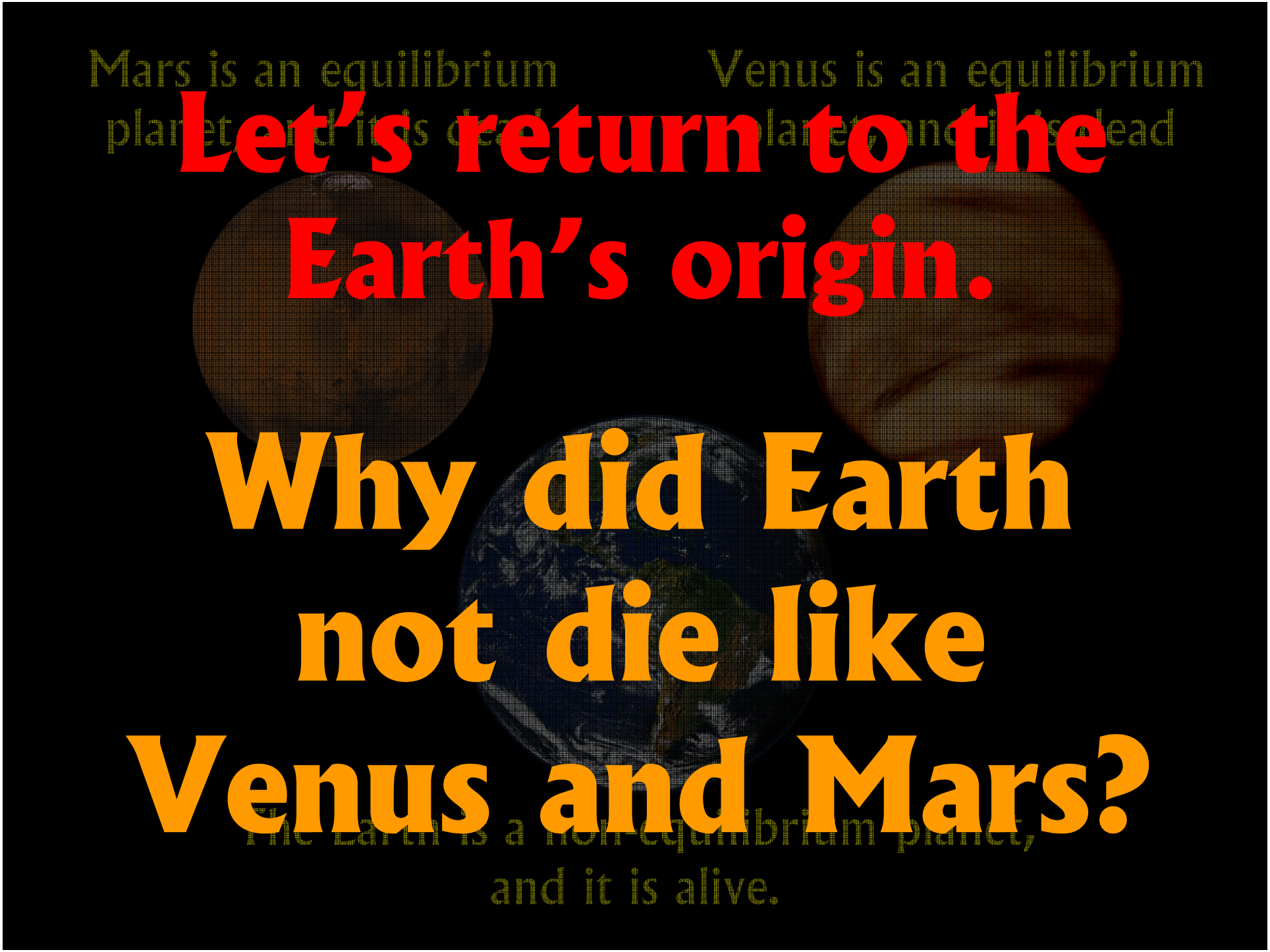

Mars is an equilibrium planet, its dead
Venus is an equilibrium planet, and it is dead
Let's return to the Earth's origin.
Why did Earth not die like Venus and Mars?
The Earth is a non-equilibrium planet, and it is alive.

