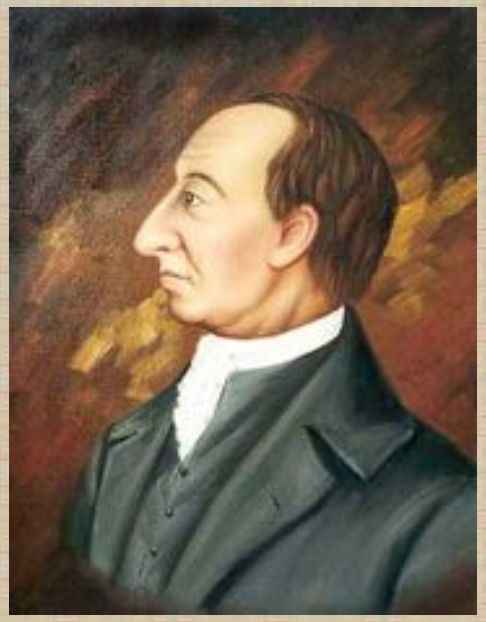
Relative Age Dating

- Uniformitarianism
- Principles of correlation
  - Original horizontality
  - Superposition
  - Inclusion
  - Cross-cutting relationships
- Biostratigraphy



http://de.wikipedia.org/wiki/James_Hutton

James Hutton, Scottish Geologist

Royal Society of Edinburgh meetings - 1785

Formations of rocks and soils on the Earth's surface formed over long periods of time via processes observable on the modern Earth

This worldview became known as the Principle of Uniformitarianism, and specifically rejected supernatural causation to explain natural processes and formations.

Coal gas first used for illumination; Louis XVI of France signs to a law that a handkerchief must be square; British government establishes a permanent land force in the Eastern Caribbean, based in Barbados; The North Carolina General Assembly incorporates Lincolnton, North Carolina (named for American General Benjamin Lincoln) as the new county seat for Lincoln County. (http://en.wikipedia.org/wiki/1785)

Principle of Uniformitarianism

Hutton's work did not gain much acceptance for a long time – probably because the writing was dry. Later, Charles Lyell published a three volume set of books about interpreting geologic history.

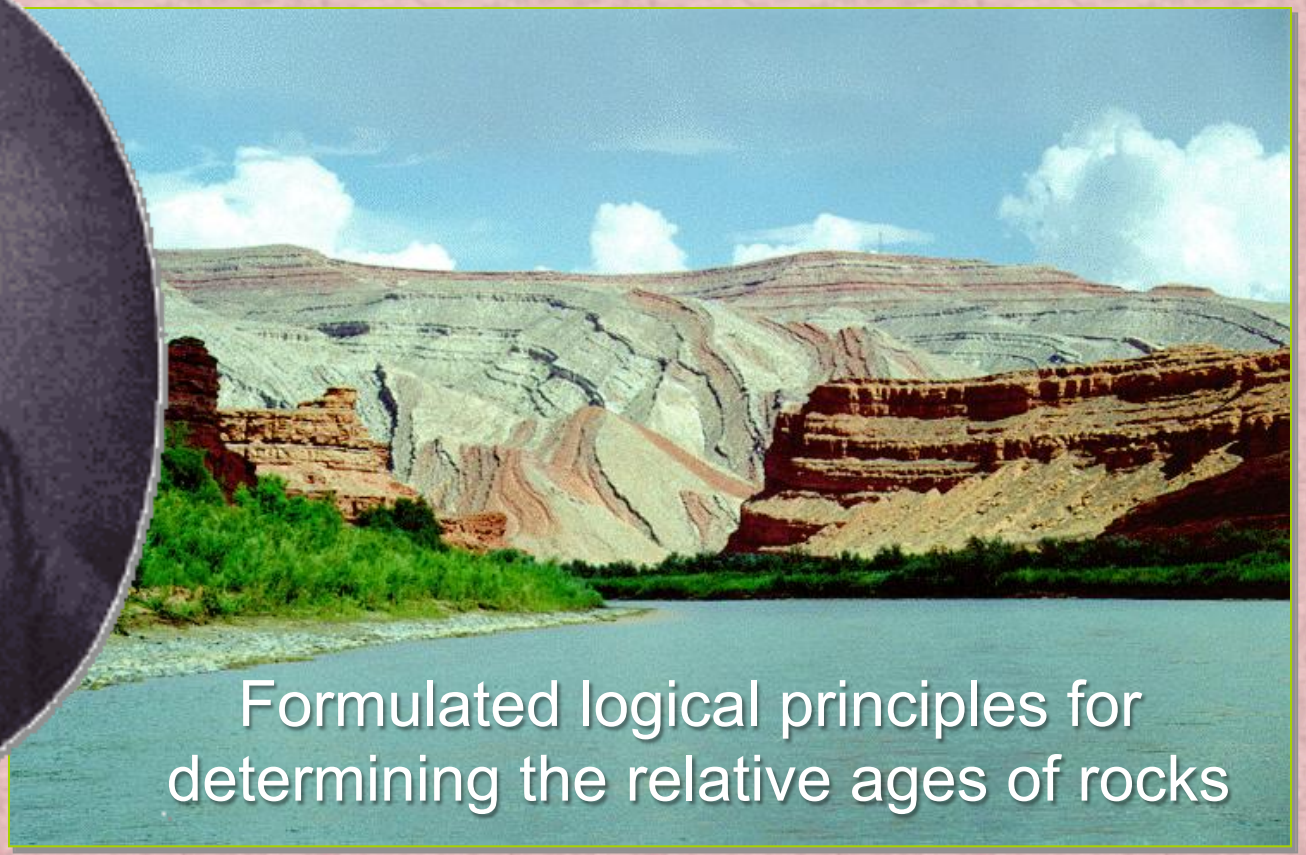
Unlike Hutton's indigestible prose, Lyell's books became required reading for the "natural philosophers" of the day.

Charles Darwin brought the first volume with him to South America on the Beagle, and arranged to have the second and third volumes sent when they were published

http://en.wikipedia.org/wiki/Image:HMSBeagle.jpeg

owen Stanley

Nicholas Steno (1638-1686)



