that resemble ocean floors on Earth
- Two higher areas of thicker crust that resemble the continental portions of the crust on Earth. These are called Ishtar and Aphrodite, and are about the size of Australia
- Strangely, no sign of tectonic plate boundaries (absence of continental drift on Venus?)

The Continents of Venus

Ishtar Terra

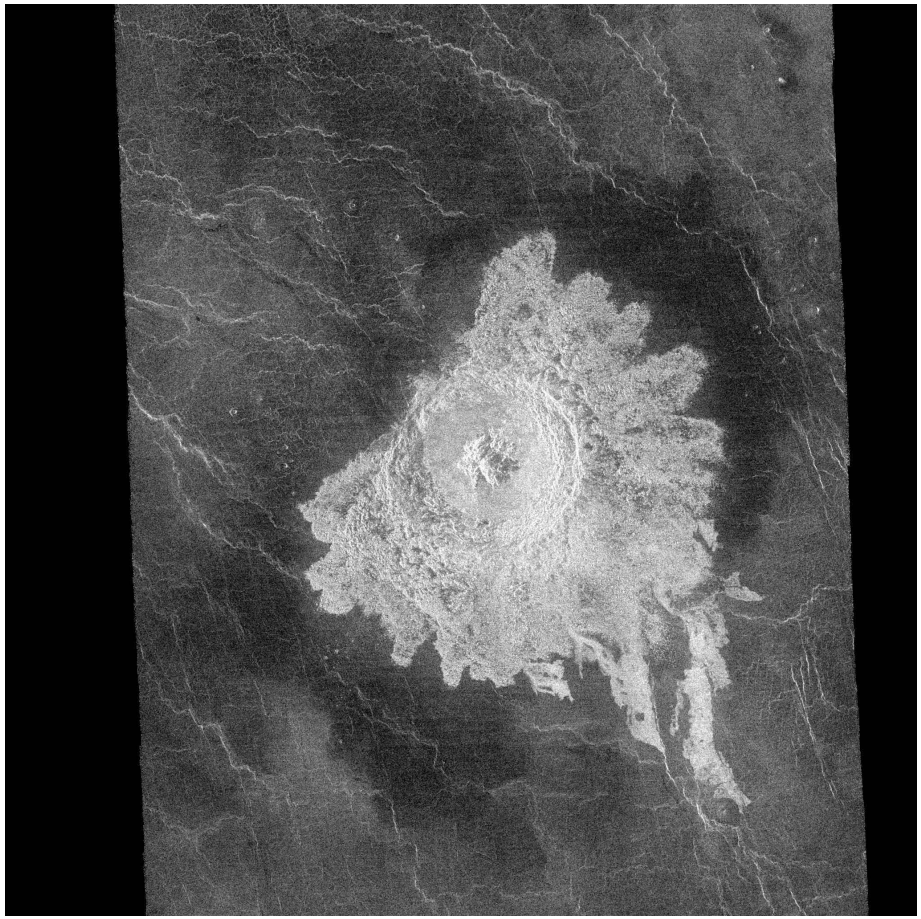
"ocean" bottoms?



Aphrodite Terra

What about craters? We have learned from the the Moon, the Earth, and Mercury that the presence (or absence) of craters is an important clue to the geological history of a planet.

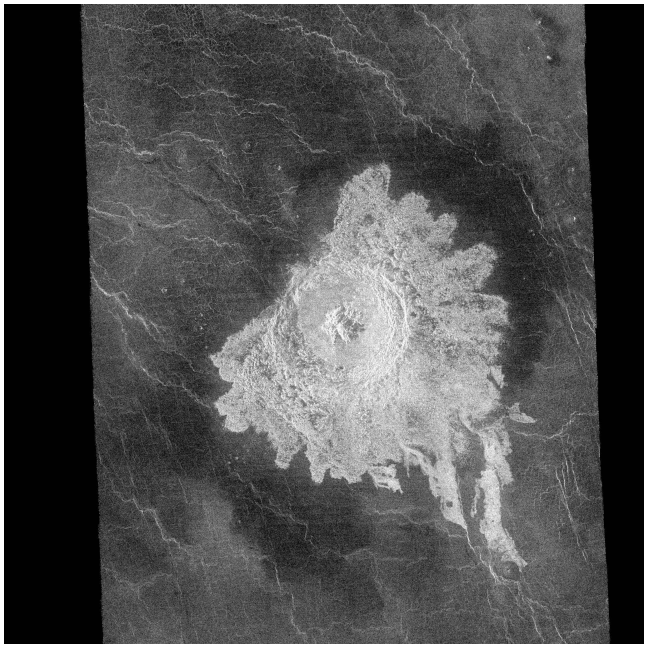
Craters are present on Venus (all discovered by Magellan radar)