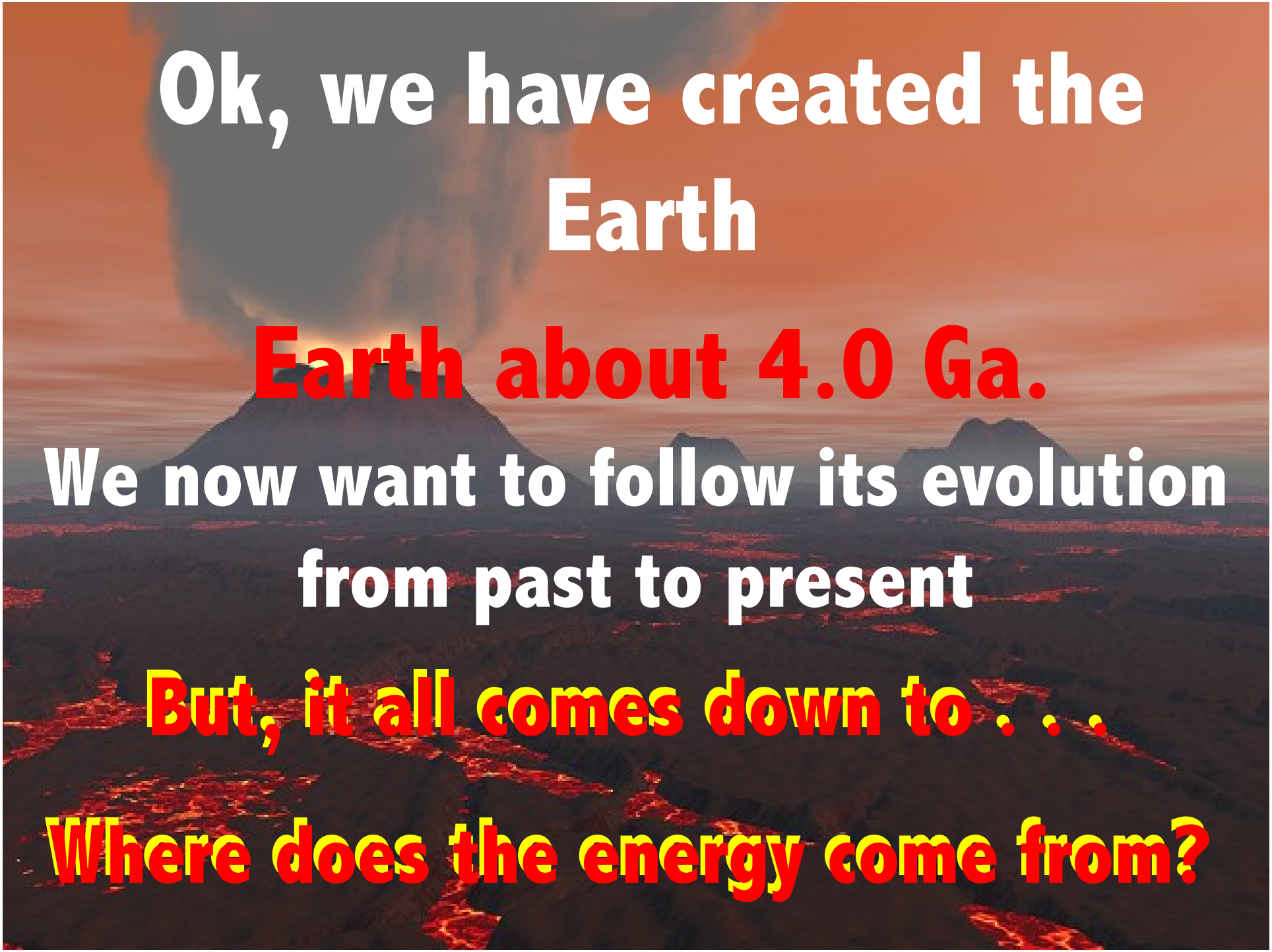
Mars is an equilibrium planet and its crust is dead

Venus is an equilibrium planet and its crust is dead

Let's return to the Earth's origin.

A bunch of reasons we will have to explore with time.

The Earth is a non-equilibrium planet,
and it is alive.


Ok, we have created the Earth
Earth about 4.0 Ga.
We now want to follow its evolution from past to present
But, it all comes down to . . .
Where does the energy come from?

It all has to do with the dissipation of energy.

Tectonic → *Initial heat + radioactive heat + its counter force, gravity*

Heat causes things to expand which causes them to move

Solar → *Heat from the sun*

Heat warms the air and water, setting up different pressures which causes them to move.

Chemical → *Inorganic reactions, of which there are many, many, many – some of which we need to understand*

Biological → *Organic chemistry, plus biological modifications of environments*

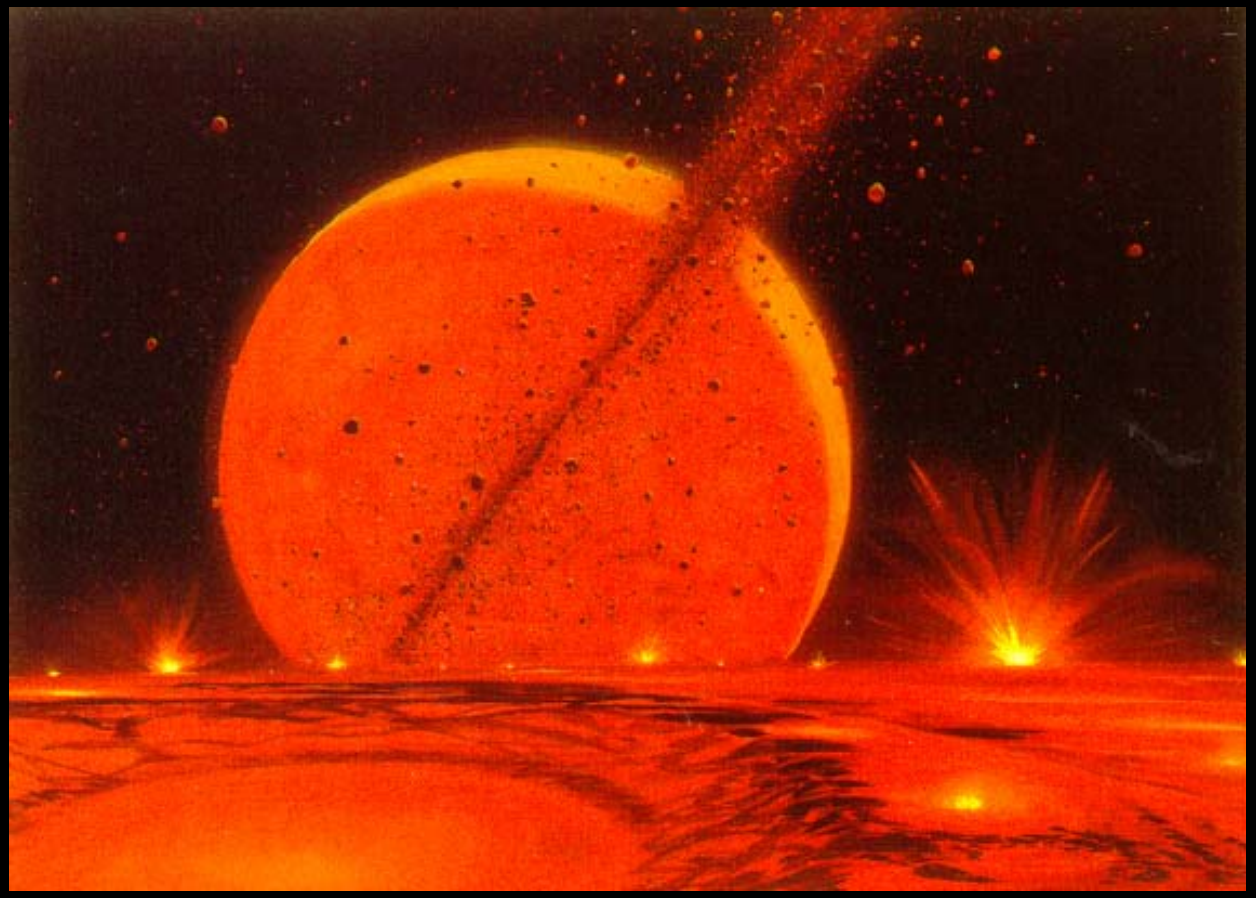
On the earliest Earth the two major sources of energy are:

