

Welcome to Class 6: Early Earth Geology



How soon could life have taken hold on Earth and WHERE on Earth would that be?

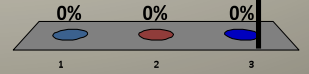
Where did our life-bearing oceans and life-sustaining atmosphere come from?

Which of the days learning objectives seem most difficult?

1. Earth age, how determined, source of atmosphere oceans & life's beginnings.
2. Earth's interior properties, role of differentiation.
3. Theory of Plate Tectonics, three observations of it, the driving mechanism.



Be sure your channel is set: Ch/Go 80 Ch/Go



The age of the Earth

Discuss in groups, then be prepared to answer:

- List three different rocks used to estimate the age of Earth.
- What value do they each give for Earth's age?
- How are ages derived from rock?

Important events during Earth's first half billion years



We learned that Earth formed from rocks and metal. So where did the Water come from?

What is it called when reduced pressure releases trapped gas?



What did this lead to?

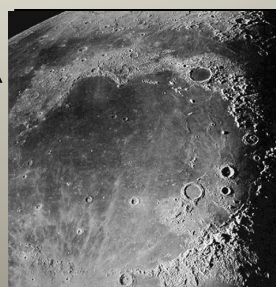


Important events during Earth's first half billion years

Heavy Bombardment Phase on Earth



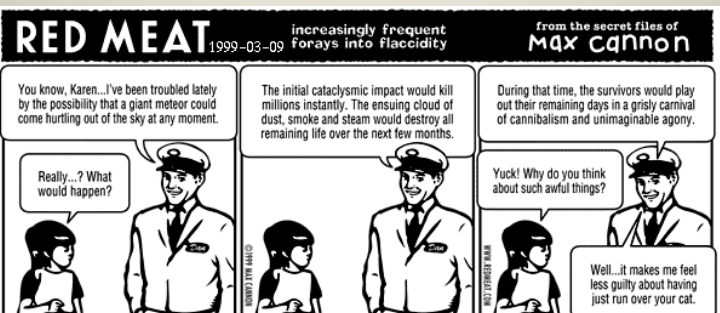
How can we know about the impact history of Earth?



What is the 'Late' Heavy Bombardment?

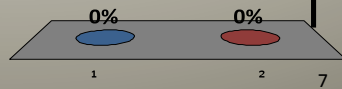
How long was Earth un-inhabitable?

What is a Sterilizing Impact?



Was the asteroid that 'killed' the dinosaurs a *Sterilizing Impact*?

1. Yes
2. No



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The structure of the Inner Earth



In *The Core*, the Earth's inner core stopped rotating, causing the planet's magnetic field to rapidly deteriorate.
Fact or fiction?

Airplanes fall out of the sky, everything electronic is destroyed, static discharge in the atmosphere creates super storms and microwave radiation will 'cook' the planet.
Fact or fiction?

How do we know the interior of our Earth?

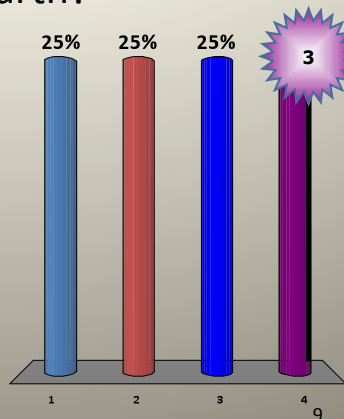
The deepest well is 50,000 feet (~8 miles), ~1/3 through the crust. The temperature is 356 F. It released high pressure water and hydrogen gas trapped beneath.



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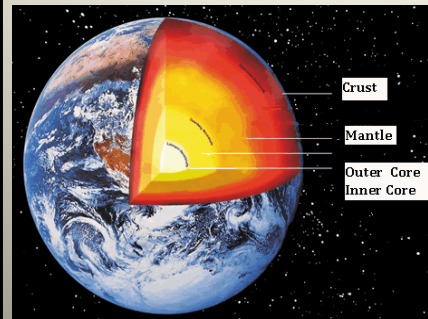
How do we know the internal structure of the Earth?

1. Radiation measurements
2. Gravitational measurements
3. Magnetic measurements
4. Seismic measurements



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The structure of the Inner Earth



Seismic studies reveal several layers, but the primary are given here.

CORE

Highest density material (Nickel & Iron)
Two Distinct Regions
Inner is solid
Outer is liquid and is the source of our magnetic field

CRUST

Lowest density, outer, thin skin of rock.

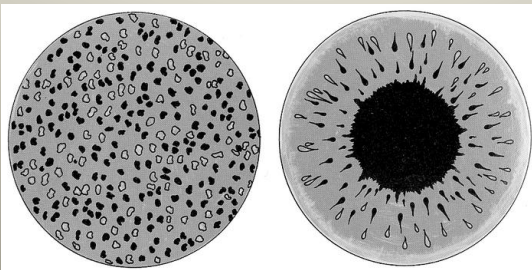
MANTLE

Rocky silicates (SiO). Makes up most of the Earth's volume. Only top is molten. Most is 'solid', but can flow and churn (convect)..