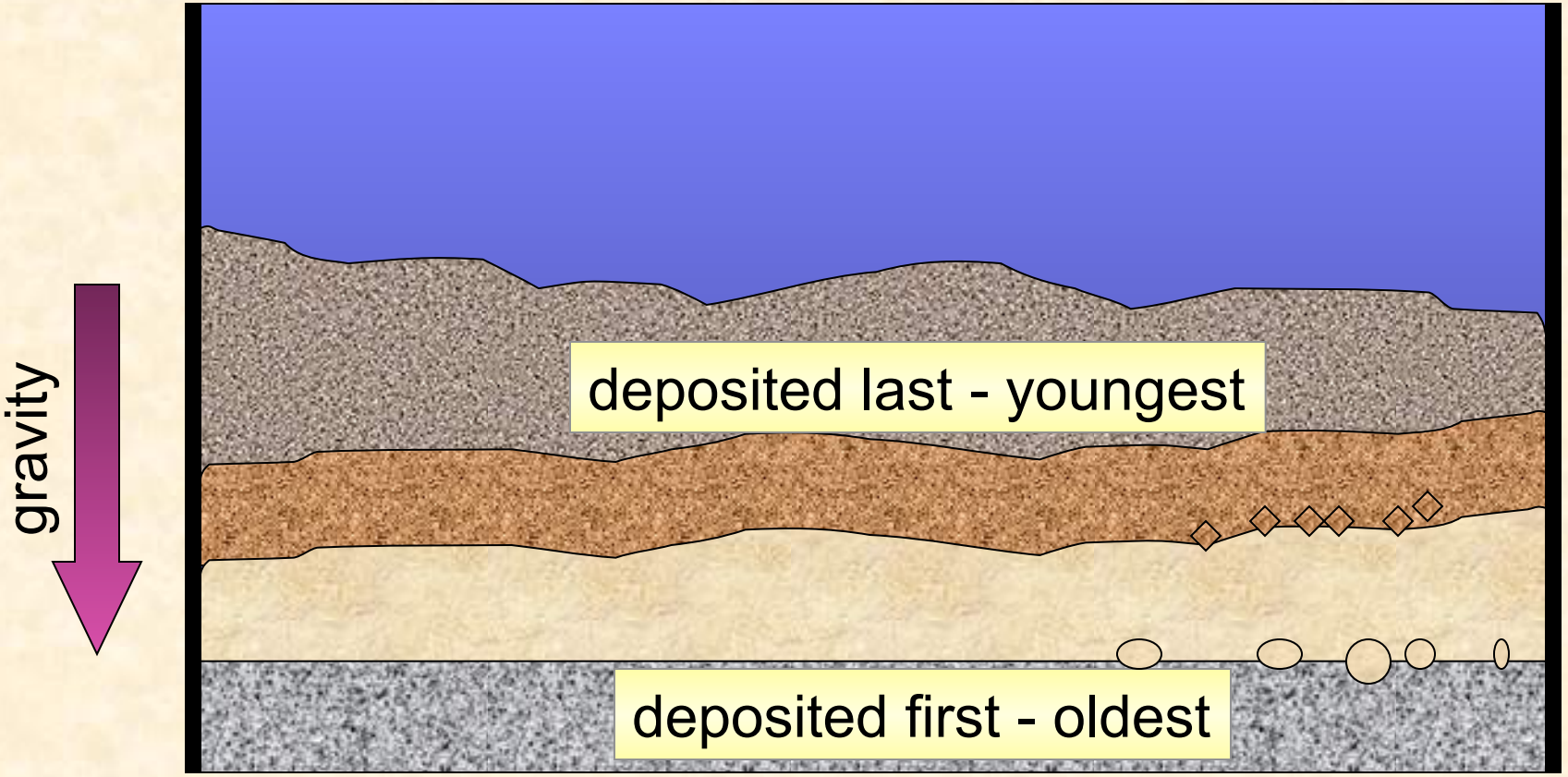
Formulated logical principles for determining the relative ages of rocks

http://www.rjsmith.com/san_juan_river.html

http://www.ucmp.berkeley.edu/history/steno.html

Principle of Original Horizontality

Sedimentary rocks were deposited in primarily horizontal beds



Principle of Superposition

In an undisturbed sedimentary sequence, the oldest rocks are on the bottom of the stack

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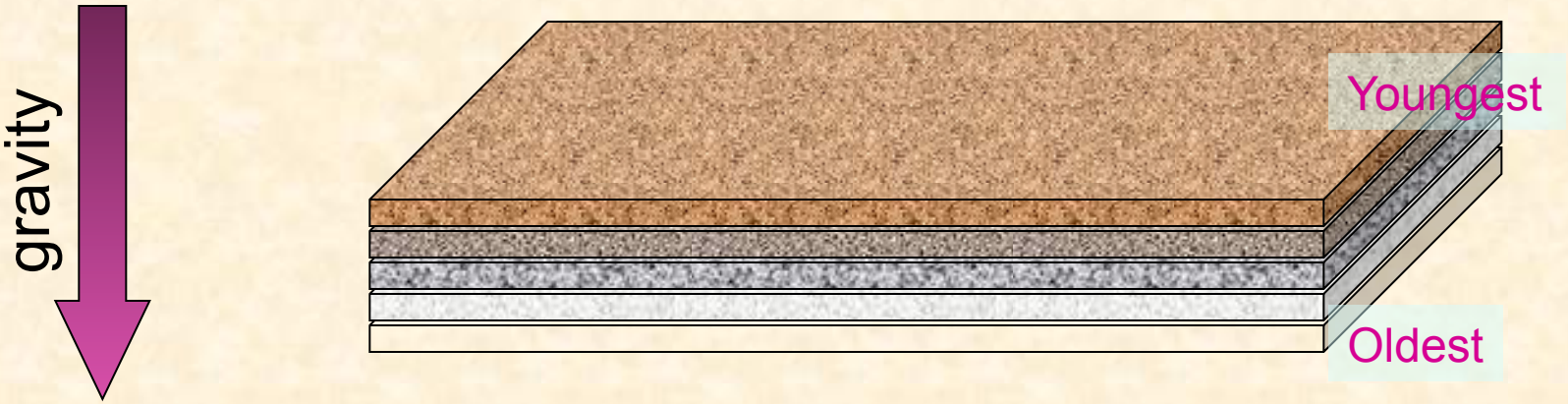
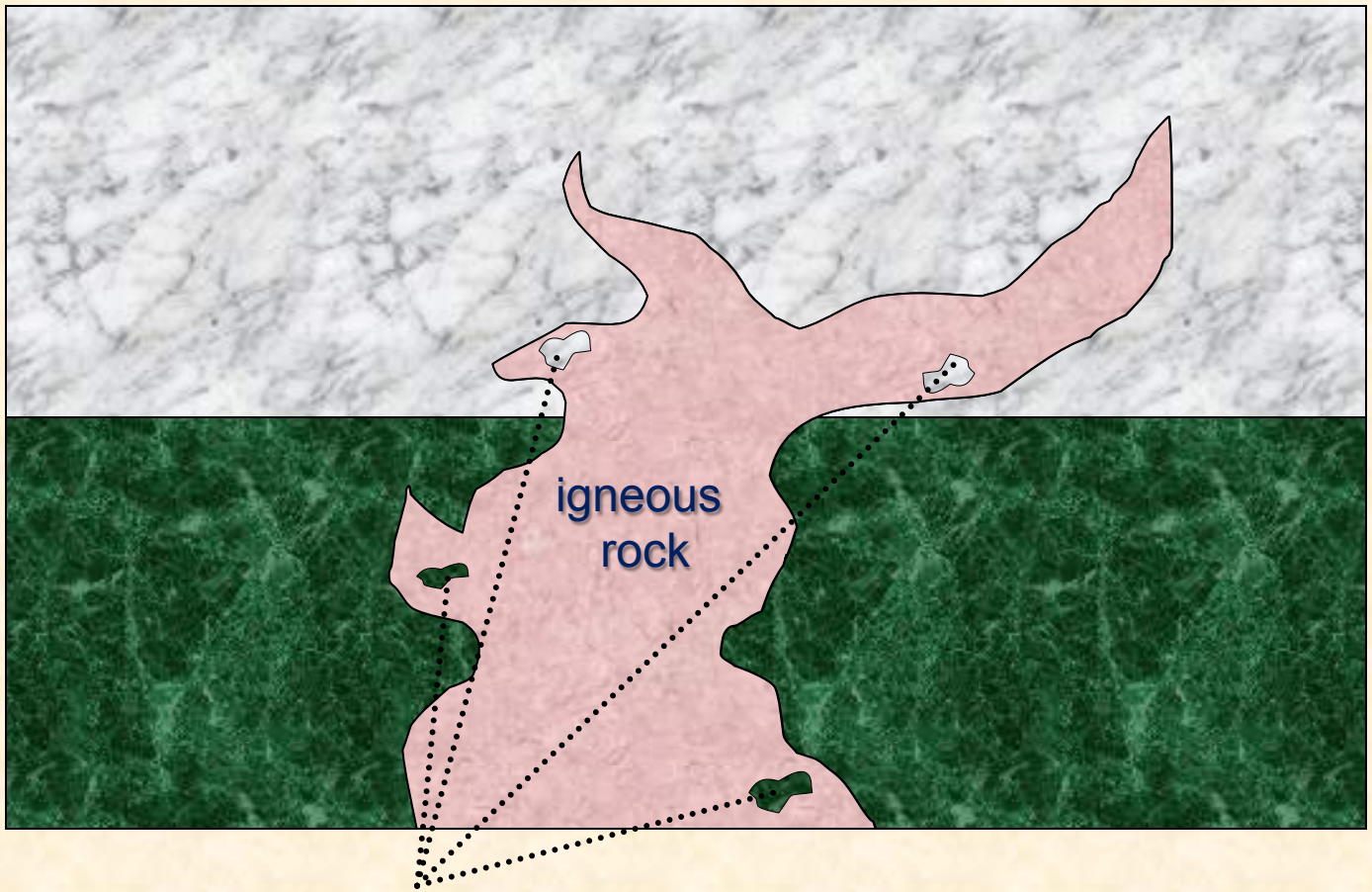