Tectonic → *Initial molten state + Radioactive heat + its counter force, gravity*

Heat causes things to expand which causes them to move

Chemical → *Inorganic reactions, of which there are many, many, many – some of which we need to understand*

The Earth and moon started off molten: lots of tectonic and chemical energy.



~ 4.5 Ga. The moon shortly after its formation as seen from the still largely molten Earth. Recent models have the Earth-Moon system emerging when the Moon hit the earth in a glancing blow that shattered the Moon, and nearly disintegrated the Earth.

Early Earth Fractionation

Fractional Stratification of the Early Earth



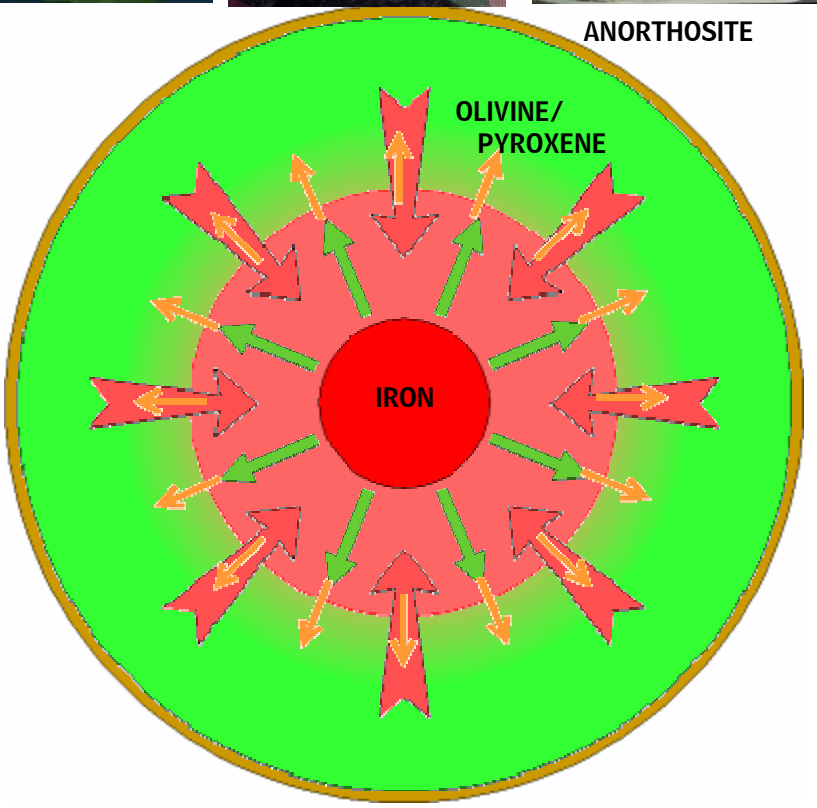
ANORTHOSITE

As the Earth was heated to molten, materials began to fractionate out by density.

