



Planetary Science

Building Models Using Data

Dr. Eric Hawker
IMSA Science Faculty

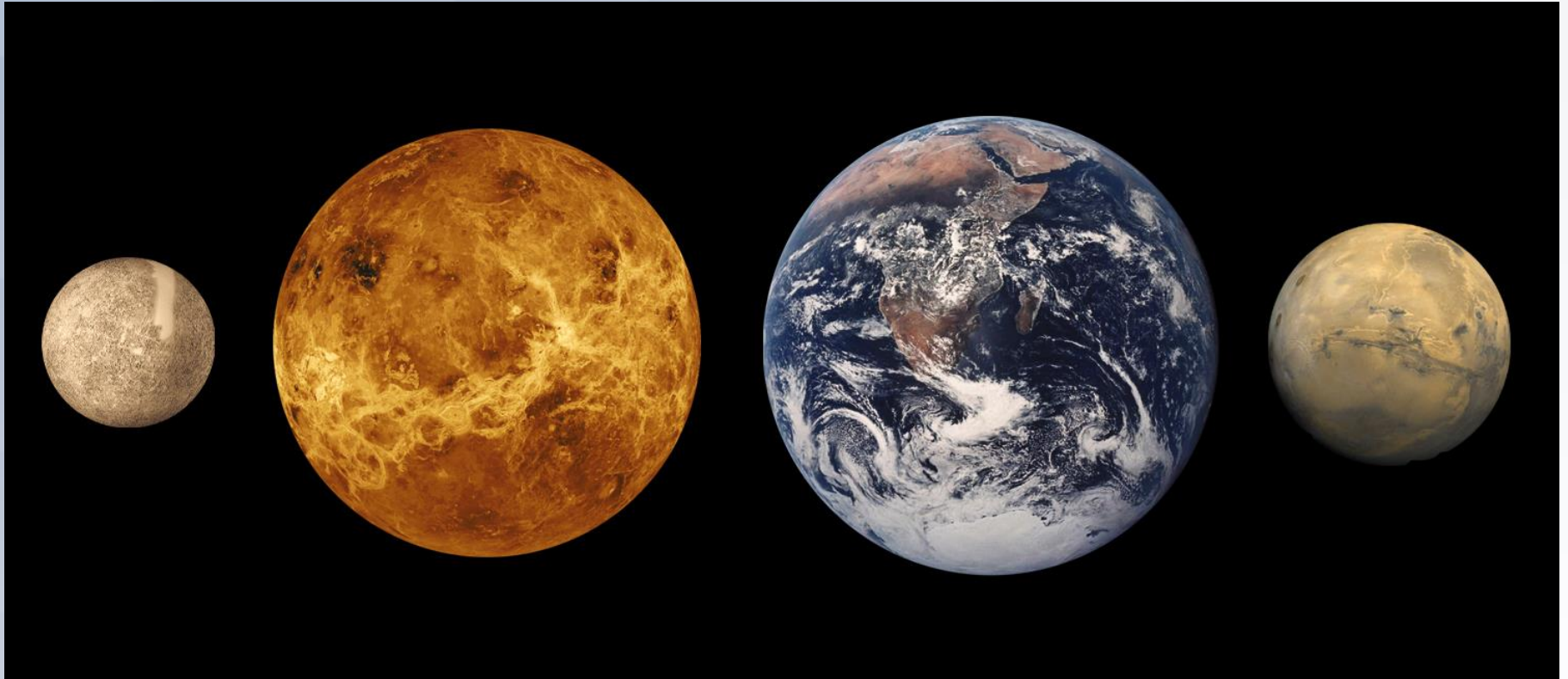
Planetary Science

- Planets are complicated dynamic systems.
- The dynamic changes that planets go through are driven by energy.
- For the terrestrial planets the two main sources of this energy are the Sun and internal radioactive decay.

Radioactivity

- When the planets formed, radioactive isotopes such as uranium, thorium, and potassium were trapped deep underground.
- When these isotopes decay, they release energy deep under the surface of the planet.
- Over the 4.5 billion years since the planets formed radioactivity has added **a lot** of energy to the planets, all in the form of **heat**.

The Terrestrial Planets



Density and Mass

Density is how much mass there is per a unit of volume. By looking at the density of planets we can learn about what it is made of.

Planet	Density*	Mass
Mercury	5.3 g/cm ³	3.3×10 ²³ kg
Venus	4.4 g/cm ³	4.8×10 ²⁴ kg
Earth	4.4 g/cm ³	5.9×10 ²⁴ kg
Mars	3.8 g/cm ³	6.4×10 ²³ kg

The density of rock is about 3 g/cm³ while the density of iron is 7.9 g/cm³

*This is the uncompressed density, taking out the factor of gravity

Heat from Radioactivity

- Most of the radioactive isotopes that release energy in planets are from very dense elements like uranium and thorium.
- So higher density means a larger fraction of the stuff the planet is made of is radioactive.
- More mass means more radioactive material

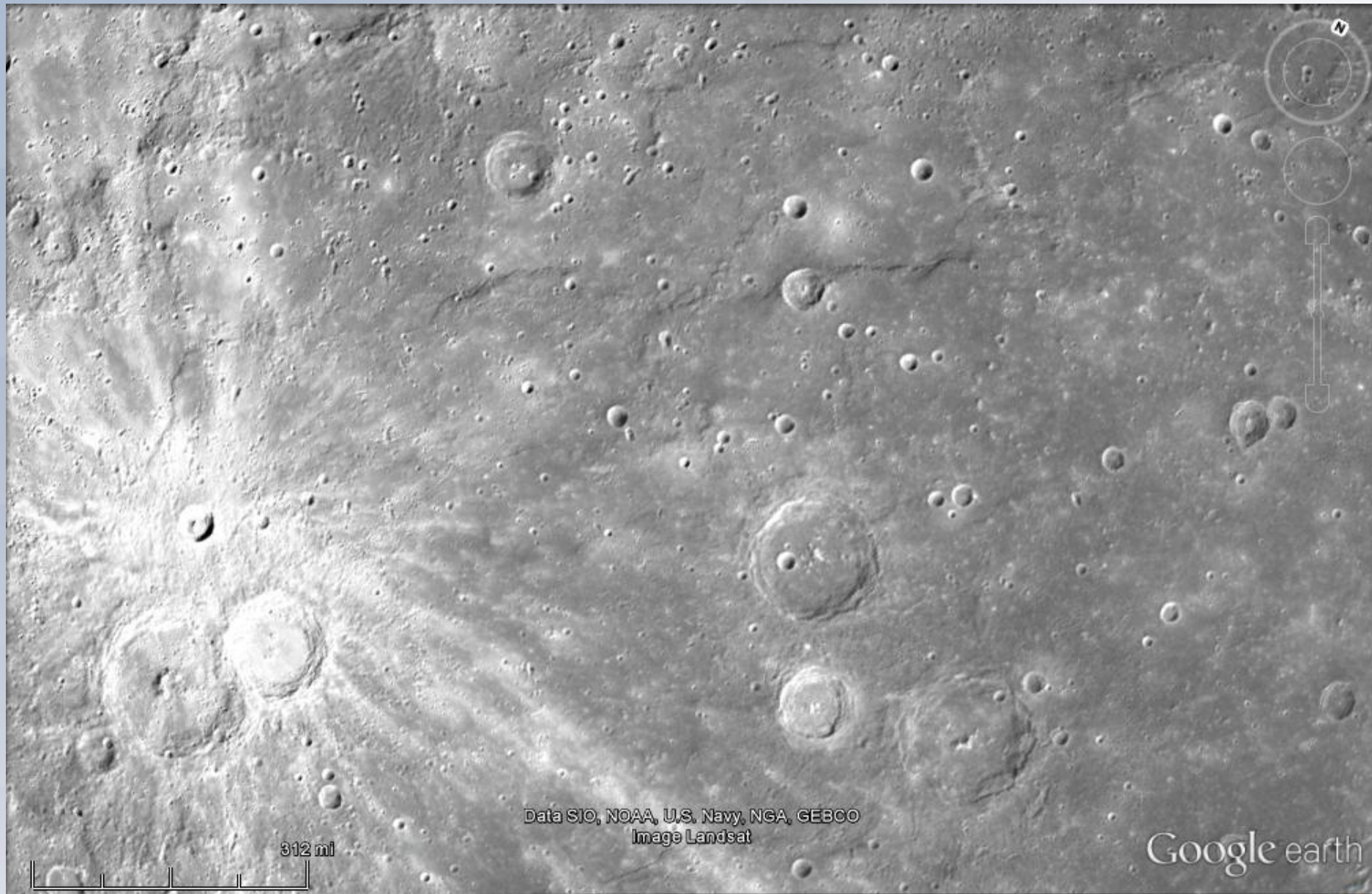
Heat from Radioactivity

- Mercury has less mass than the Earth but a higher density.
 - Higher percent of its mass is made up of radioactive isotopes, but less mass overall.
 - Less heat
- Mars has less mass than the Earth and a lower density.
 - Lower percent of its mass is made up of radioactive isotopes, and less mass overall.
 - Less heat
- Venus and Earth have about the same mass and density..... So they should have the same amount of heat.



What does this heat do?