Principle of Inclusion

When clasts of one rock are found in another, the rock from which the clasts were derived is the older rock, since it must have already existed in order to be included in the new rock



Inclusions - pieces of older rock incorporated into younger rock

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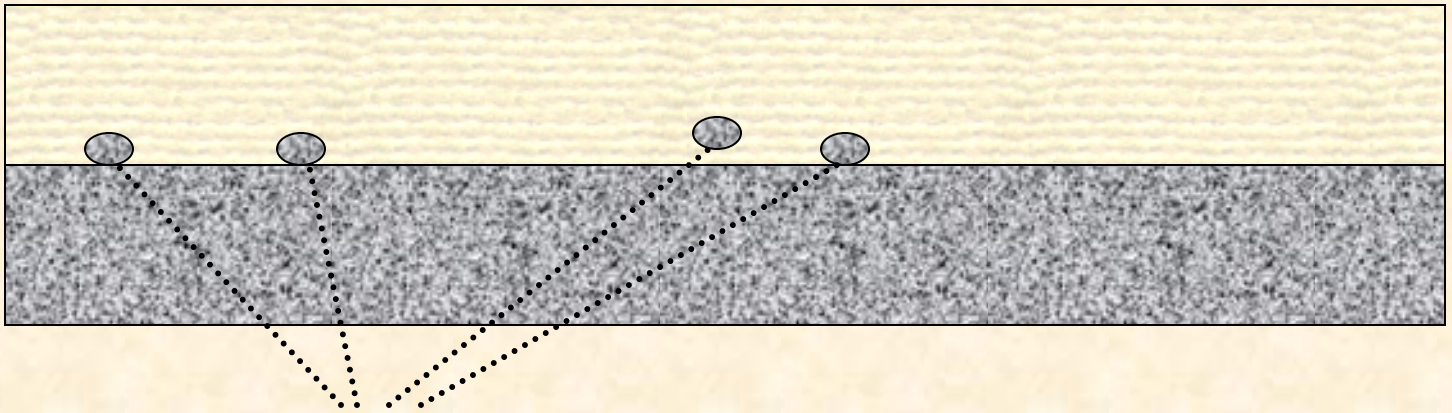
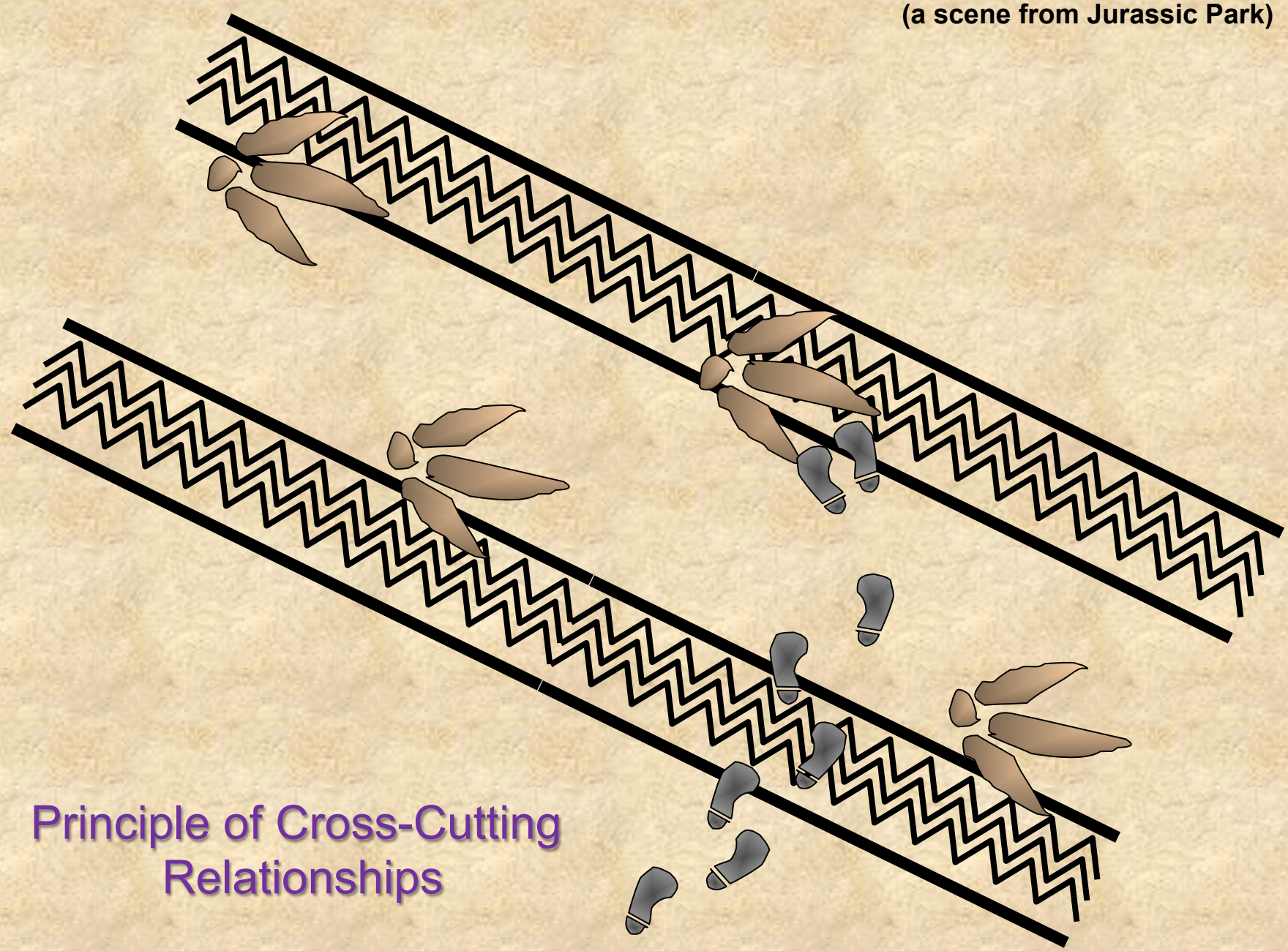