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Other important events during the first half billion years

What is this illustrating?

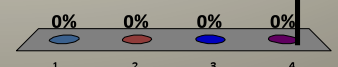


What did this eventually lead to in Earth's interior?

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What is a current source of heat for the Earth's center?

1. Fusion at its center
2. Differentiation
3. Gravitational settling
4. Radioactive decay

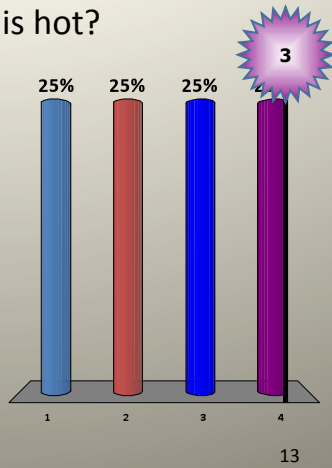


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Why is the Moon, Mars and Mercury cool, while the Earth's center is hot?

1. They do not have radioactive decay.
2. They have had more time to cool off.
3. They never differentiated.
4. They are smaller than Earth.



Work through this exercise in groups

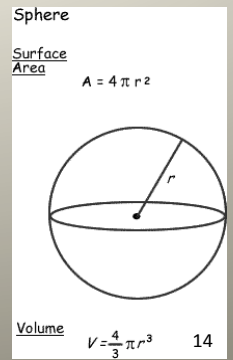
FACT: The heat escaping (cooling) is proportional to surface area (where heat escapes). Write down the equation for surface area of a sphere.

FACT: The amount of heat is proportional to the volume of material. Write down the equation for volume of a sphere.

Look at your equation for the VOLUME and SURFACE AREA.

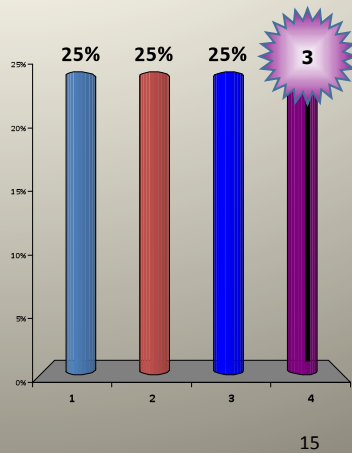
Which increases faster with 'r'?
Surface area (cooling) or Volume (heat)?

What does this mean?



Will the Earth ALWAYS be hot at its center?

1. Yes, from radioactive decay.
2. Yes, because it can trap the heat.
3. No, because radioactive decay will stop.
4. No, because it will always lose more heat than it generates.



Early evidence for Plate Tectonics



1. It looks like they fit together!

The observation that led to the theory of Continental Drift.

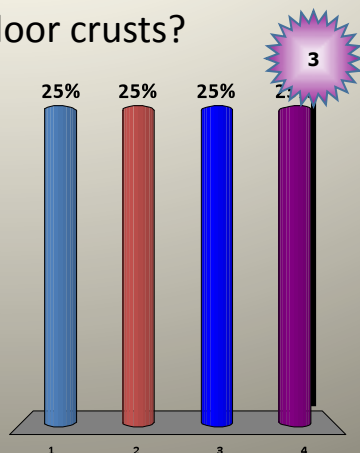
Why wasn't continental Drift ever accepted as a scientific theory?

2. Discovery of the mid-ocean ridges.
3. There are two distinct crusts on Earth.

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PRS: What is the difference between continental and seafloor crusts?

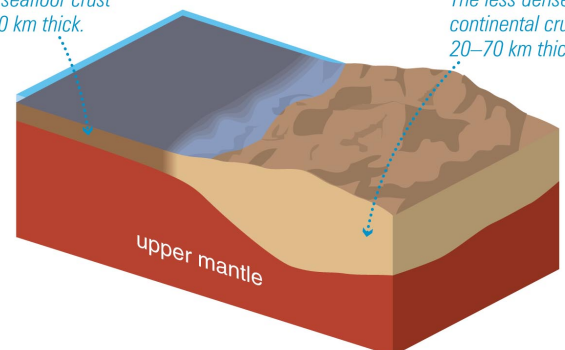
1. Seafloor crust is less dense
2. Continental crust is thinner
3. Seafloor crust is always older
4. Continental crust presses deeper into the mantle



Further evidence for Plate Tectonics: Continental vs. Seafloor Crust

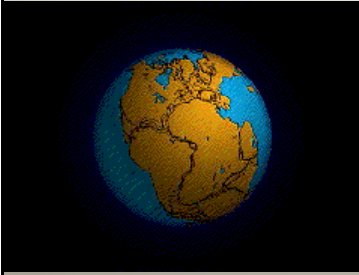
The relatively dense, young seafloor crust is 5–10 km thick.

The less dense, older continental crust is 20–70 km thick.