Mercury



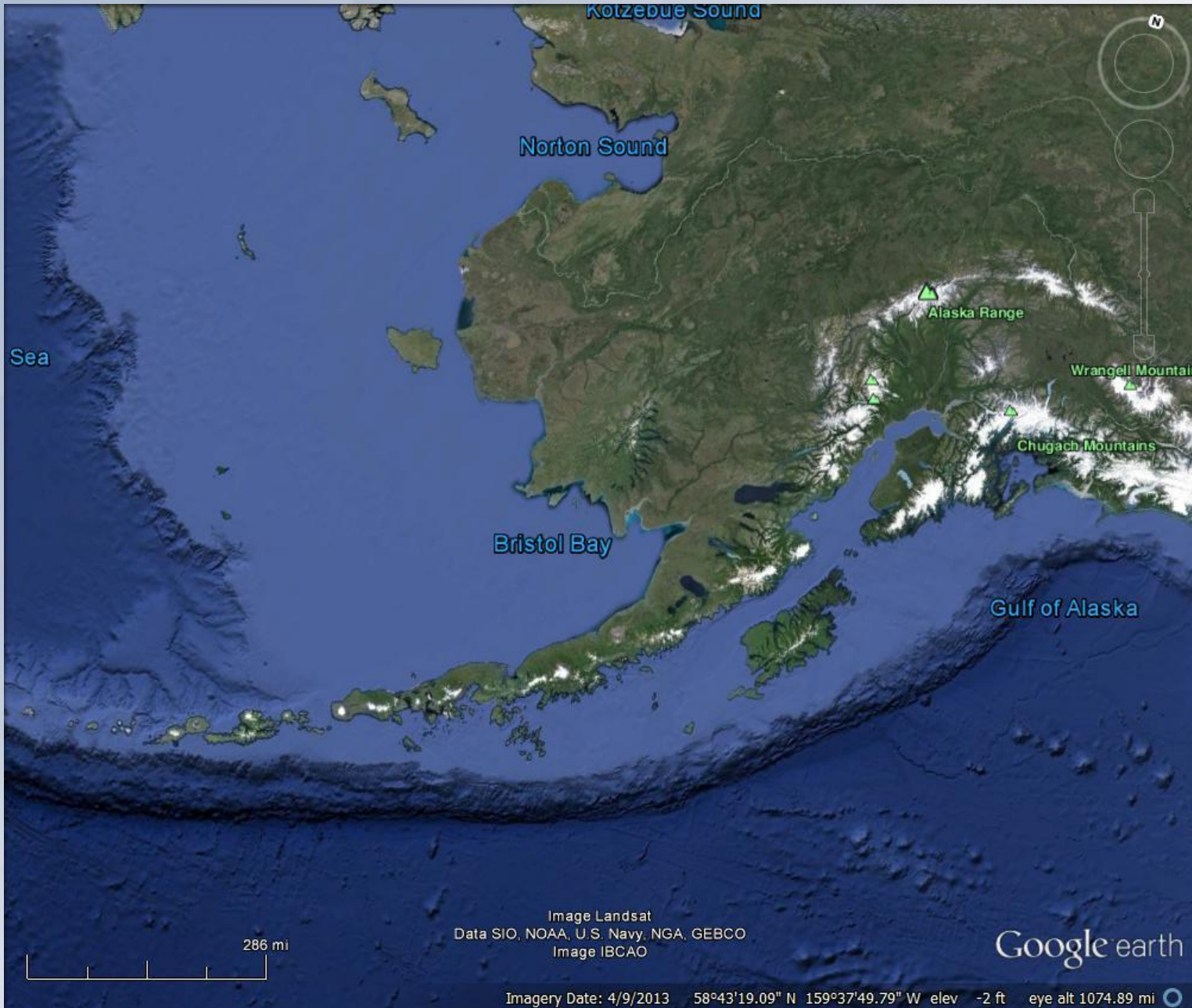
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Image Landsat