Inclusions - pieces of older rock (clasts) incorporated into younger rock

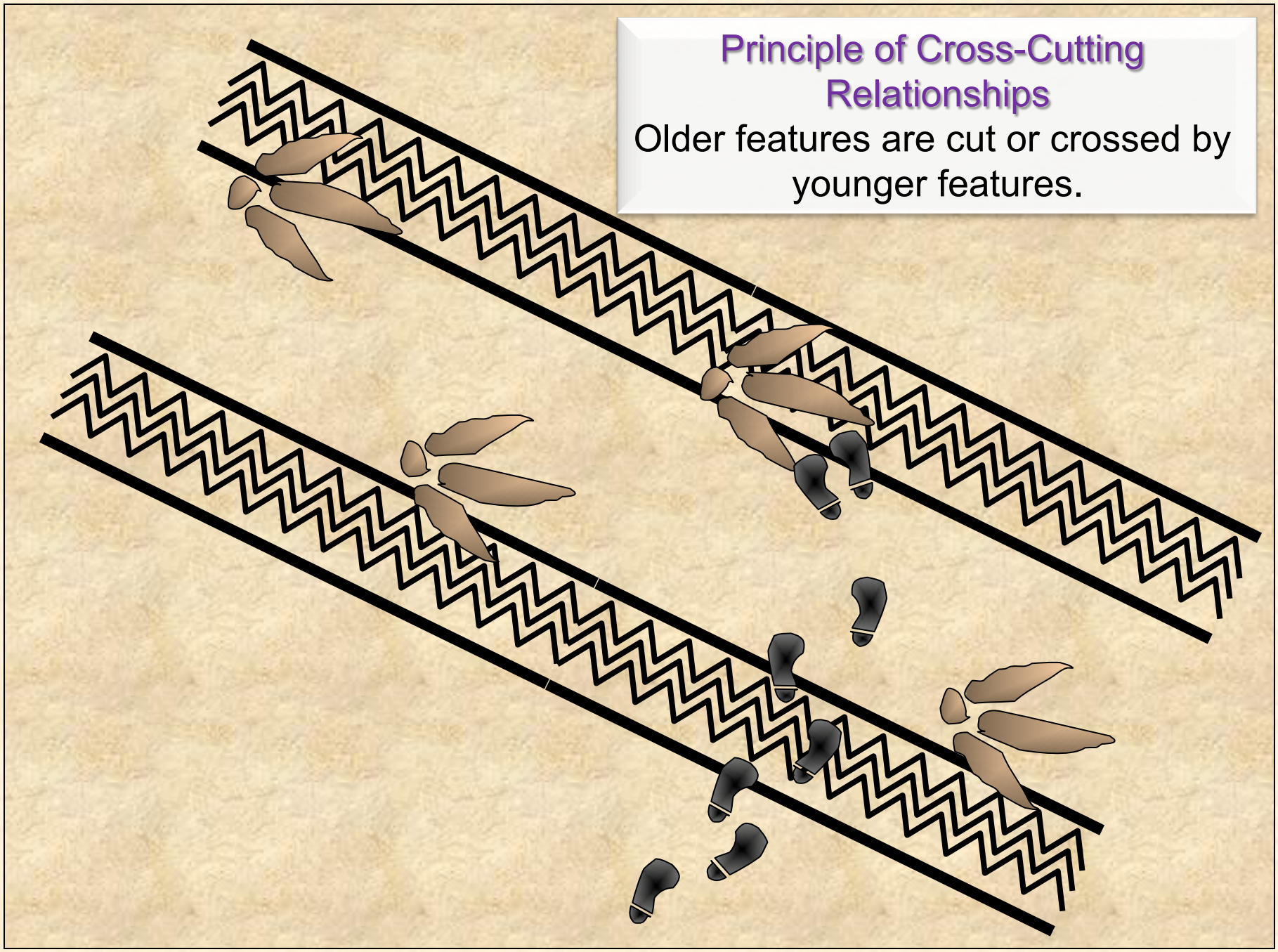
(a scene from Jurassic Park)



Principle of Cross-Cutting Relationships

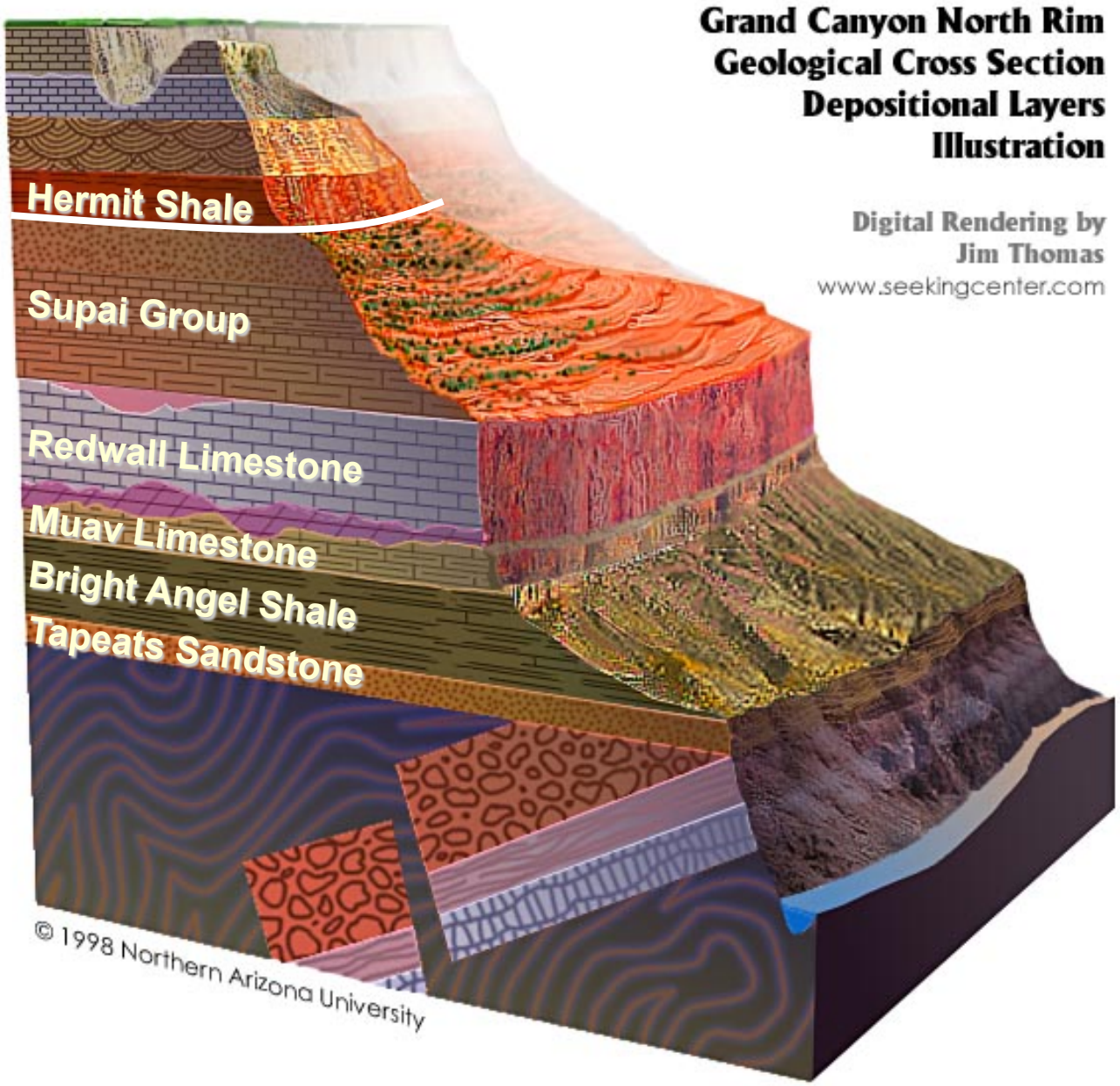
Principle of Cross-Cutting Relationships