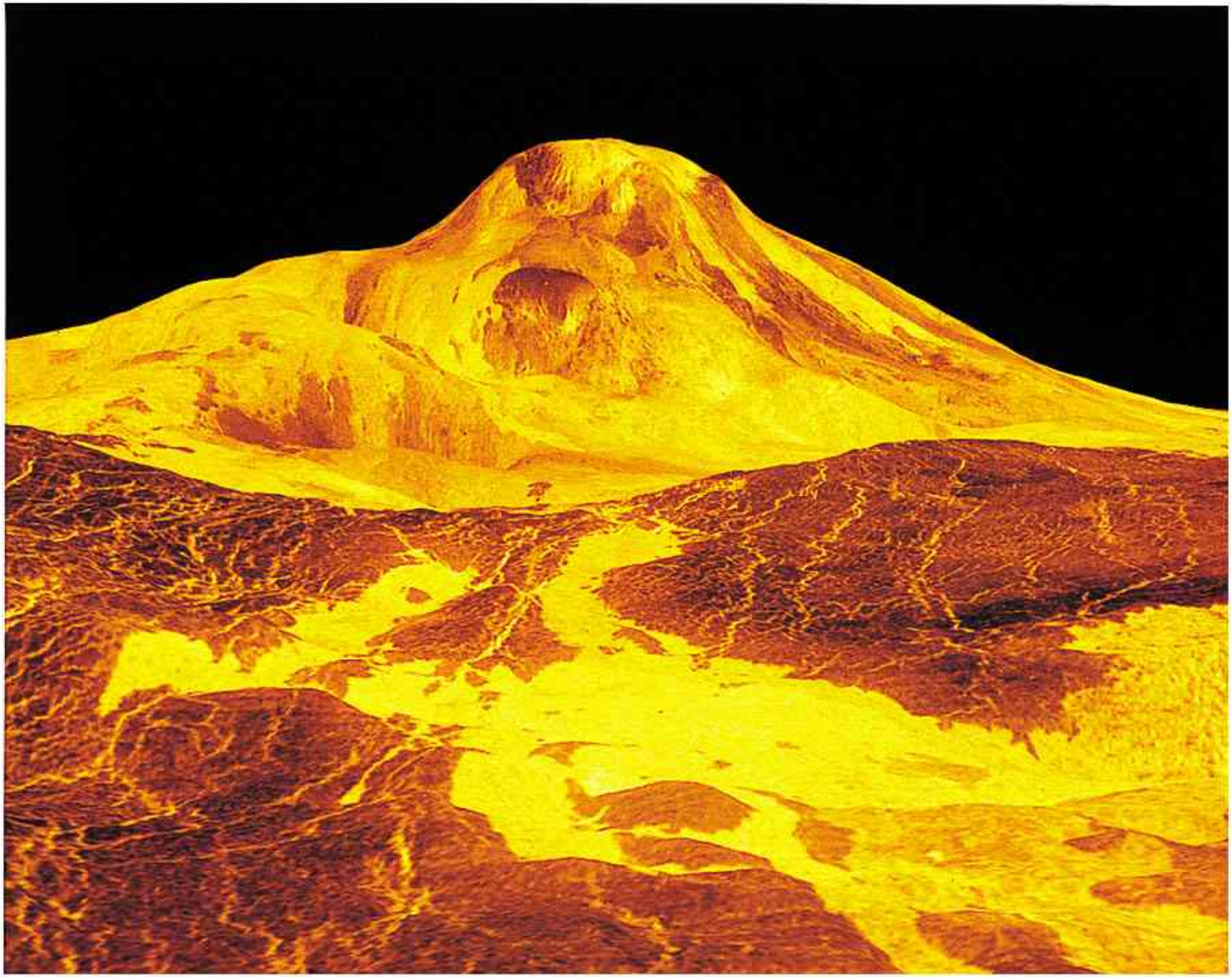
But *relatively* few in number. Consistent with an "exposure time" of about 500 million years rather than 3-4 billion years

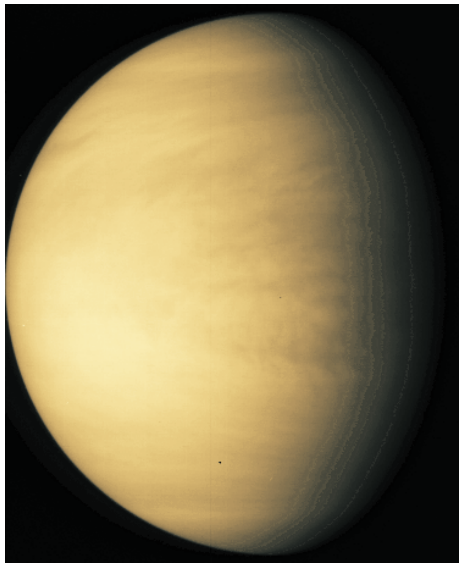
500 million year old “surface exposure” of Venus may point to an enormous, planet-wide eruption of lava at that time. Quote from book: “to erase all preexisting impact craters, even large ones, the surface of Venus must have been covered with lava to a depth of several kilometers”

An event which *may* be similar is the lava eruptions which occurred at the end of the Permian Age on Earth (250 Myr ago). The end of the Permian was the largest mass extinction event in Earth’s history

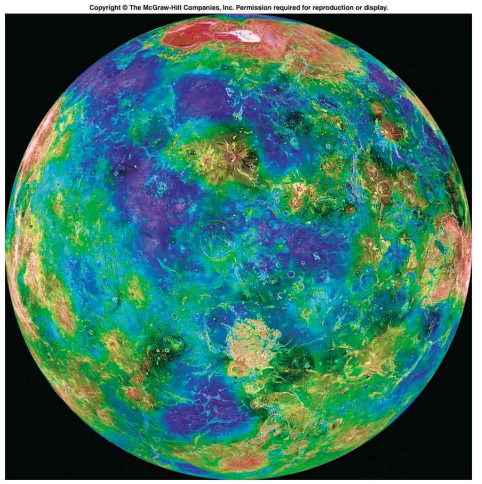


A hint of the volcanism of Venus: The shield volcanoes of Venus





Remaining questions about Venus



- Why is the surface temperature so high?
- Did Venus ever have oceans like the Earth?
- If it did have them, where did they go?
- These questions may be related…tune in next time