Google earth

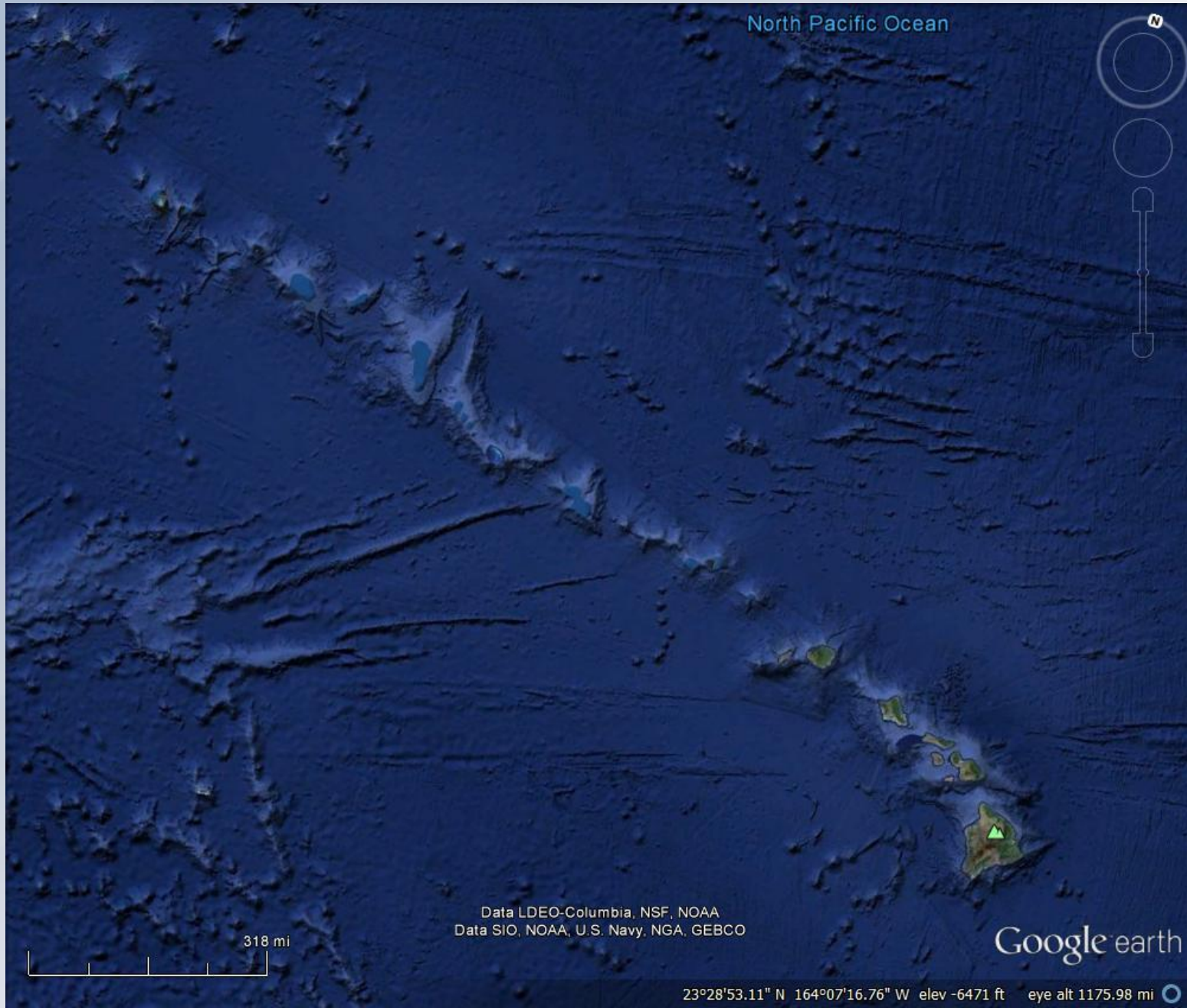
312 mi

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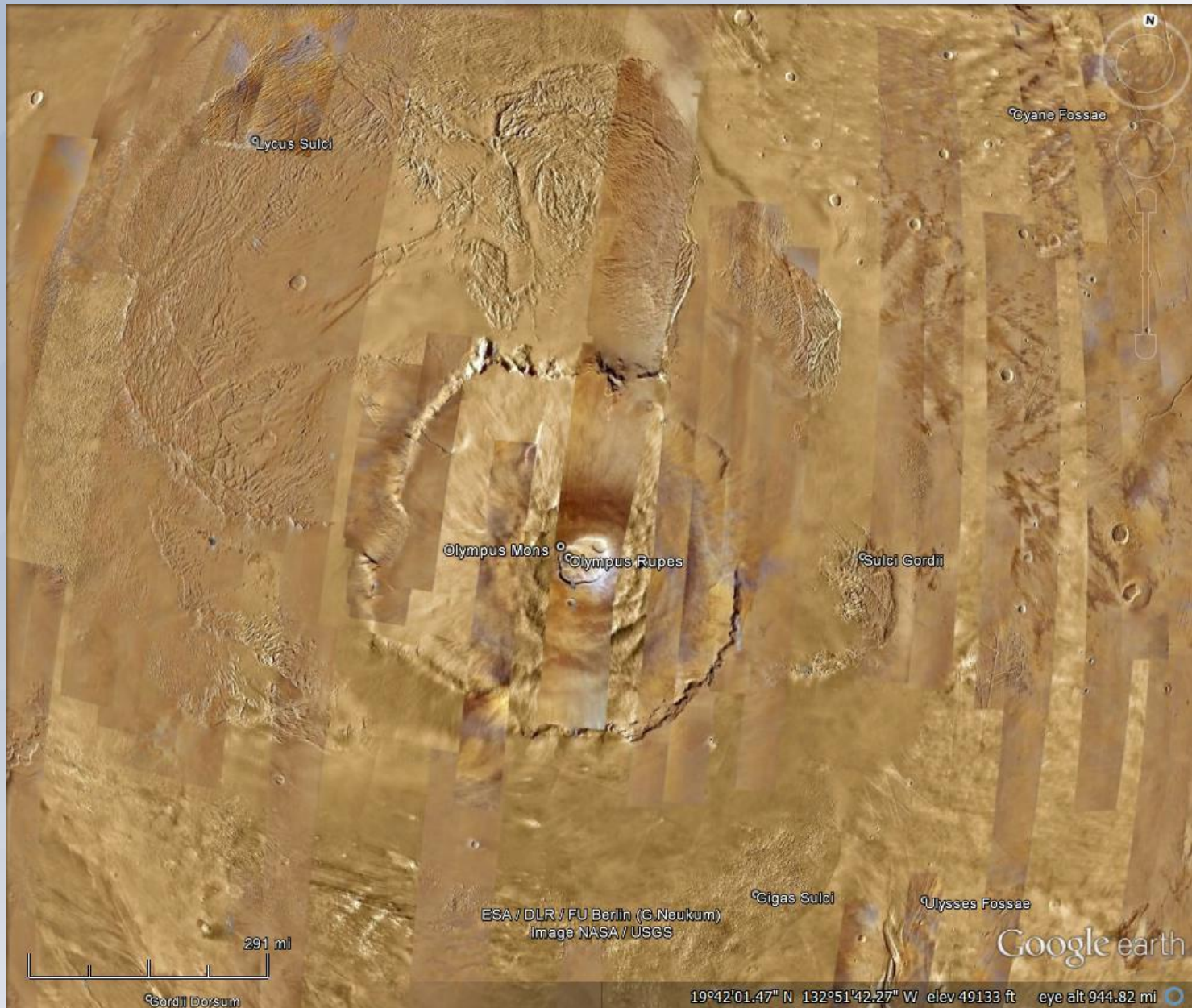
Aleutian Islands



Hawaii



Olympus Mons, Mars



Venus

Earth - Wikipedia, Solar System - Wikipedia, Mars - Wikipedia, Mercury (planet) - Wikipedia, Venus - Wikipedia, (6000*2*pi*1000/1), Zimbra: Inbox, Venus Global GIS

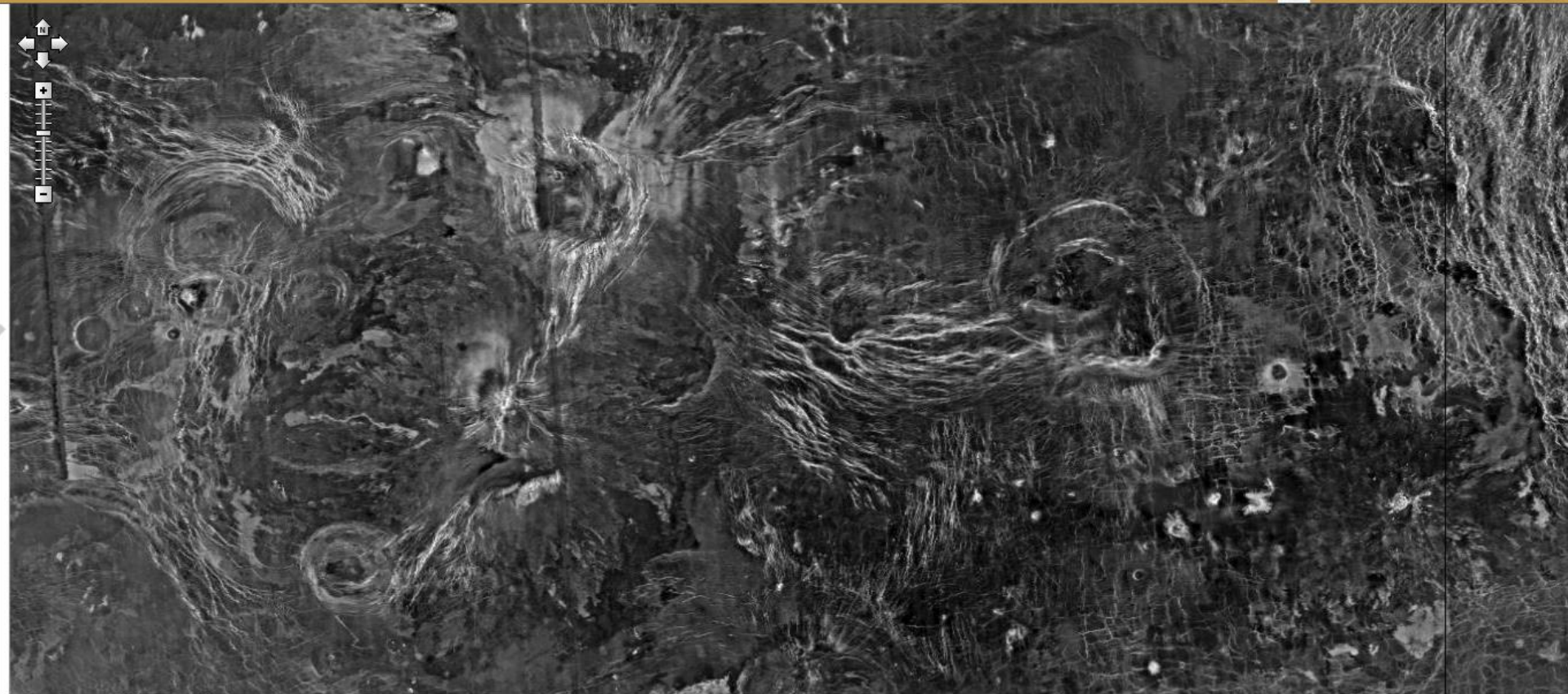
webgis2.wr.usgs.gov/Venus_Global_GIS/

Yahoo! Digg Zimbra Google Wikipedia PowerTeacher Turnitin Quest Moodle Google Docs planetary MSL tvc Weather ZAP TV Prezi Wolfram|Alpha Other bookmarks

Venus Global GIS Mapping Application

Print | Search Nomenclature

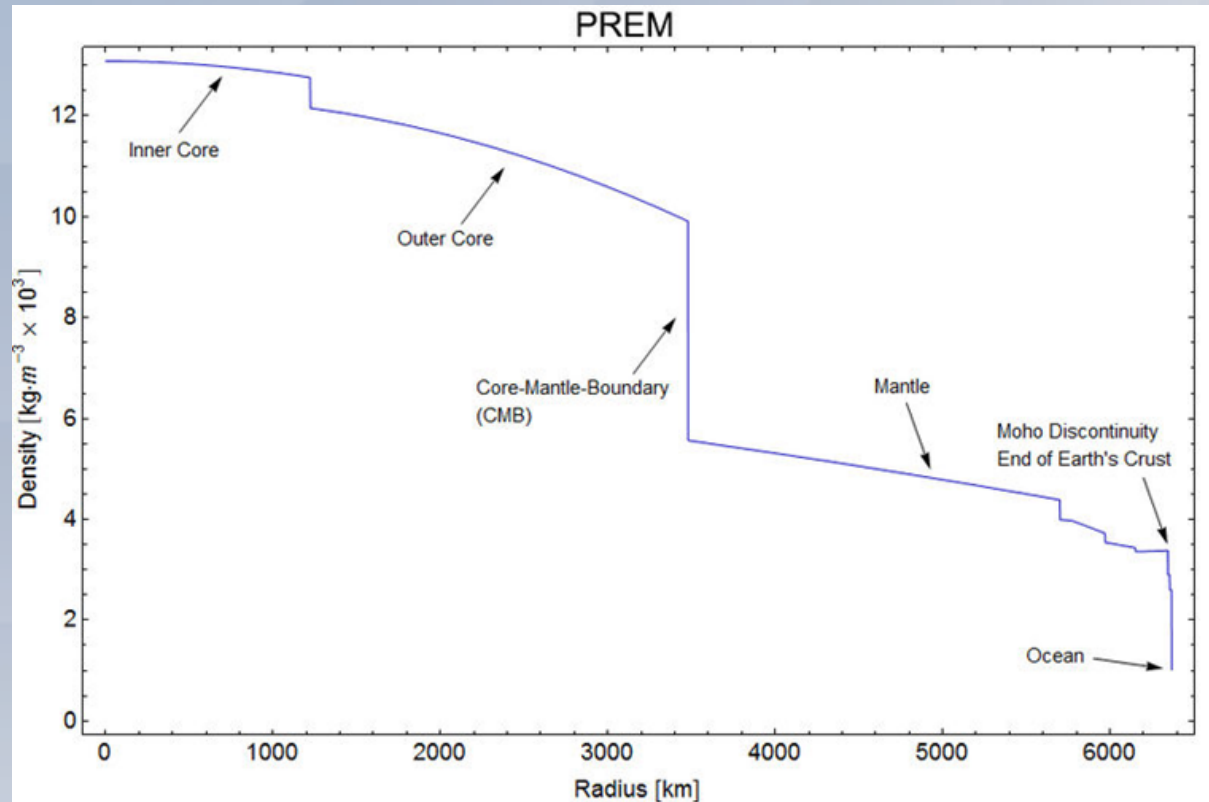
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What can you deduce from these pictures?