Older features are cut or crossed by younger features.



Contact – surface separating two formations

Formation – bodies of rock with recognizable characteristic that are thick enough to map



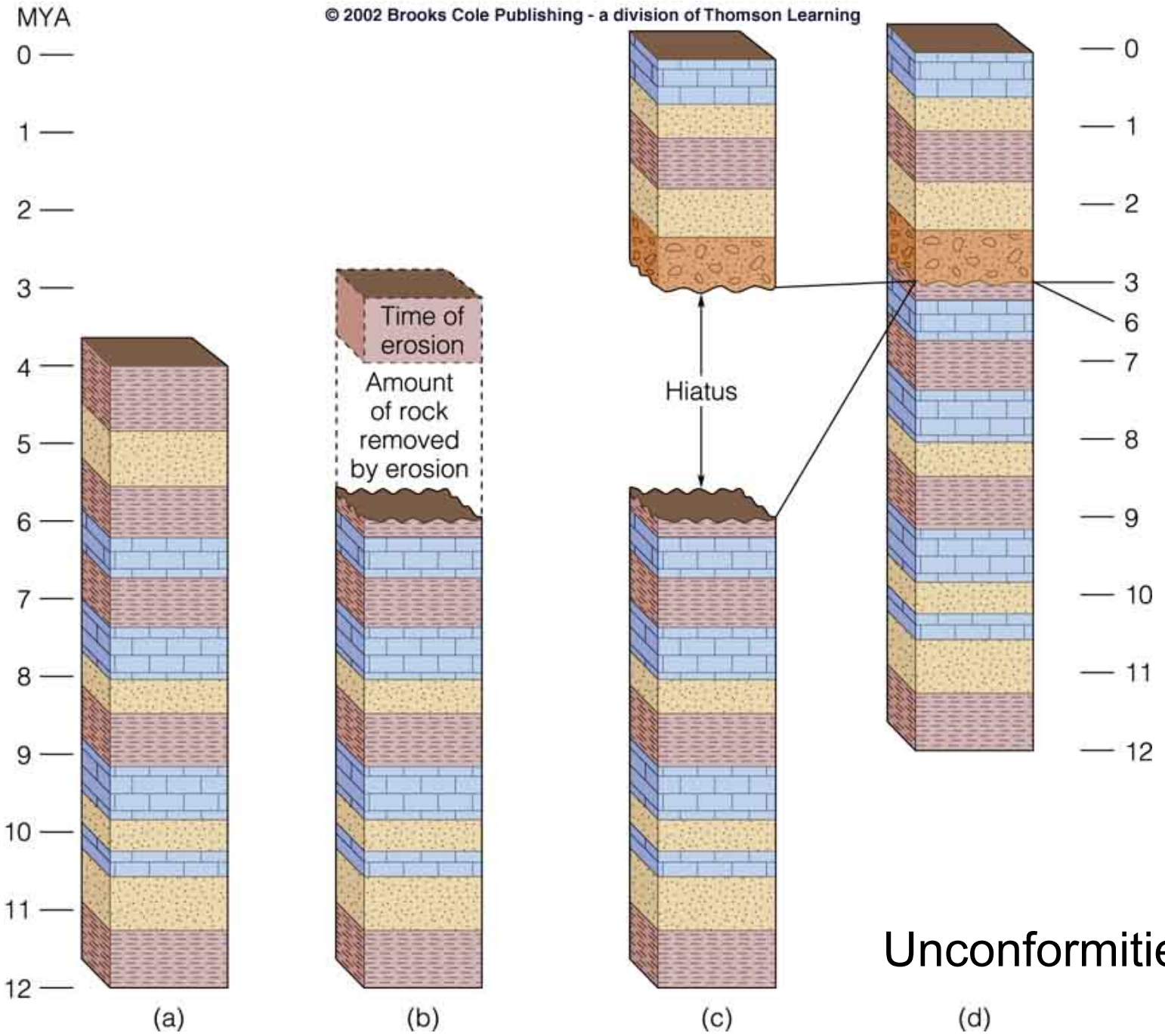
Reconstructing Geologic History

The geologic history of an area can be divided into times during which:

- Rock is being formed or altered
- Rock is being eroded

Periods of rock formation leave positive evidence of what geologic processes were in effect at the time of formation.

Periods of rock erosion leave unconformities.