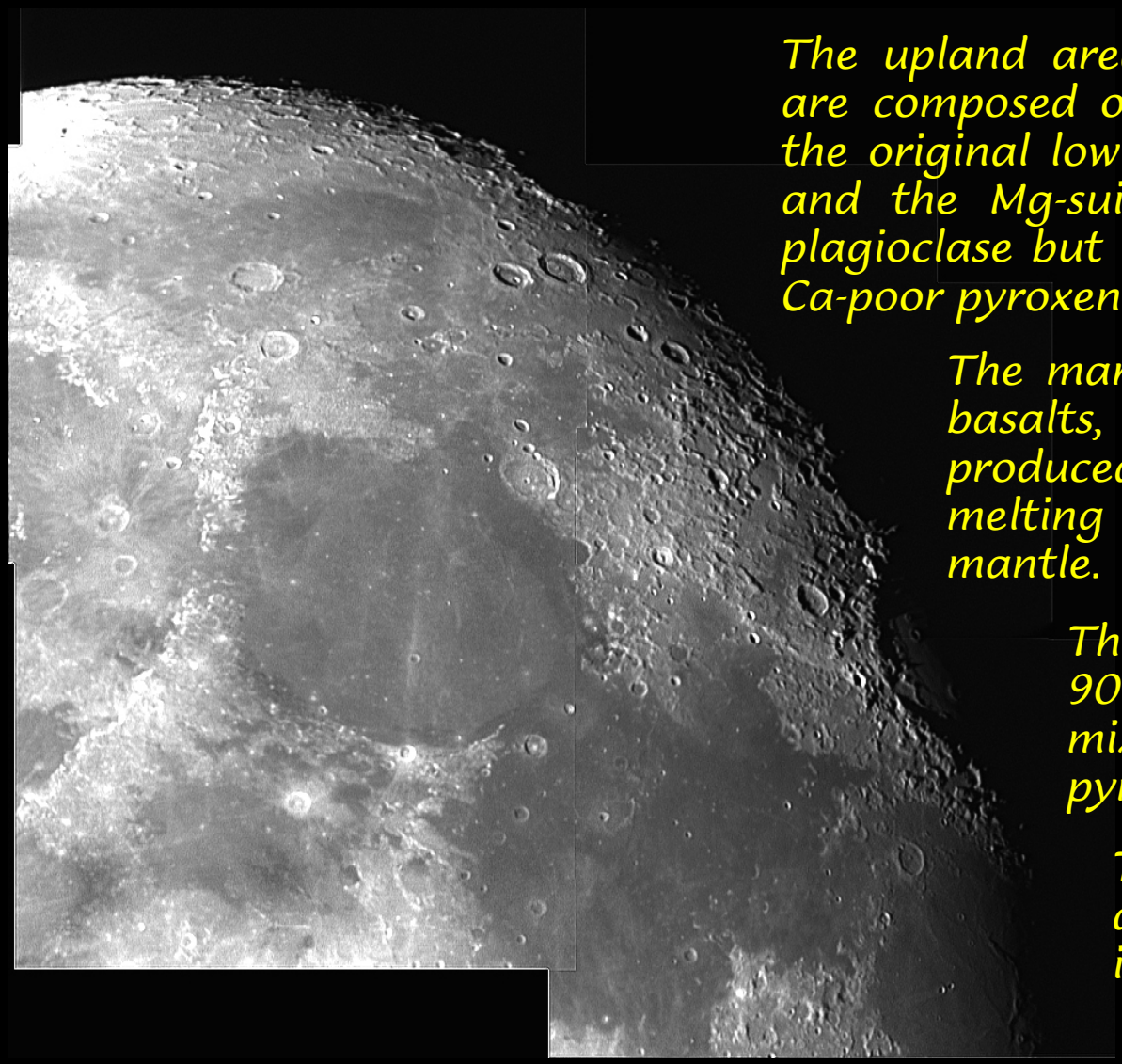
Iron (s.g. 7.2), the heaviest and most abundant material settled toward the center of gravity to form the core; still molten hot after 4 billion years.

Lighter materials, like olivine (s.g. ~4.3) and pyroxene (s.g. ~3.3) floated upward to form the mantle – mostly dunite and peridotites and their metamorphic equivalents – like ecolgite.

Finally the lightest slags, calcium plagioclases (anorthosite; s.g. ~2.76) gathered as a scum on the surface to form the lithosphere.



This is pretty much how the moon is structured today, and likely was the original structure of the Earth.



The upland areas (light colored in photo) are composed of anorthosite (remnants of the original low density crust of the moon, and the Mg-suite - rocks with abundant plagioclase but also substantial olivine and Ca-poor pyroxene

The maria (dark smooth areas) are basalts, thought to have been produced by radiogenic heating and melting of regions of the moon's mantle.

The mantle constitutes about 90% of the moon and is a mixture of olivine and pyroxene.

The core is about 400 km in diameter and is composed of iron.

A link with illustrations discussing moon origin theories

Another link with a nice, brief discussion of the Geologic History of the moon.

http://www.nightskyobserver.com/images.htm

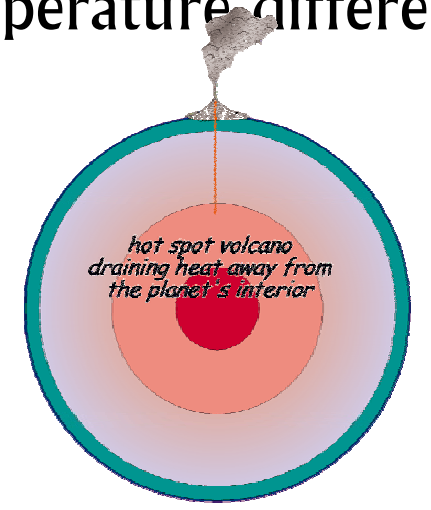
Dissipation of the The Tectonic Energy

Heat is transferred from the Earth's center and escapes to space a number of ways.