The Core



We believe that just after they formed 4.5 billion years ago, all of the terrestrial planets were molten liquid.

Since denser materials sink in liquid, most of the metal sank to form the core

The Core and the Magnetosphere

The Earth's magnetic field is produced because the Earth's core has certain properties.

The core is ...

- Electrically conductive (it is made of metal)
- Liquid
- Rotating
- Convection is occurring

If a planet has all of these properties, it will generate a magnetic field, if it is missing any of them then no magnetic field is produced.

The Core and the Magnetosphere

- Mercury has a magnetic field 300 times weaker than the Earth's
- The core of Venus produces no magnetic field
- The Earth has an average magnetic field
- The core of Mars produces no magnetic field



What can you conclude from this data?

Additional data

- Smaller planets not only produce less heat, but also lose that heat to space faster
- The planet's atmosphere can trap some of the heat produced in the planet.
 - Venus has a very thick, very insulating atmosphere
- The presence of liquid water can make the planet's crust more malleable.
- The average age of the Earth's surface is about 100 million years, for Venus it is between 300-600 million years.
- While Venus has lots of volcanoes, we don't know how active they are.

Based on everything that you have deduced about other planets, what can you deduce about the Earth...

- In the past?
- In the present?
- In the future?



Additional supporting slides....

The Magnetosphere

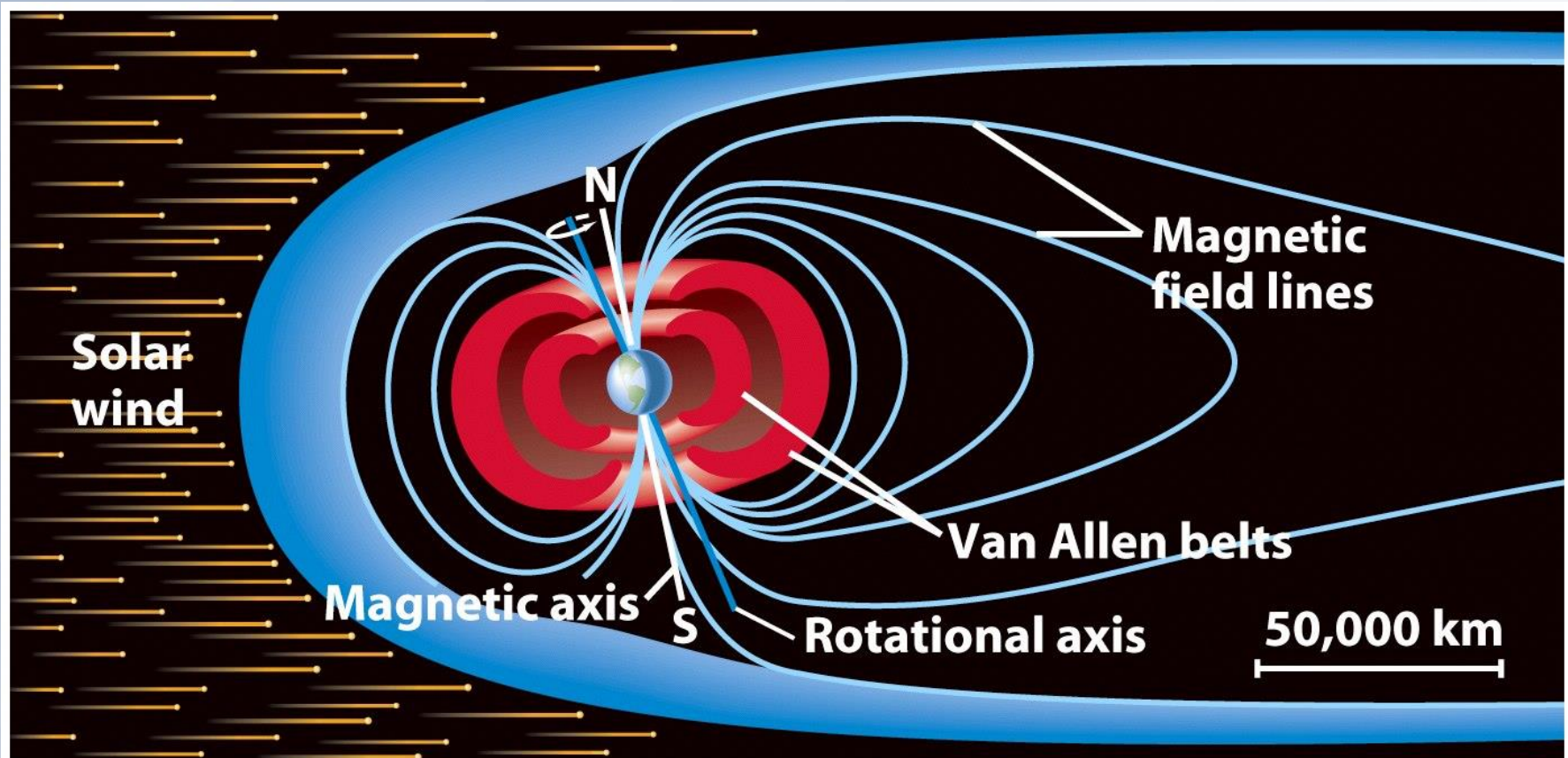
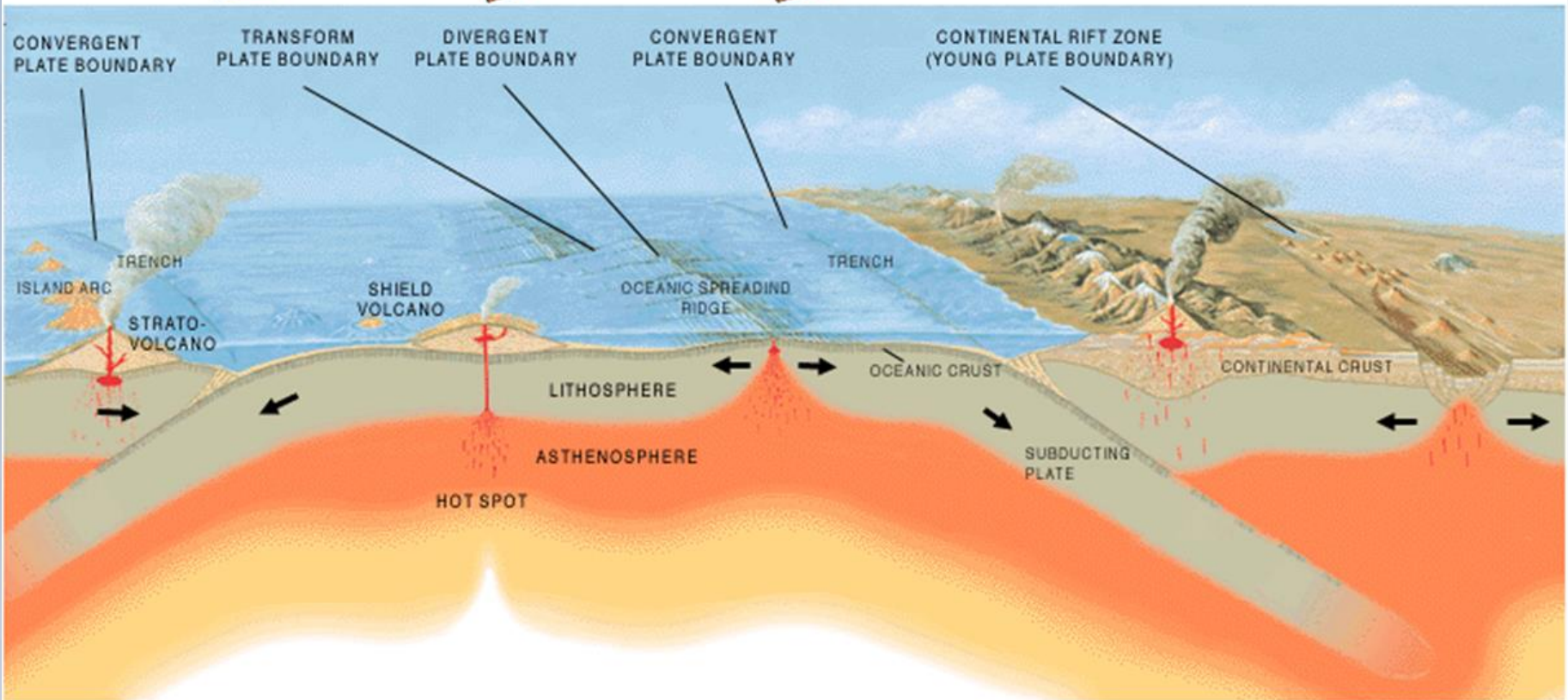
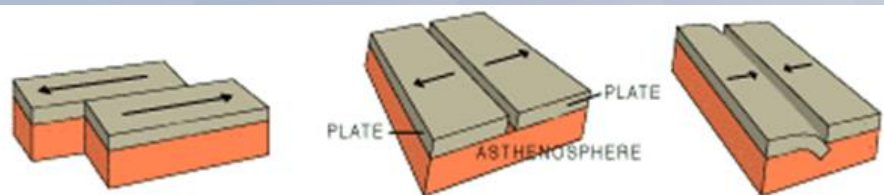
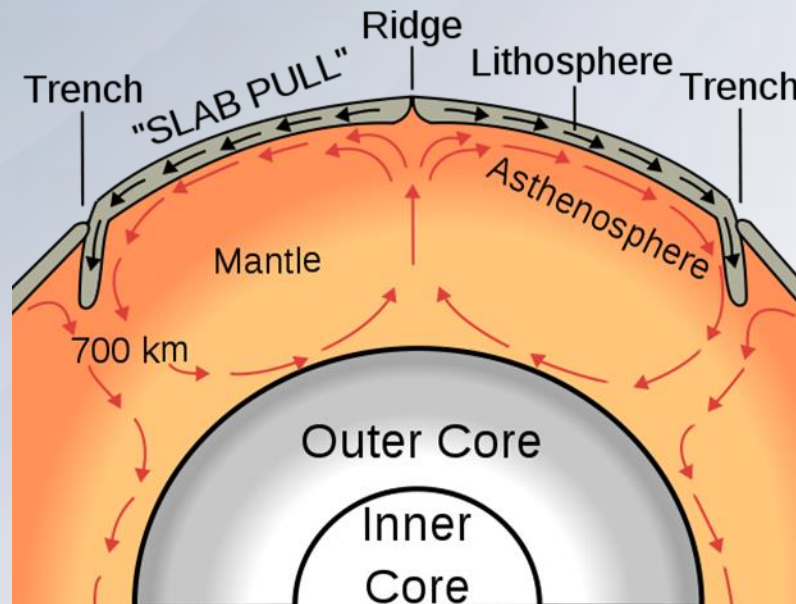
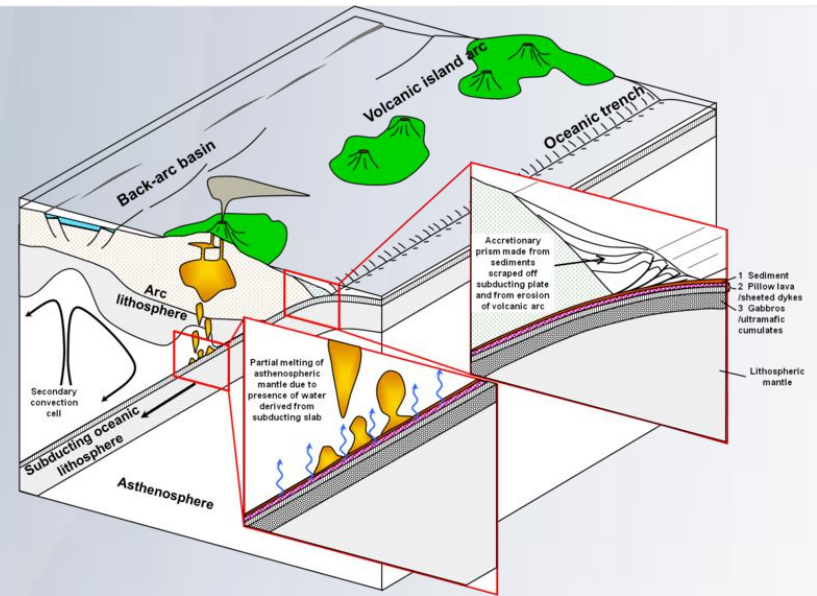
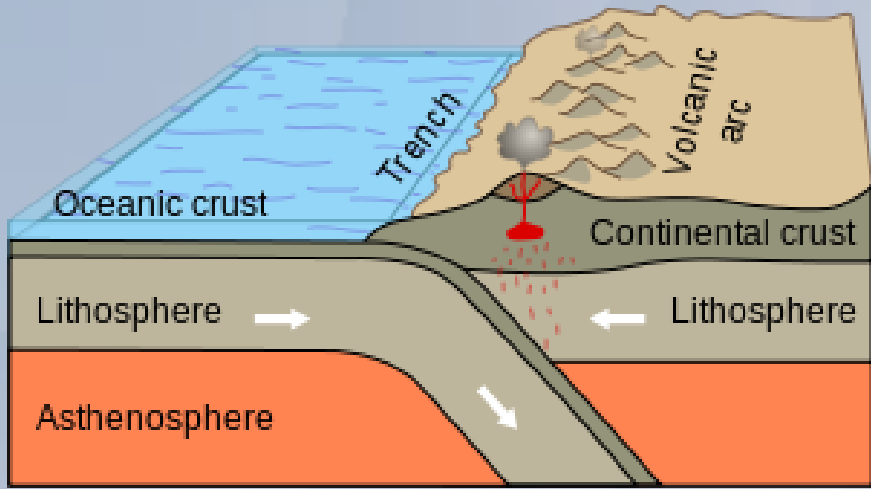