Unconformities

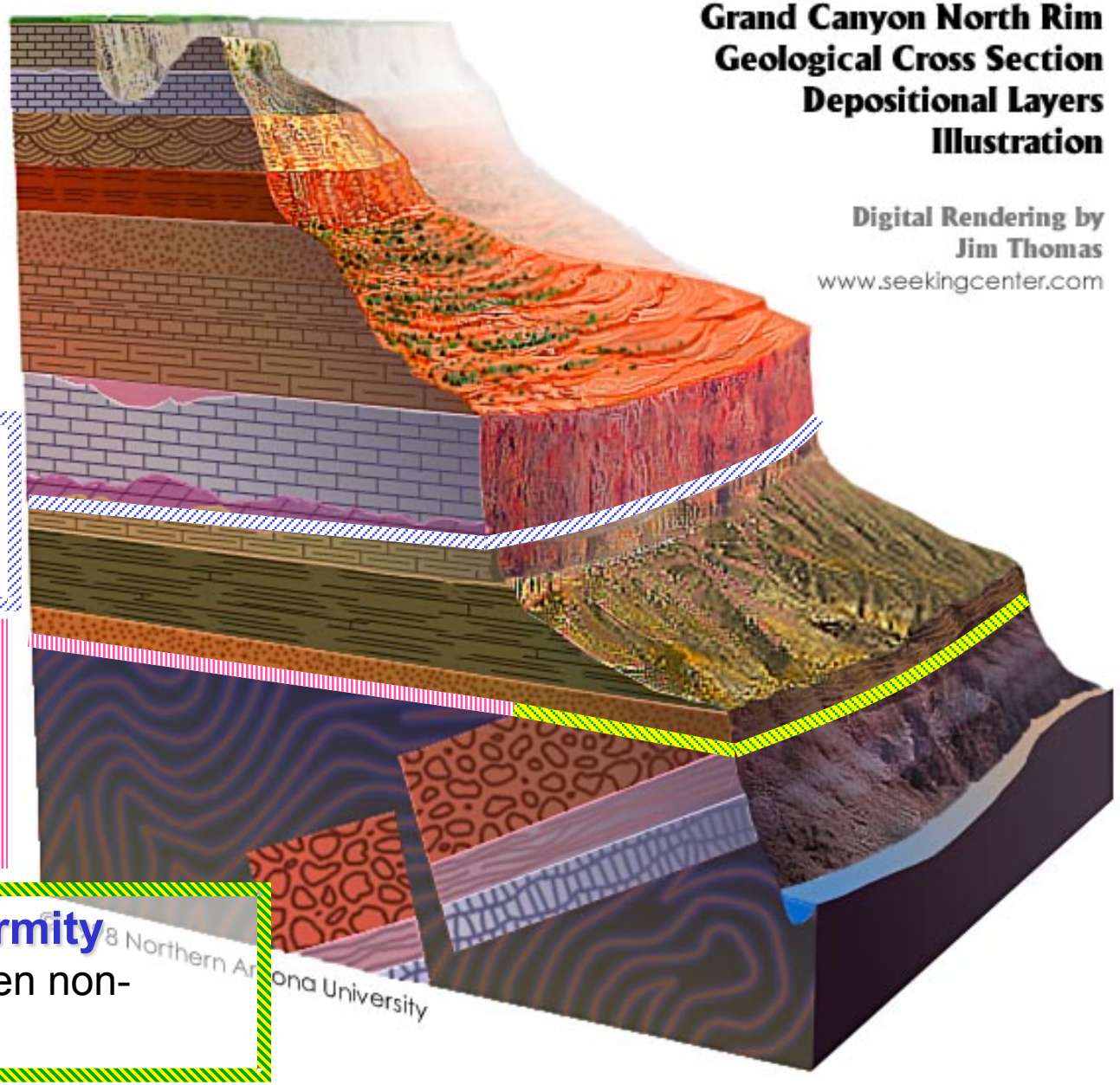
Reconstructing Geologic History

Unconformities represent missing time in the geological sequence, either due to no rock being formed or rock being removed.

There are three kinds of unconformities:

- disconformity – unconformity between parallel strata. Represents a time of non-deposition or erosion without deformation of strata.
- angular unconformity – unconformity between non-parallel strata. Strata were deformed as well as eroded (not necessarily at the same time)
- nonconformity – unconformity representing erosion of a non-sedimentary rock

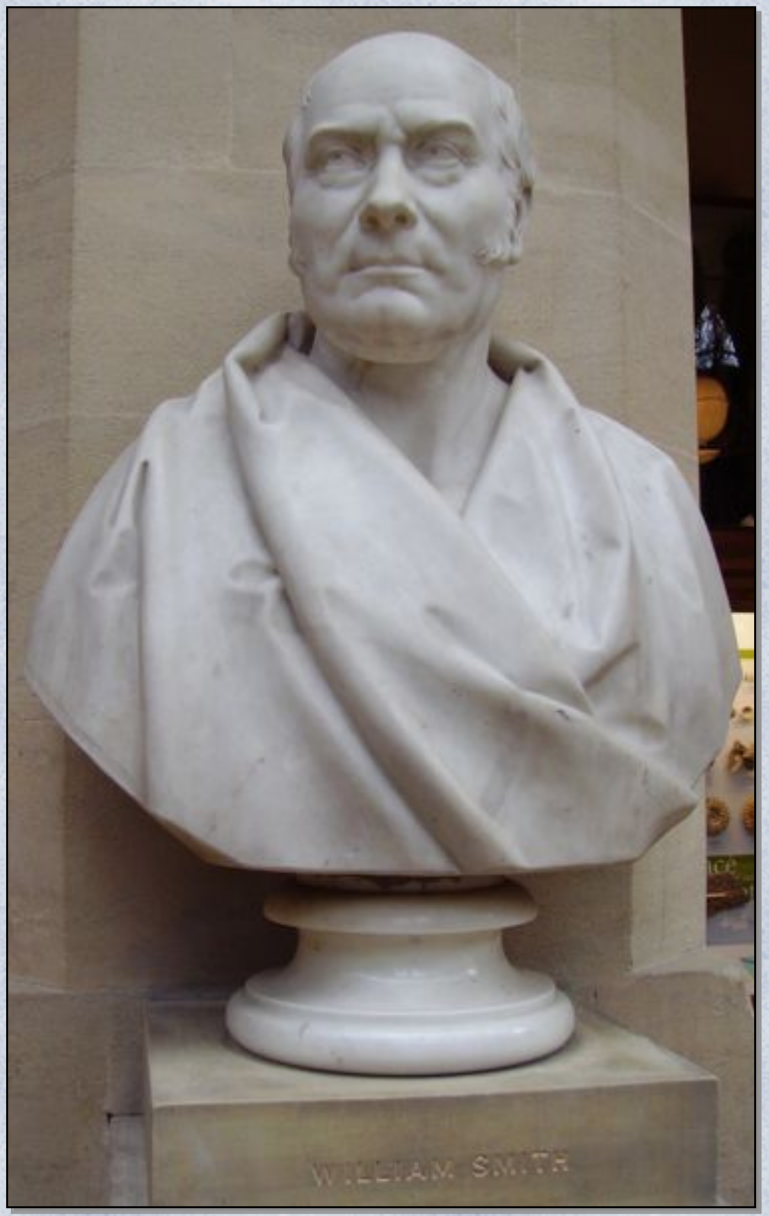
Reconstructing Geologic History



disconformity
unconformity between parallel strata.