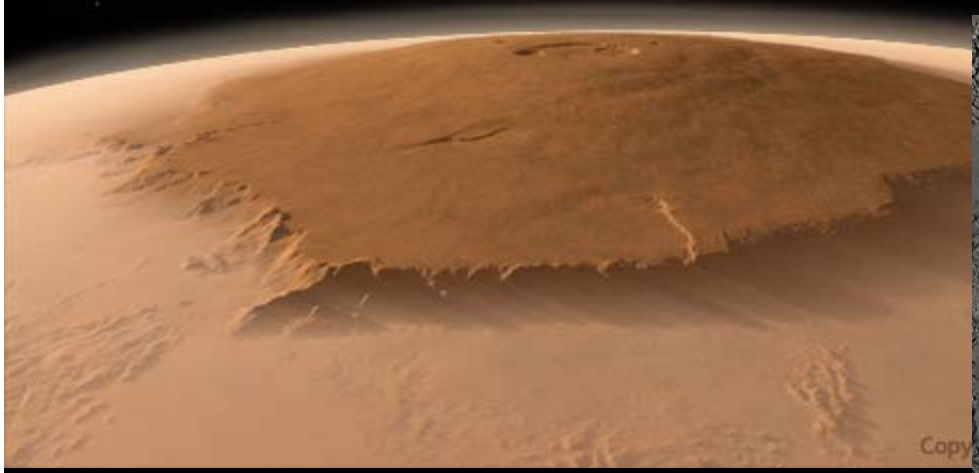
Radiation: energy is emitted as particles or waves through space

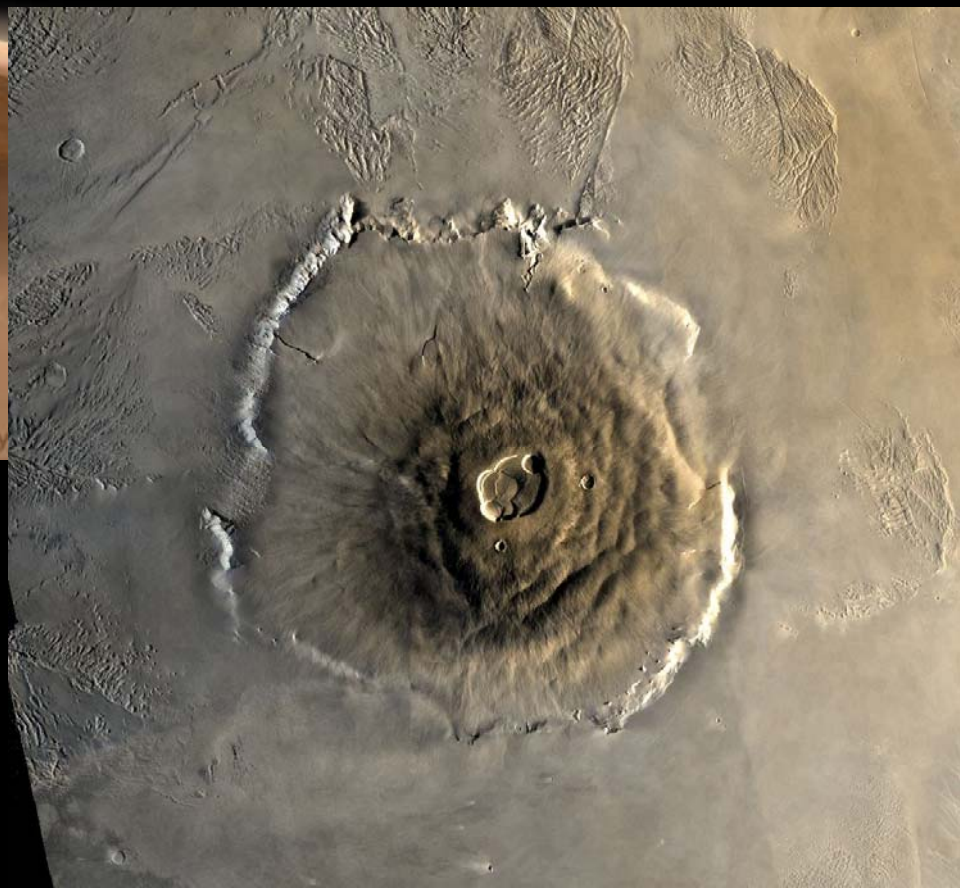
Conduction: the transfer of heat between two parts of a stationary system, caused by a temperature difference between the parts

Direct Transfer: along a conduit from the interior to the surface.