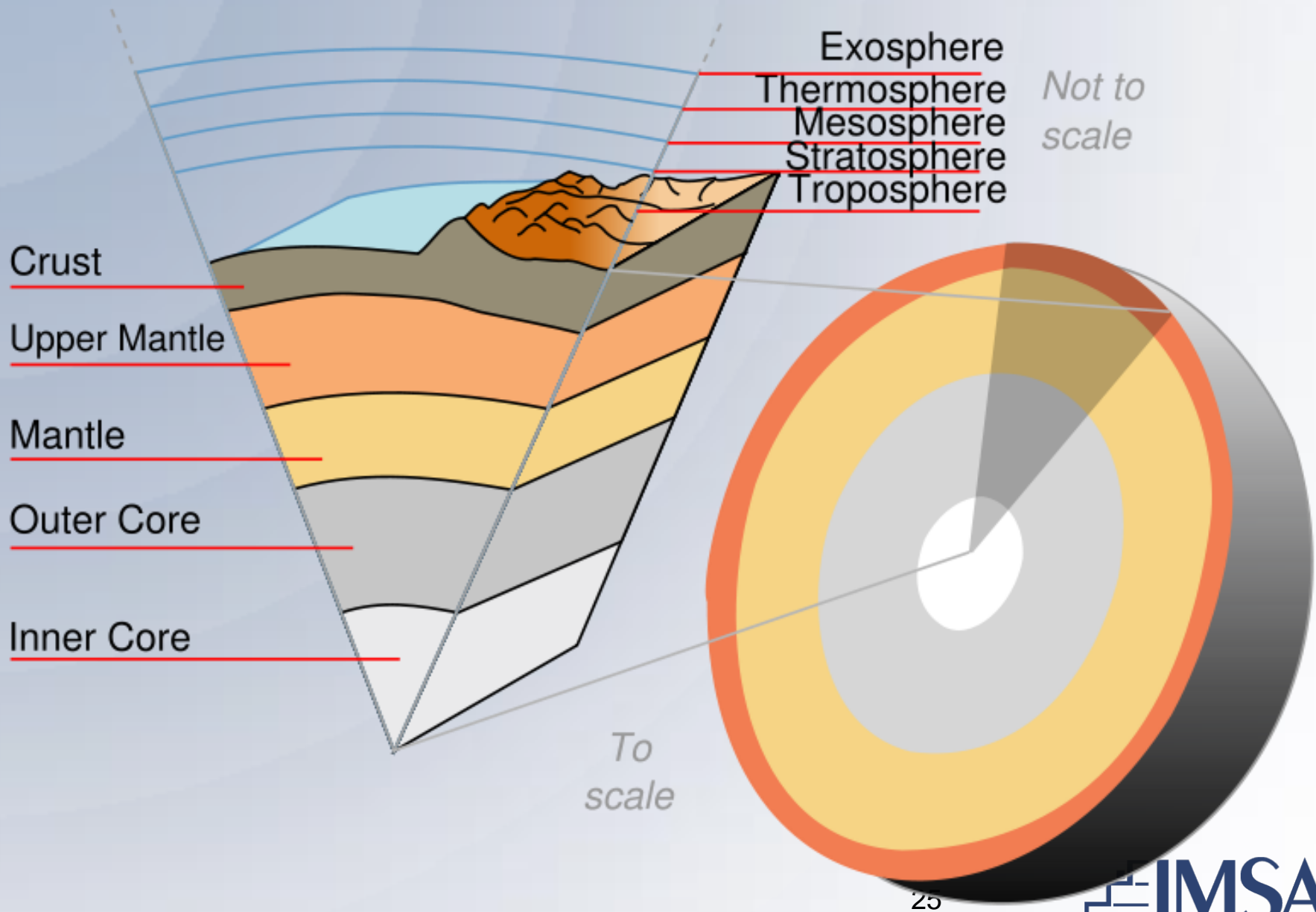
Figure 6-9
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The Earth's magnetic field deflects particles of the solar wind.