nonconformity
unconformity between non-sedimentary and sedimentary rocks

angular unconformity
unconformity between non-parallel strata

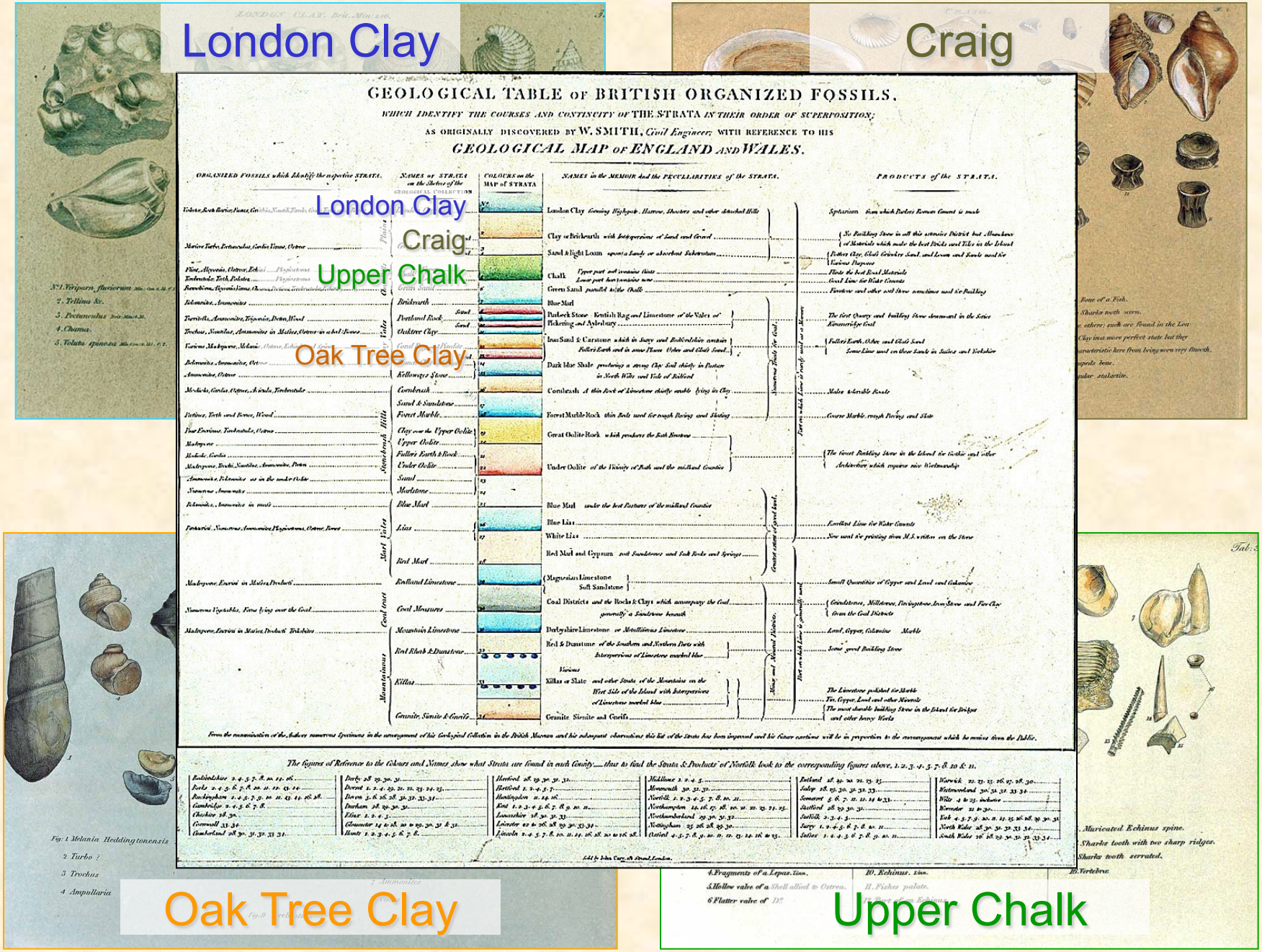


http://en.wikipedia.org/wiki/Image:William_Smith.JPG

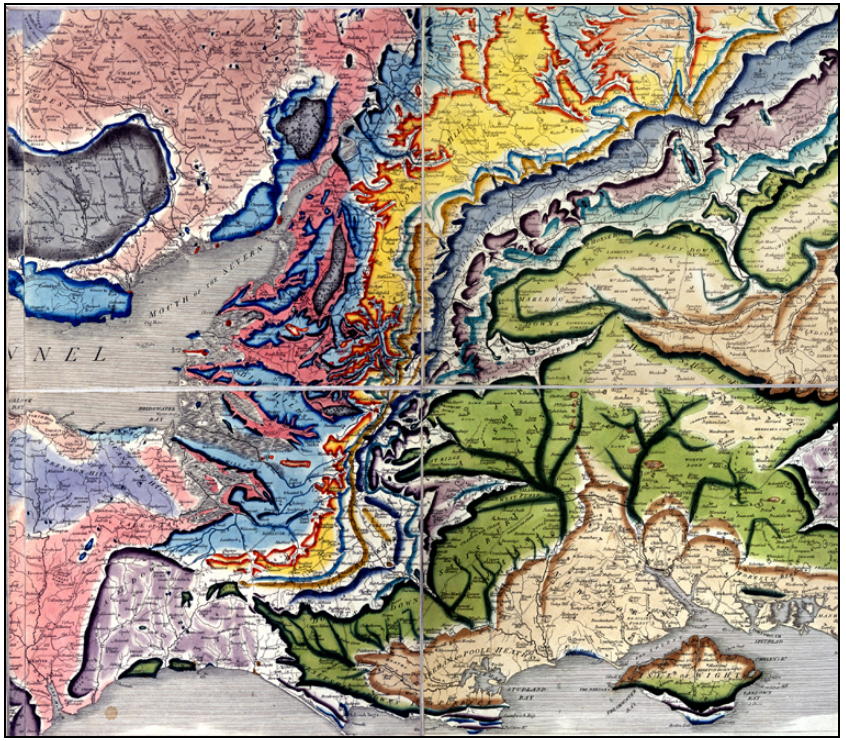
William “Strata” Smith
1769-1839

A trained surveyor with an avid interest in fossils, Smith suffered from rare condition for naturalist of his time - lowly birth. He worked in both the coal industry and supervised the digging of the Somerset Canal in England, but still spent time in debtors’ prison.

Smith formulated the *Principle of Faunal Succession*, which he then used to draft the first modern geologic map, which serves as a model to the present day.


London Clay
Craig
GEOLOGICAL TABLE OF BRITISH ORGANIZED FOSSILS.
WHICH IDENTIFY THE COURSES AND CONTINUITY OF THE STRATA IN THEIR ORDER OF SUPERPOSITION;
AS ORIGINALLY DISCOVERED BY W. SMITH, Civil Engineer; WITH REFERENCE TO HIS
GEOLOGICAL MAP OF ENGLAND AND WALES.
ORGANIZED FOSSILS which Identify the respective STRATA.
NAMES of STRATA on the Sheets of the GEOLOGICAL COLLECTION
COLOURS on the MAP of STRATA
NAMES in the MEMOIR and the PECULIARITIES of the STRATA.
PRODUCTS of the STRATA.
London Clay
Craig
Upper Chalk
Oak Tree Clay
Oak Tree Clay
Upper Chalk
http://www.unh.edu/esci/wmsmith.html

William Smith's geologic map of England, Wales ,and Scotland.