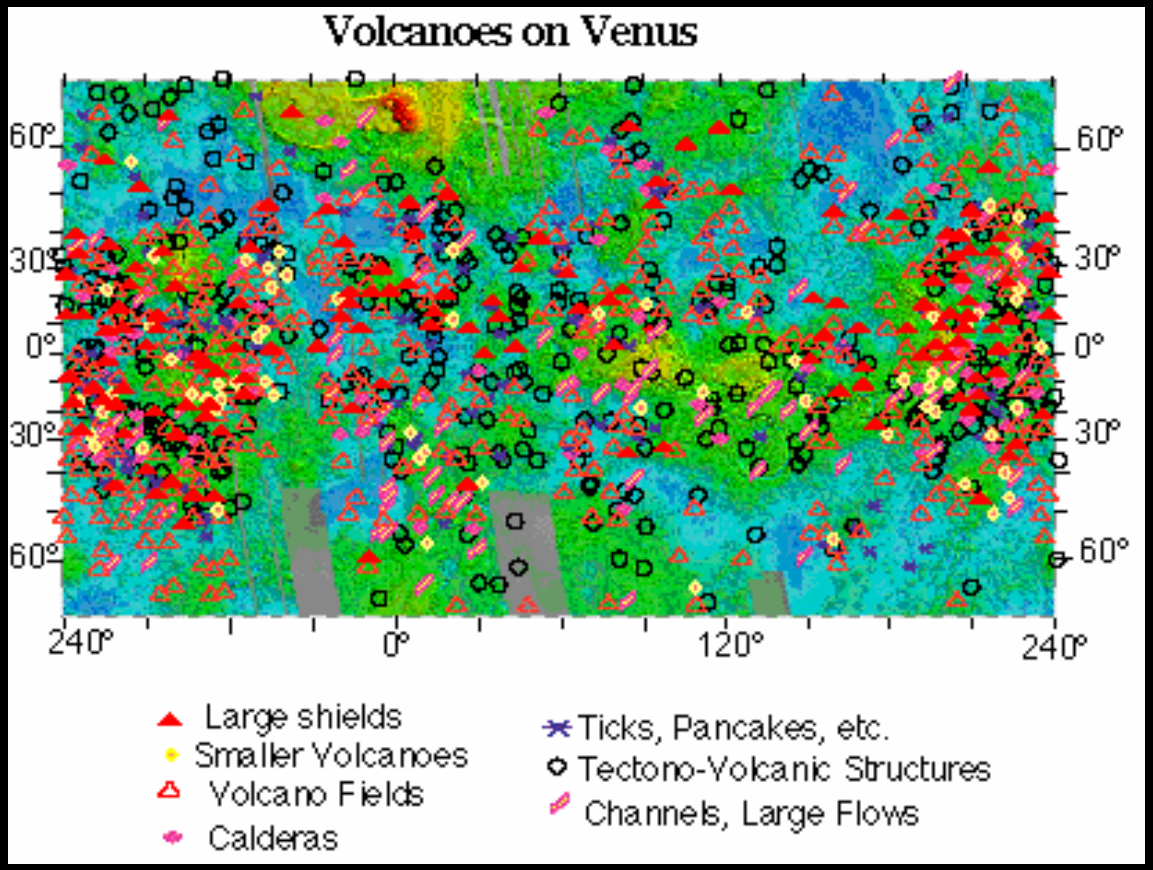
Olympus Mons on Mars





Shield Volcano

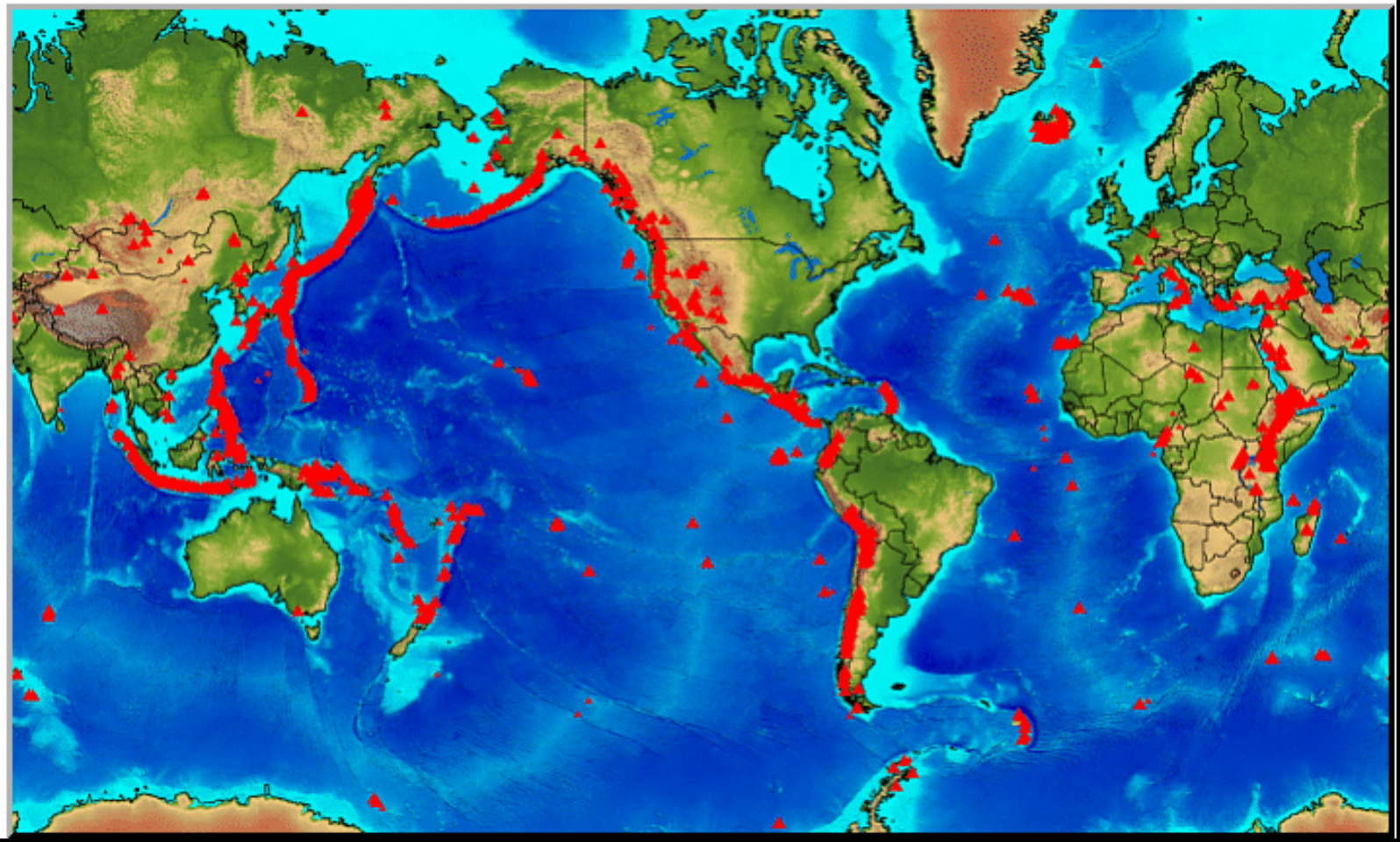
Venetian Volcanoes



Venus has over 1600 volcanoes, more than any other planet in the solar system (most or all long extinct). But, most of these are shield type, which on Earth stem from plumes (pipes) rising straight out of the interior.