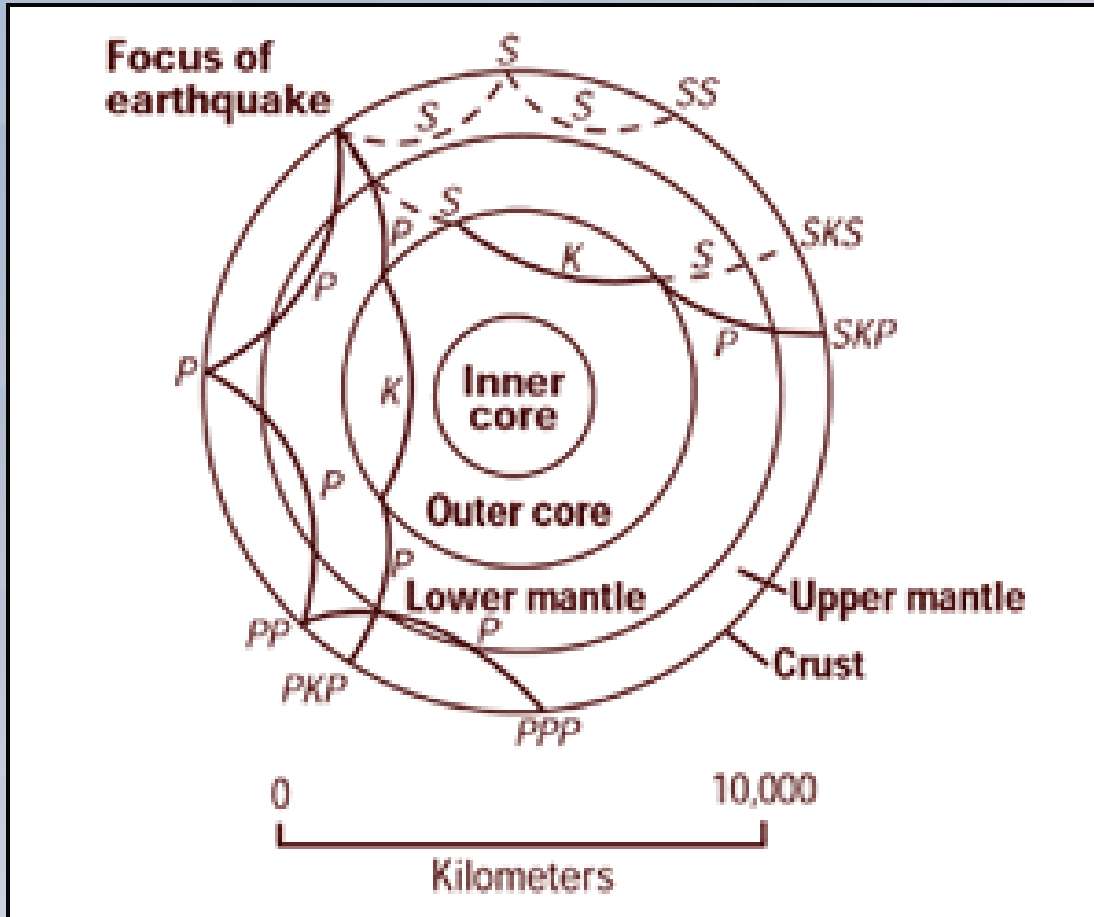




Earth's Interior



Seismic Waves



By studying how shock waves from Earthquakes travel through the Earth, we can learn about the density of the interior of the Earth.

Sudden changes in density can cause these waves to be reflected or refracted.

Plate Drift

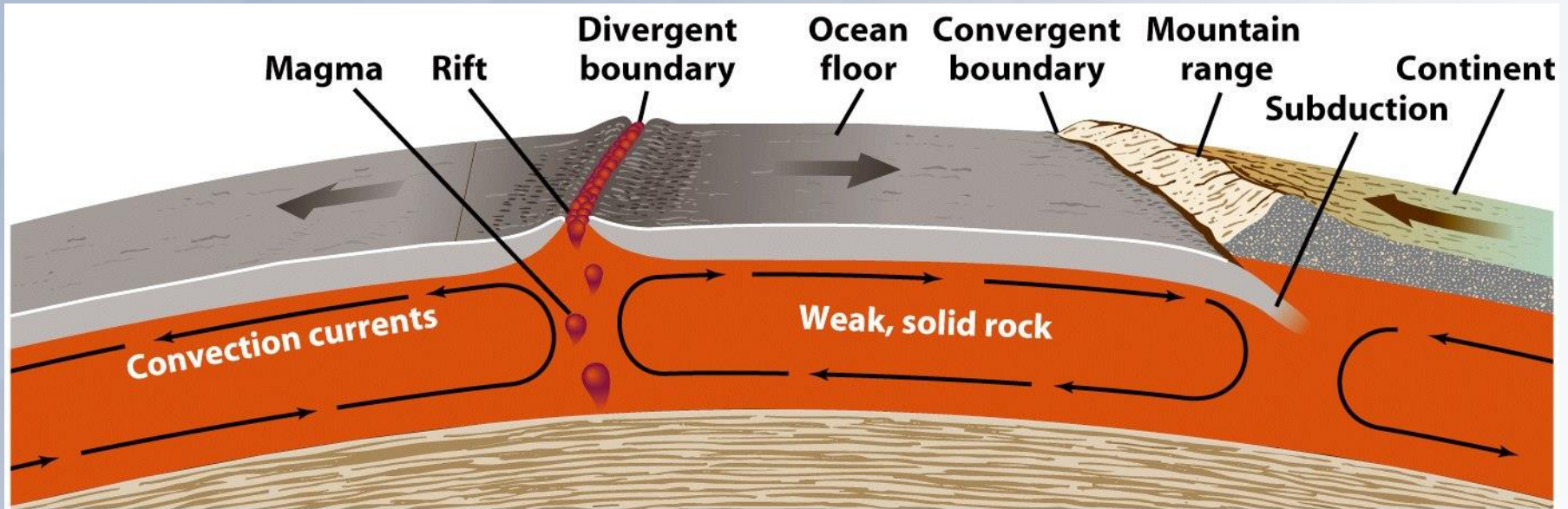
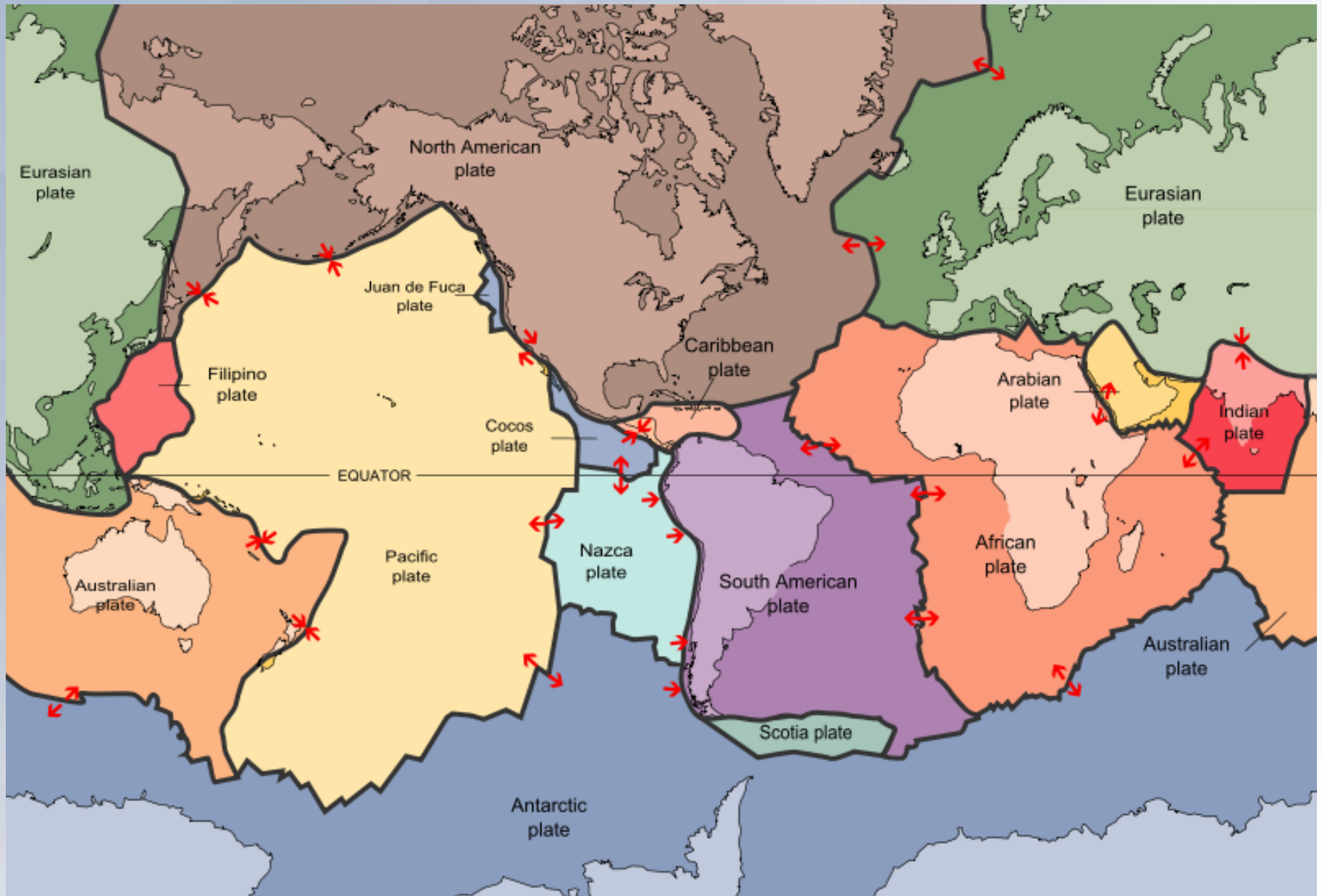
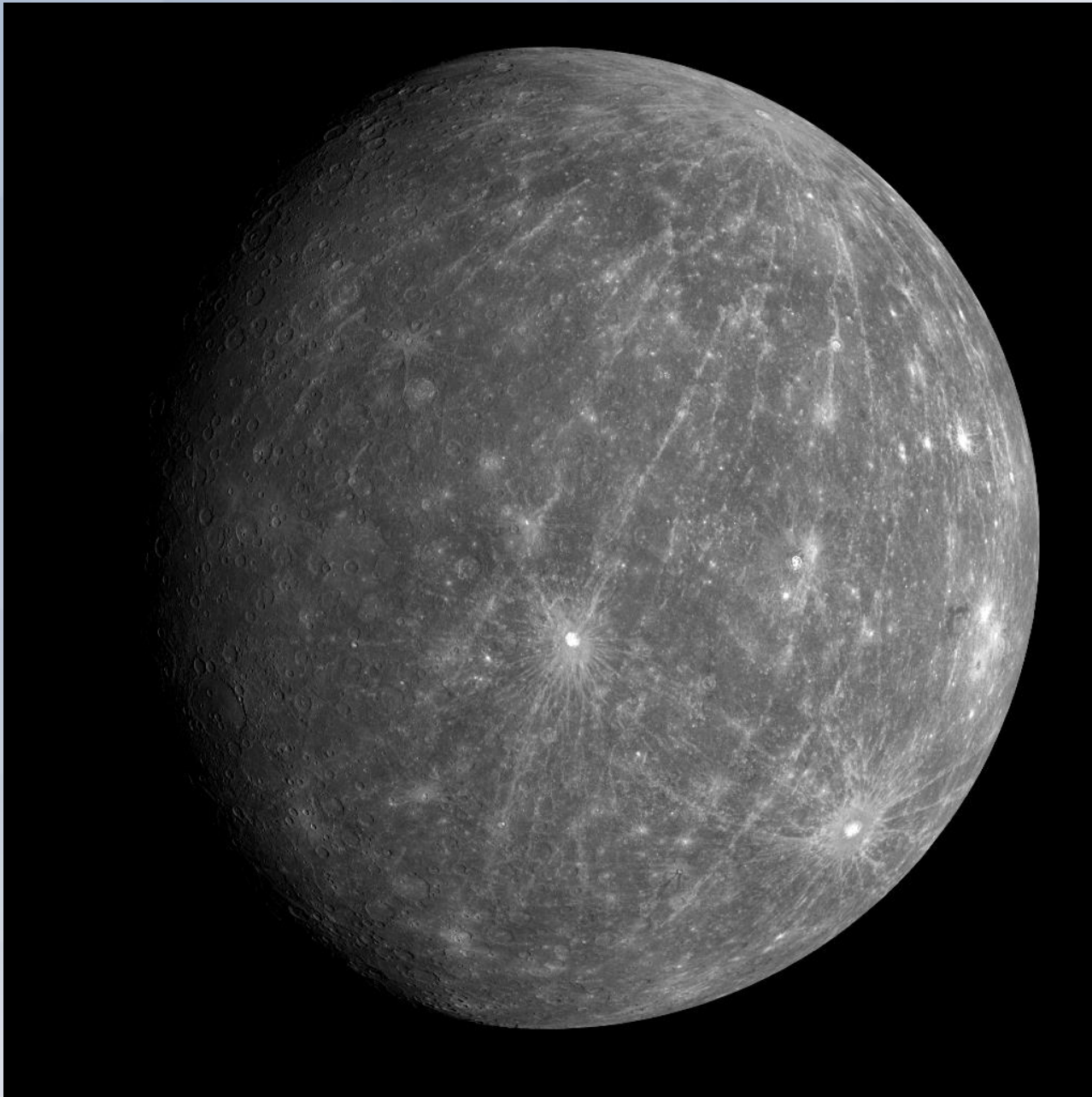


