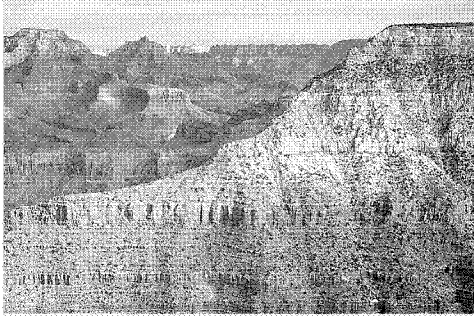


Wednesday, October 6
The Geological Record



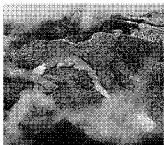
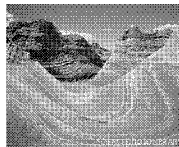
Copyright © 2007 Pearson Education, Inc., publishing as Pearson Addison-Wesley.

The Geological Record
Key Concepts

- 1) The four **eons** of Earth history are: Hadean, Archaean, Proterozoic, & Phanerozoic.
- 2) The **Phanerozoic** is the current eon, when complex life arose.
- 3) The **Hadean** was the earliest eon, when the Earth's atmosphere & ocean formed.

The three main types of crustal rock are classified by how they formed.

Sedimentary rocks are made by compressing sand or mud (sometimes containing fossils).



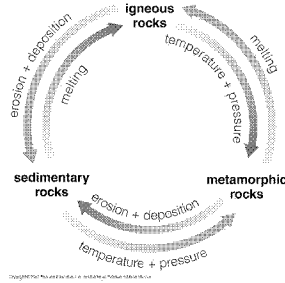
Igneous rocks are made by cooling lava.

Metamorphic rocks are made by squeezing & heating other rocks.

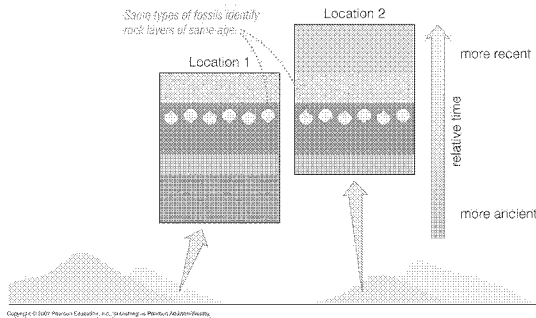


The **Rock Cycle** describes how the 3 types of rocks can be transformed into each other.

Atmosphere & oceans drive erosion & deposition.
Plate tectonics drives melting, temperature & pressure.



Stratigraphy is the practice of dating strata (or layers) of sedimentary rock relative to each other.



Detailed analysis lets us reconstruct the history of a rock.

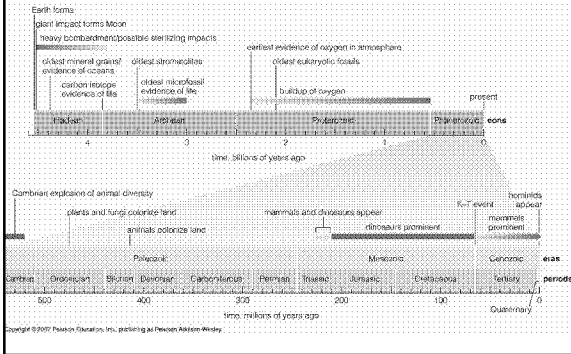
Mineralogy tells us what **minerals** are present (& hence the temperature & pressure when the rock formed).

Chemistry tells us what **elements** are present, and in what proportions.

Isotopic analysis tells us the mix of isotopes present in the air and water when the rock formed.

Radiometric dating tells us the time when an igneous rock solidified.

The **geological time scale** is our reconstruction of the Earth's history, using all available tools.



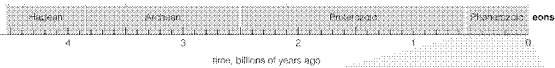
Because the Earth is old, the geological time scale employs **long** units of time.



1 Myr = 1 megayear = 1 million years

1 Gyr = 1 gigayear = 1 billion years

The four **eons** are the major divisions of geological time.