Plus, Venus has none of the more common volcanoes that compose the Earth.

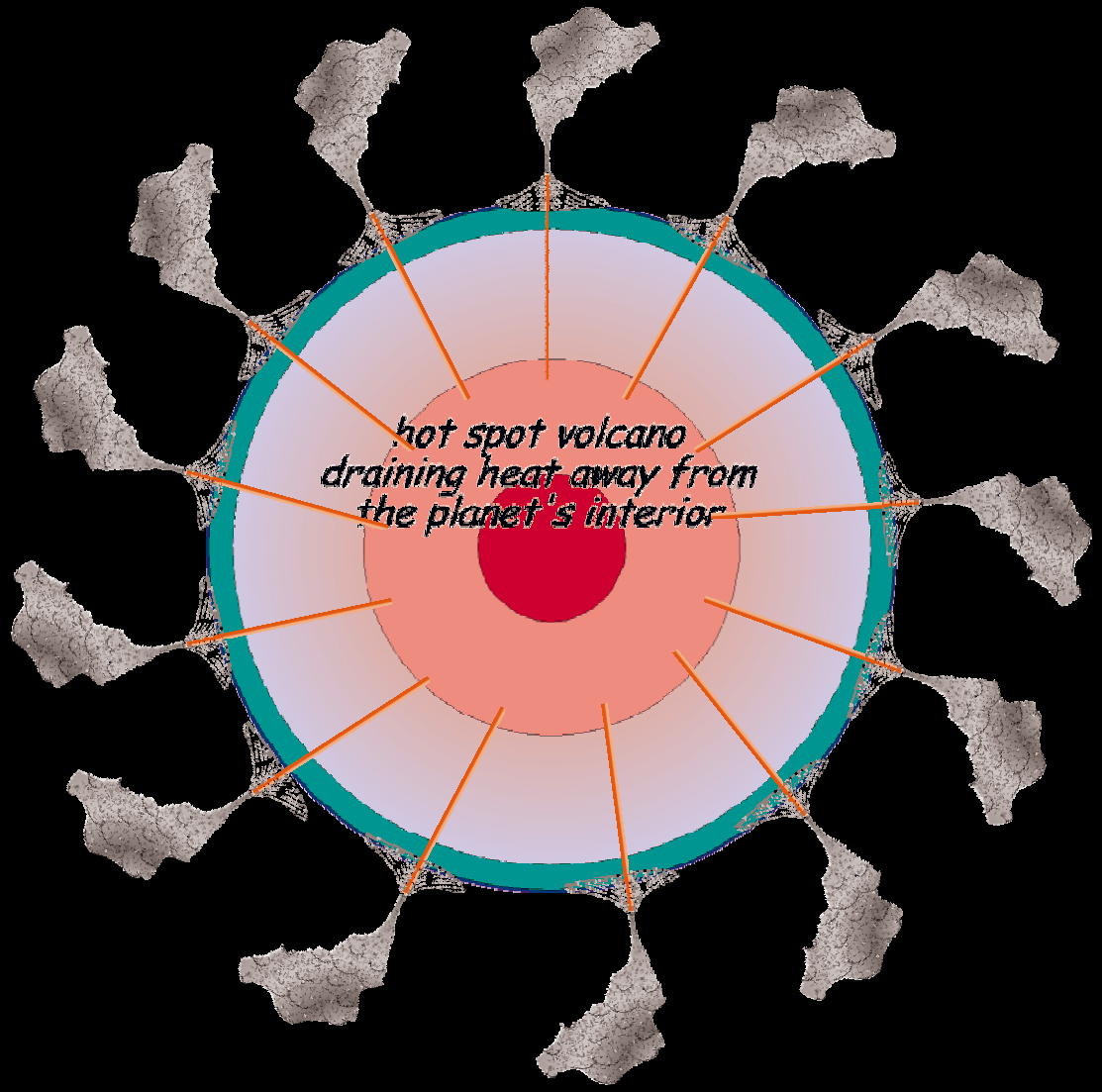
Find a Volcano by Region



One of the differences between Earth and Venus may be all those volcanoes

1600 volcanoes will drain a lot of heat out of a system fast.

It is thought that between every 300 to 800 million years Venus “burps” out a vast out pouring of heat (in the form of magma) that dissipates any accumulated heat.