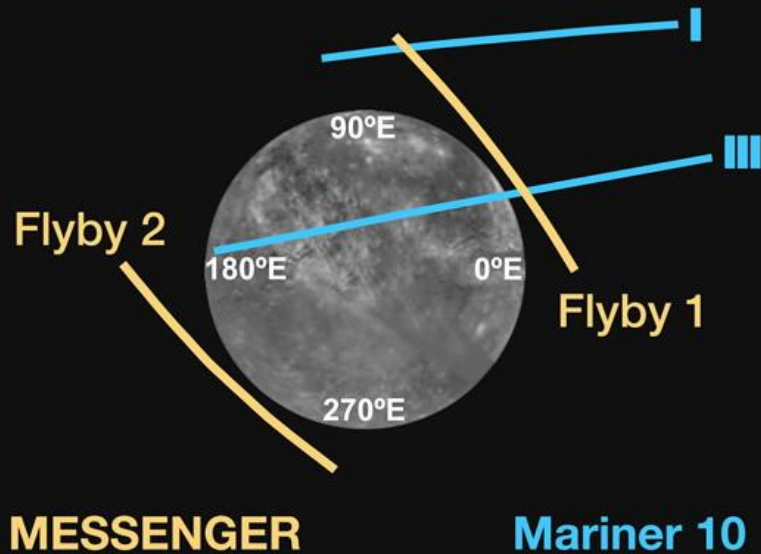
Figure 6-7b
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Earth is a very geologically active place with volcanoes and plate tectonics. The mantle is semi-molten, with convection slowly causing hotter material to rise and cooler material to fall in the mantle. The tectonic plates of the Earth “float” on these convection currents.

Global Plates

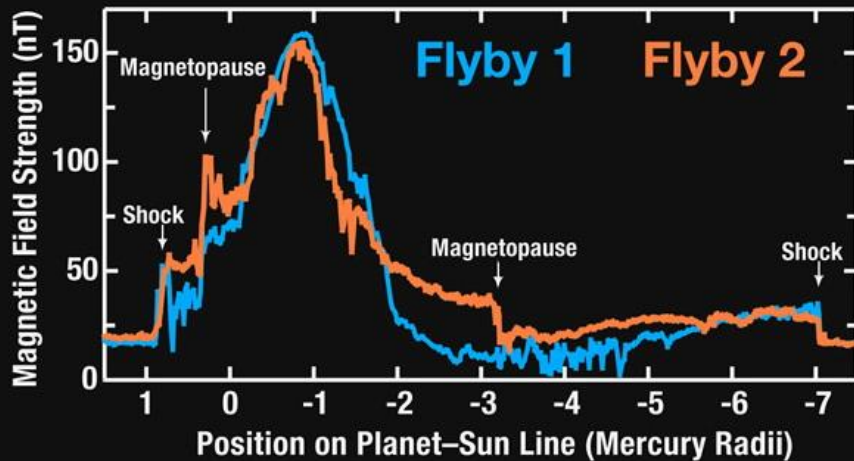






Because it is so small the core of Mercury is probably mostly solid, meaning that scientists did not expect to find a magnetosphere!

One the scale shown the Earth's field would register at around 50,000nT, so we think that something very different is causing Mercury's magnetic field.



Venus, Up Close

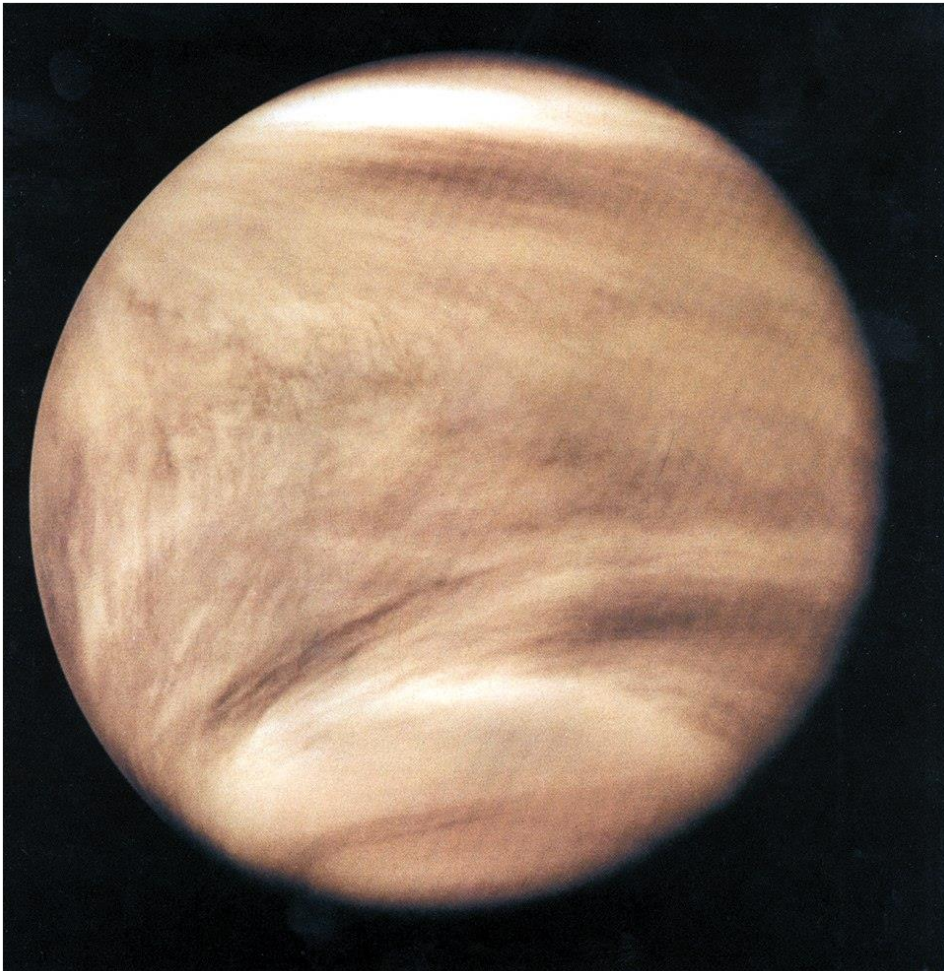
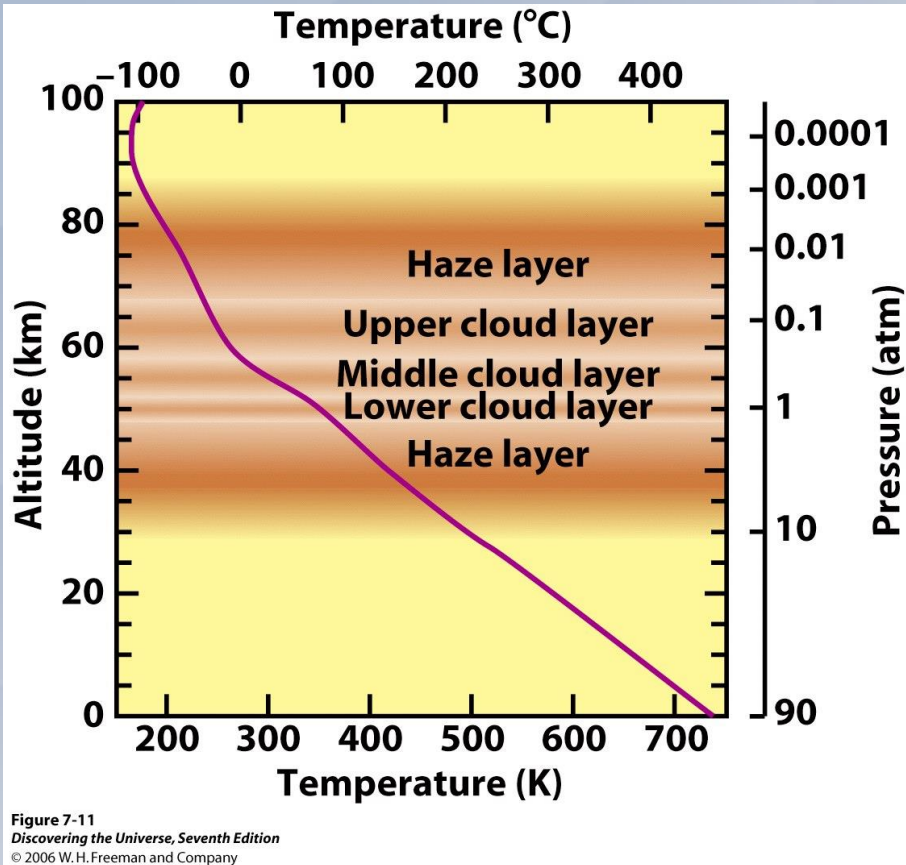