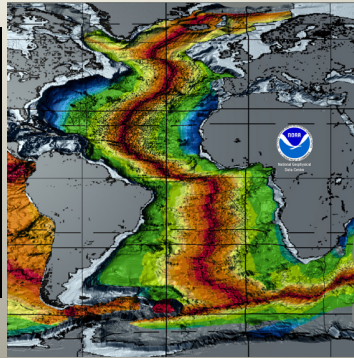


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Modern evidence for Plate Tectonics



21 Satellites, 20,000 km above Earth,
Can measure a few mm/yr motion.



Advancing age of seafloor rock when moving
away from the mid-ocean ridge center

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A scientific theory must be able to explain
observed phenomenon and **make predictions**:

Haiti's vulnerability on the Caribbean tectonic plate



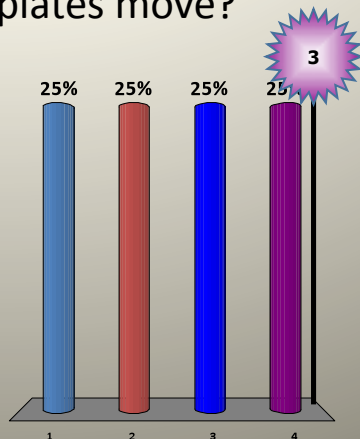
Haiti's Earthquake



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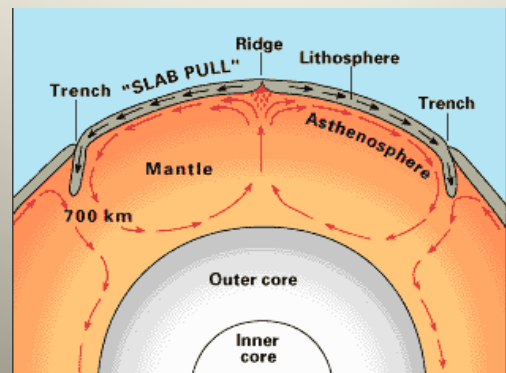
Why do the plates move?

1. Pressure from volcanoes.
2. Radioactive heat escaping.
3. Coriolis effect from the Earth's rotation.
4. Convection in the mantle.



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The center of the Atlantic



Convection of the Mantle is the mechanism driving Plate Tectonics

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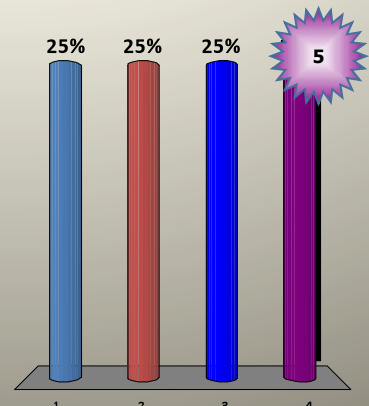
Let's test your knowledge of the days
learning objectives.

Please work ALONE.

Please NEVER enter answers for
another student.

1. How old are the oldest rocks (zircons)
found on Earth?

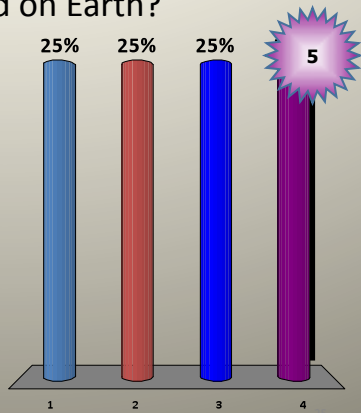
1. 4.6 billion years
2. 4.5 billion years
3. 4.4 billion years
4. 4.3 billion years.



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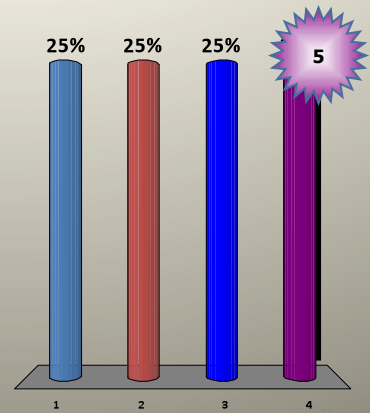
2. When did the heavy bombardment phase come to an end on Earth?

1. 4.4 billion years ago
2. 4.2 billion years ago
3. 4.0 billion years ago
4. 3.8 billion years ago



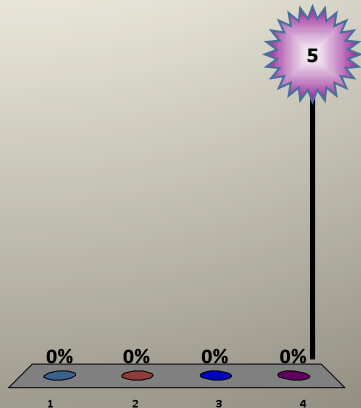
3. Differentiation occurred

1. while young Earth was entirely molten
2. once Plate Tectonics began
3. during the formation of the oceans.
4. After the moon was formed



4. We know the composition and structure of the inner Earth from _____.

1. Direct observations
2. Seismic studies
3. Drilling studies
4. Moon based studies



5. Earth's Plate tectonics is driven by convective motions in the _____.

1. Crust
2. Mantle
3. Outer liquid core
4. Inner solid core