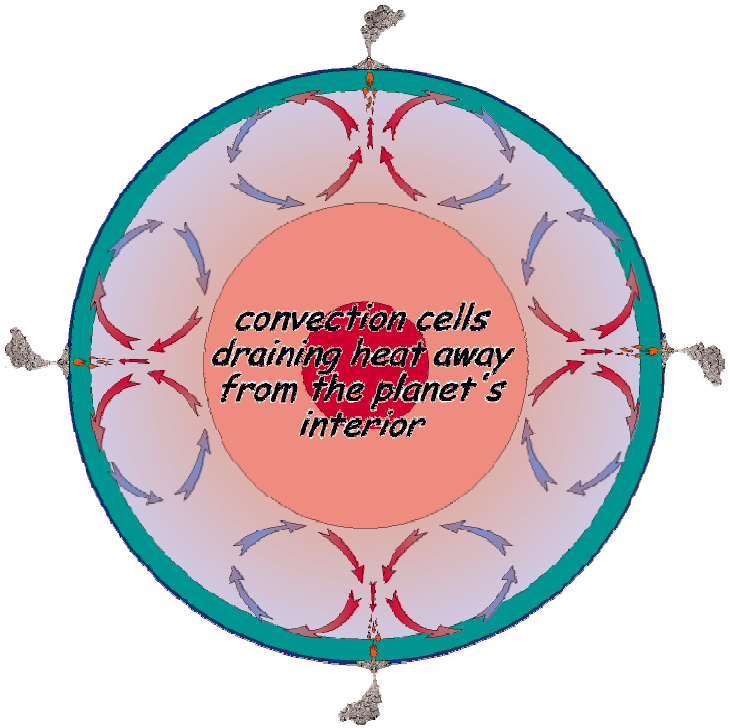


Dissipation of the The Tectonic Energy

Heat is transferred from the center and escapes to space a couple of ways.

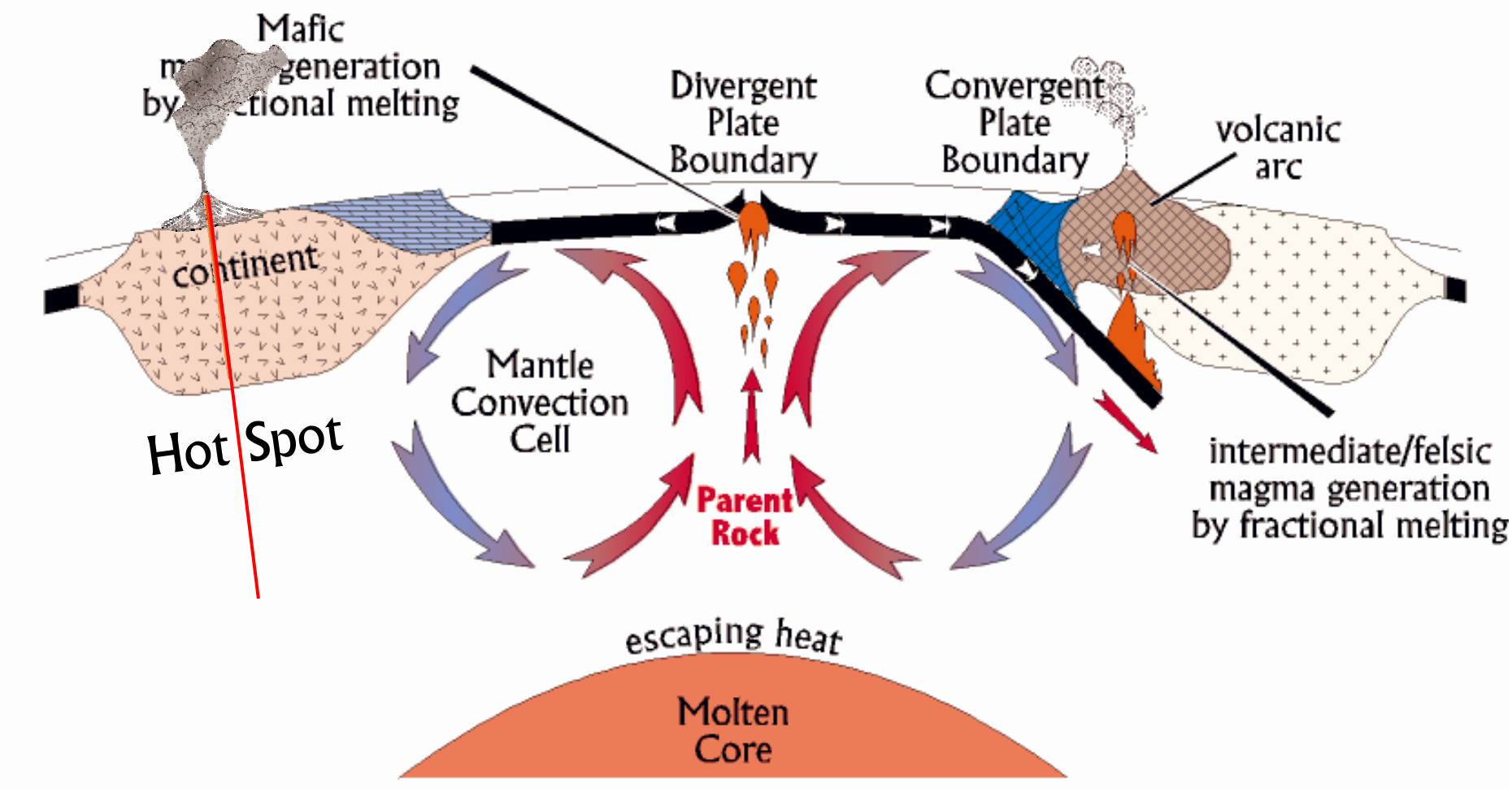
Convection: transfer of heat by the circulation or movement of the heated parts

This is what is happening on Earth, and is the only known place it is occurring.



And, it is the cause of plate tectonics (but requires special conditions, like the presence of abundant water).

Plate Tectonic Dissipation of the The Tectonic Energy P 115



Dissipation of The Chemical Energy

First Stages