Figure 7-10 photo
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Because of Venus's dense cloud cover most of what we know about Venus's surface and rotation comes from using radar.

There has been only a few spacecraft to land on Venus, but each survived for only a short time.

The Atmosphere of Venus



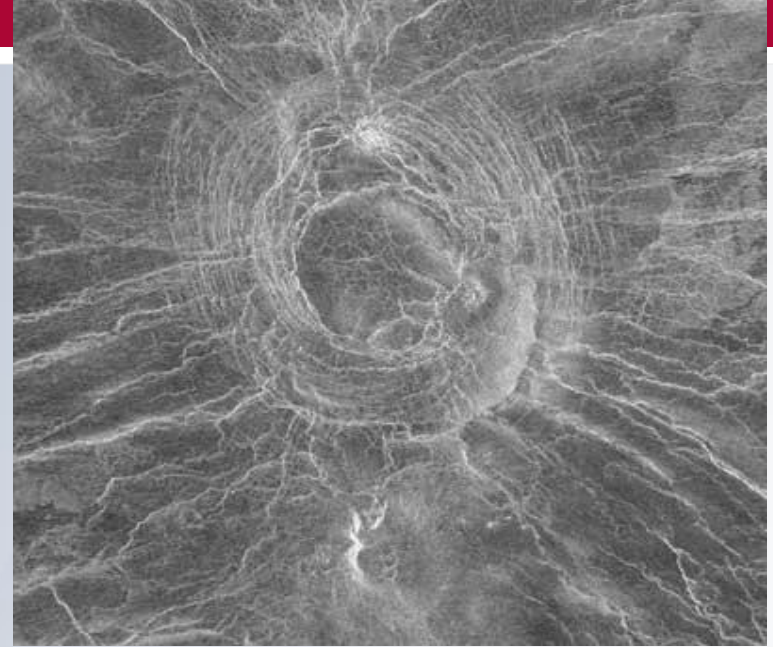
The atmosphere of Venus is made up of carbon dioxide, with clouds of sulfuric acid. The atmosphere is some 90 times denser than Earth's. The Greenhouse effect causes the surface temperature of Venus to be close to 730K day or night.

This is warmer than even Mercury which is a lot closer to the Sun! Venus is far too hot for gases lighter than CO₂ to stay in its atmosphere. Venus has almost no water, O₂, or N₂.

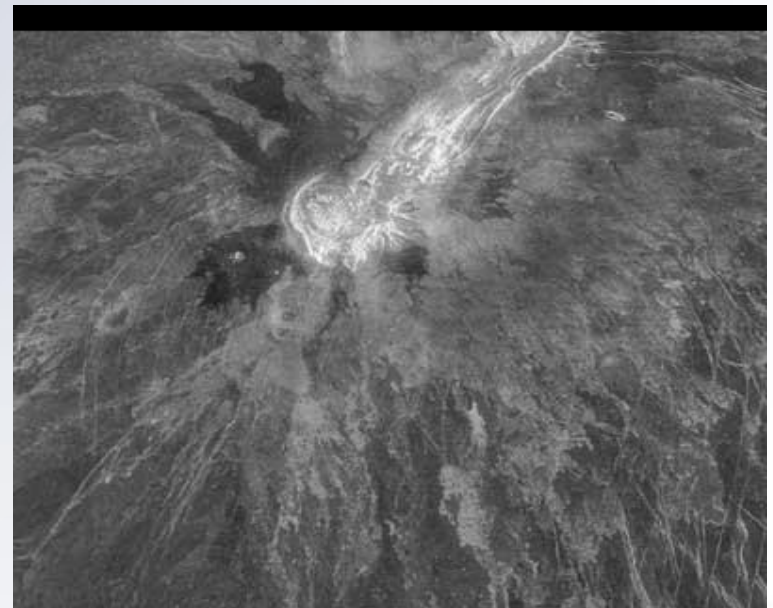
Venus Corona and Volcanoes

Venus has several times more volcanoes as Earth does, however Venus does not have plate tectonics like Earth. This could be why the surface of Venus appears older than Earth's surface (~500 million years vs. ~100 million).

We can not tell from these radar images if Venus is geologically active right now, but we believe it could be active. We believe that Venus is much like a “young” Earth was just before Earth's oceans formed.



pictures from Magellan spacecraft NASA/JPL



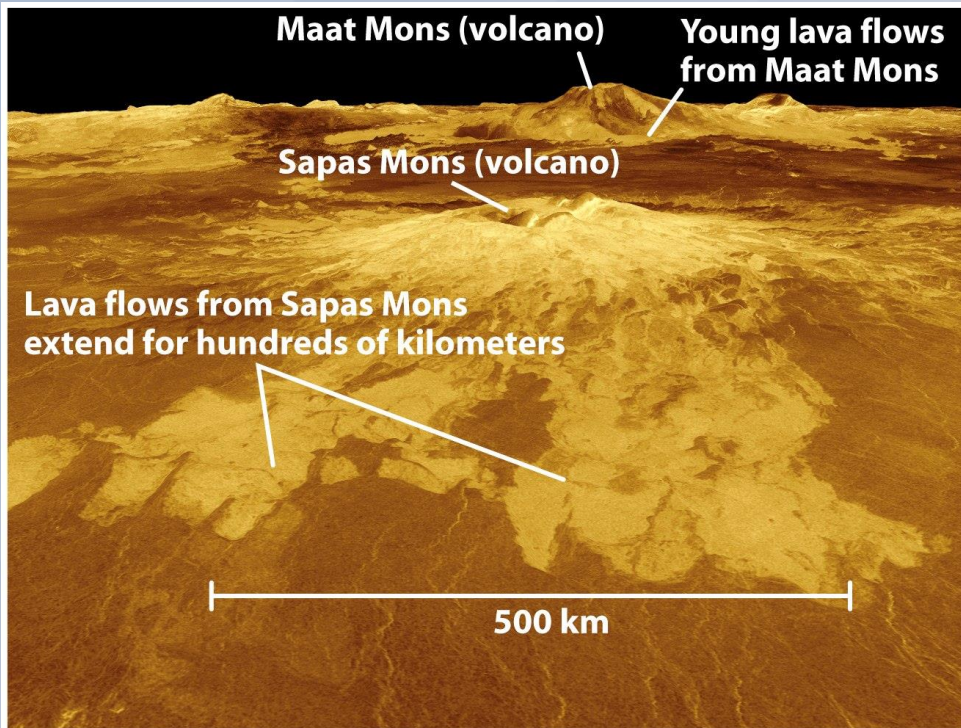


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Venus

Venus has no detectable magnetosphere, probably due in part to Venus's very slow rotation rate and a lack of convection in the core.

We expect Venus to have a crust, mantle and a core like Earth