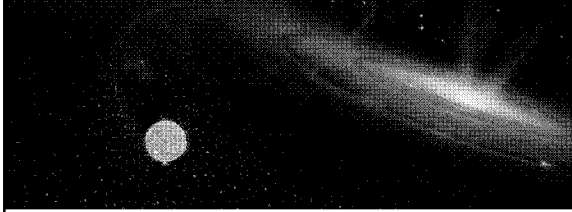
Hadean: 3.8 – 4.5 Gyr ago: Formation of oceans

Archaean: 2.5 – 3.8 Gyr ago: First micro-organisms

Proterozoic: 540 Myr – 2.5 Gyr ago: First multi-celled organisms, buildup of oxygen.

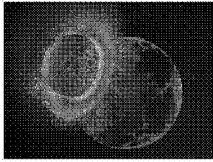
Phanerozoic: <540 Myr ago: First animal life.

Start of the Hadean Eon: Earth formed by accretion of rocky & metallic “planetesimals” in the dusty gas disk that formed the Sun.

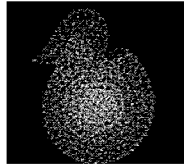


The proto-Earth was hot & molten; thus, it began to differentiate.

The Moon was formed when a giant planetesimal slammed into the Earth ~50 Myr after formation.

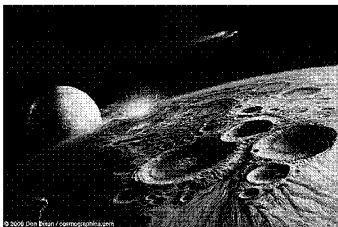


artist's impression



computer simulation

The giant impact that formed the Moon would have stripped off any atmosphere on the Earth.

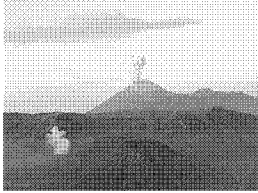


Airless

Dry surface

However, gases were trapped in the interior of the Earth, & later belched out by volcanoes.

The oceans probably formed from **both** volcanic gases and comet impacts.

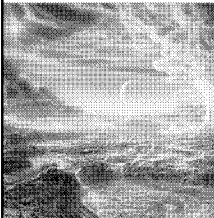


Volcanoes emit copious H₂O (but not enough to form all the oceans).



Comets (& asteroids) are rich in water.

4.4 Gyr old zircons have oxygen isotope ratios that imply the existence of abundant liquid water.

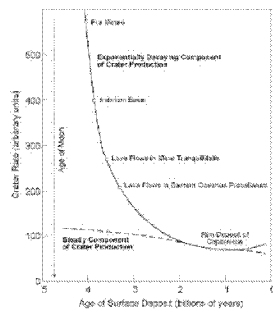
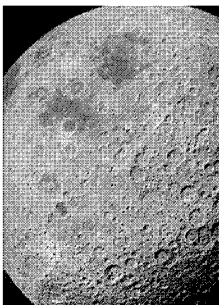


mini-zircon



Implication: Oceans formed early in the Earth's history.

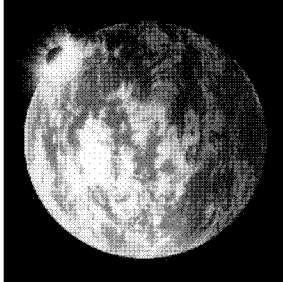
The cratering history of the Moon records an 700 Myr long epoch of heavy bombardment.



Bombardment with ~400 km diameter asteroids would have sterilized the early Earth.

Vaporizing oceans!
Melting crust!

Any early life would have been wiped out.

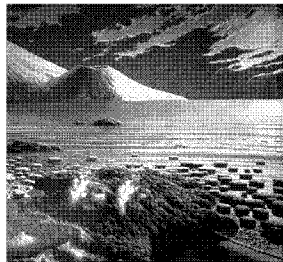


Last sterilizing impacts occurred ~3.8 Gyr ago.

The end of heavy bombardment 3.8 Gyr ago marks the end of the **Hadean Eon**.

Earth became life-friendly (but still no atmospheric oxygen).

The first known fossils appear within ~300 Myr of the end of the Hadean.



Tomorrow's Lecture:
Climate Change

Pre-Quiz Reading:
Chapters 1-4
