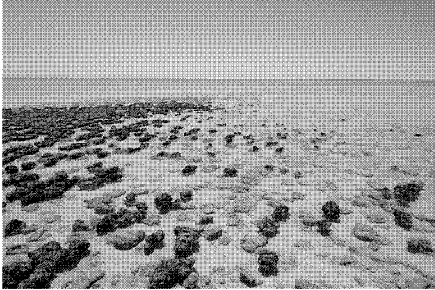


Monday, October 18
Origins of Life

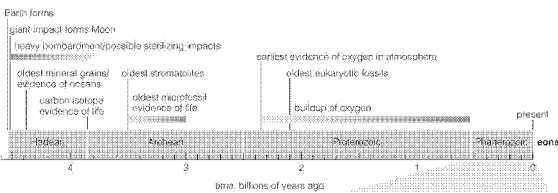


Quiz #2 will be on Friday.

Origins of Life
Key Concepts

- 1) Fossil **stromatolites** (layered mats of cyanobacteria) can be 3.5 billion years old.
- 2) **Microfossils** of individual micro-organisms may also be as old as 3.5 billion years.
- 3) Carbon isotope ratios indicate that life existed as much as 3.85 billion years ago.

The first living things on Earth arose during the Archaean eon.



(I say "Archaean", the text says "Archean" – both spellings are acceptable.)

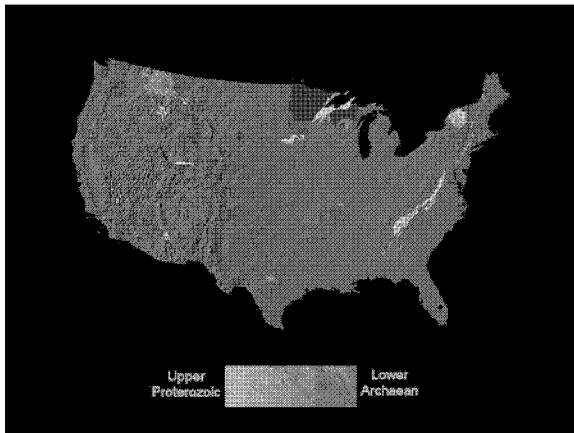
Geological activity has destroyed much of the evidence for early life.

Most crustal rocks have been melted & solidified many times; average rock age is ~100 Myr.

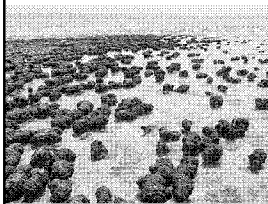
Oldest known rocks:
Jack Hills, Australia (4.4 Gyr zircons)
Acasta Gneiss, Canada (4.0 Gyr)



Finding the oldest fossil remnants of life is challenging.

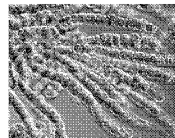


Stromatolites are layered rocks formed of sediment trapped by colonies of **cyanobacteria**.



Shark Bay, W. Australia

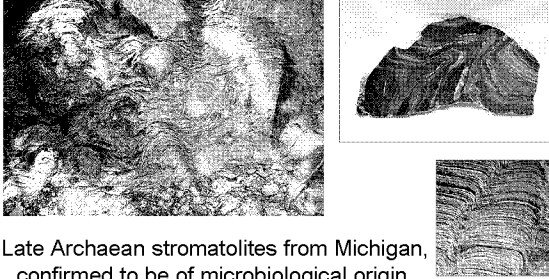
Stromatolites are found today in shallow bays & salt lakes.



Cyanobacteria 40 µm

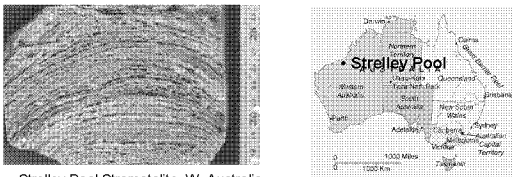
Sediments are trapped by mucus-like secretions from the cyanobacteria.

Many fossil stromatolites have been dated to the Late Archaean Eon (2.8 Gyr ago).



Late Archaean stromatolites from Michigan, confirmed to be of microbiological origin.

Some fossil stromatolites have been dated to the Early Archaean Eon (3.5 Gyr ago).



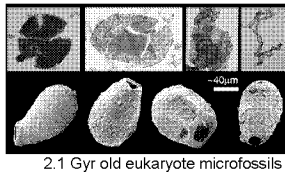
Strelley Pool Stromatolite, W. Australia

Old stromatolites have been subjected to geological processing; organic compounds have been destroyed.

Only carbon and the layered structure remains.

Microfossils are the (very small) preserved remains of individual cells.

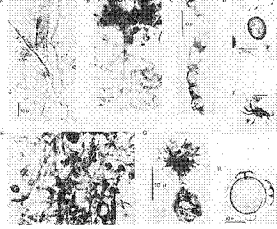
Old microfossils are scarce; the older, the scarcer.



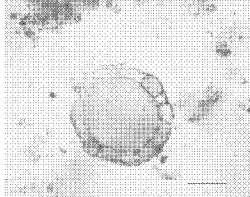
2.1 Gyr old eukaryote microfossils

A few survive; in well-preserved microfossils, we see outlines of cellular structures and detect organic compounds.

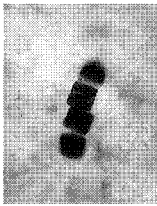
2 Gyr old microfossils are found in the Gunflint Formation north of Lake Superior.



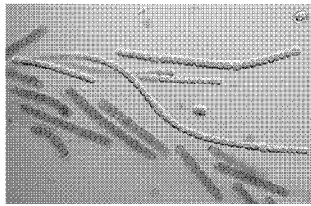
← Some microfossils found in the flint of the Gunflint Formation. ↓



Some multi-billion year old microfossils resemble modern bacteria and archaea in shape.

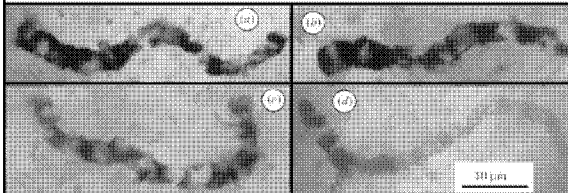


microfossil (Gunflint Formation)



modern cyanobacteria

Microfossil candidates from the Apex Chert in Western Australia are claimed to be ~3.5 Gyr old.



Isotopic analysis of carbon is another way to find traces of biological metabolism.

Carbon has two stable isotopes: ^{12}C and ^{13}C .

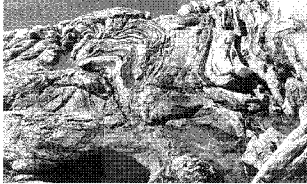
Cell metabolism takes up ^{12}C slightly more readily than ^{13}C , leaving more ^{13}C behind in the environment.

Carbon accumulated by living beings is **depleted** in ^{13}C relative to ^{12}C .

The earliest (claimed) ^{13}C depletion of biological origin is in 3.85 Gyr old rocks in Greenland.

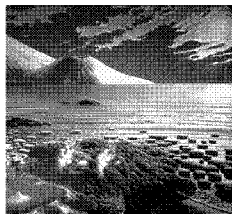
Oldest known sedimentary rock: on Akilia Island, off Greenland, dated to the Late Hadean Eon.

The biological origin of its ^{13}C depletion is still controversial.



Simple life may have arisen on Earth within a few hundred Myr of the end of heavy bombardment.

Life arose fairly quickly after conditions on Earth settled down.



We aren't sure what the first organisms were. We don't know if photosynthesis or chemosynthesis came first.