http://www.unh.edu/esci/wmsmith.html

Biostratigraphy

More Recent

Time

More Ancient

X

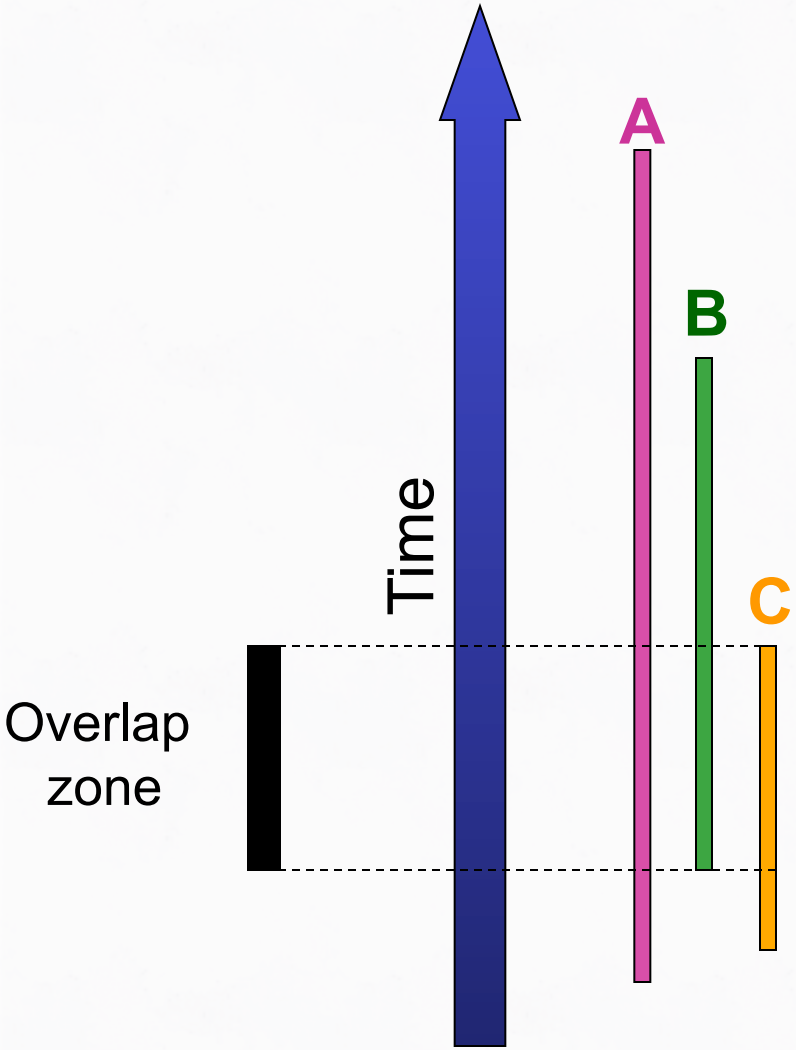
O

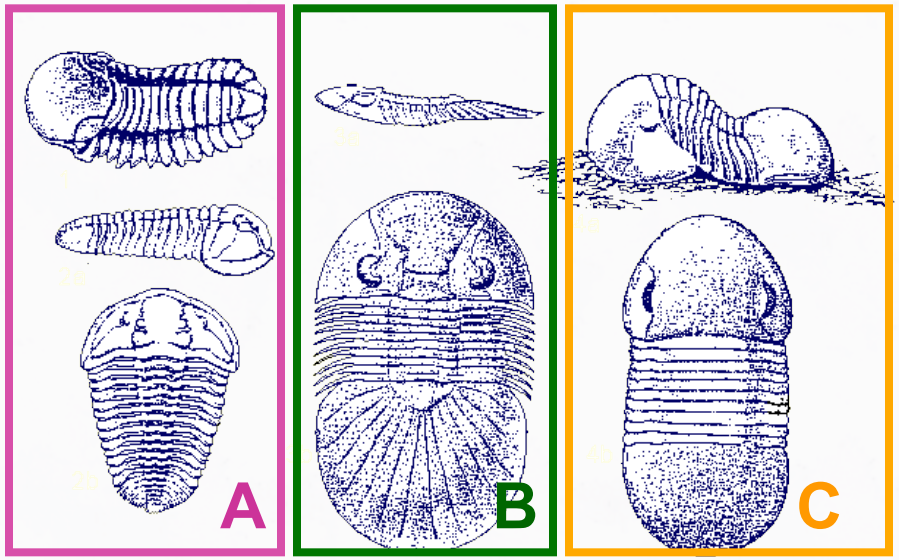
Extinction *- last appearance of species in fossil record*

Fossil A

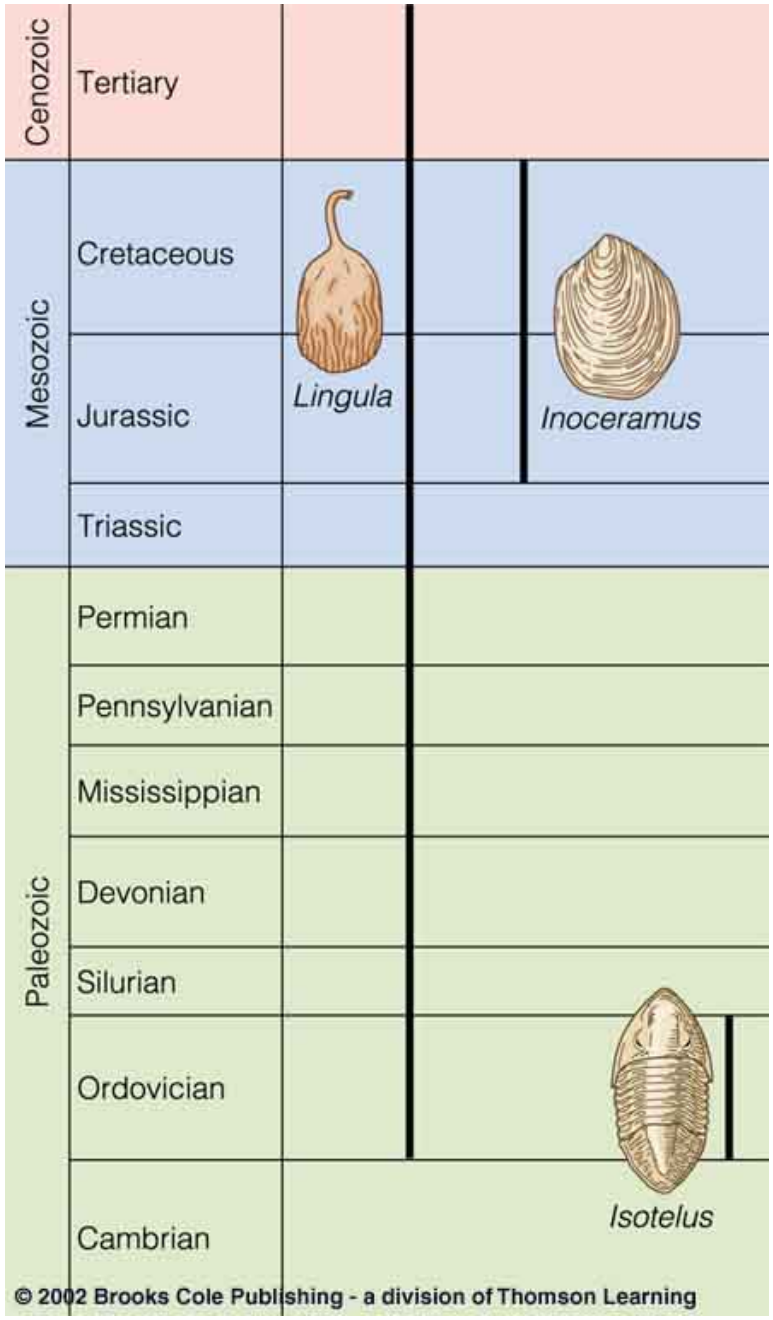
Origination *- evolution of species*

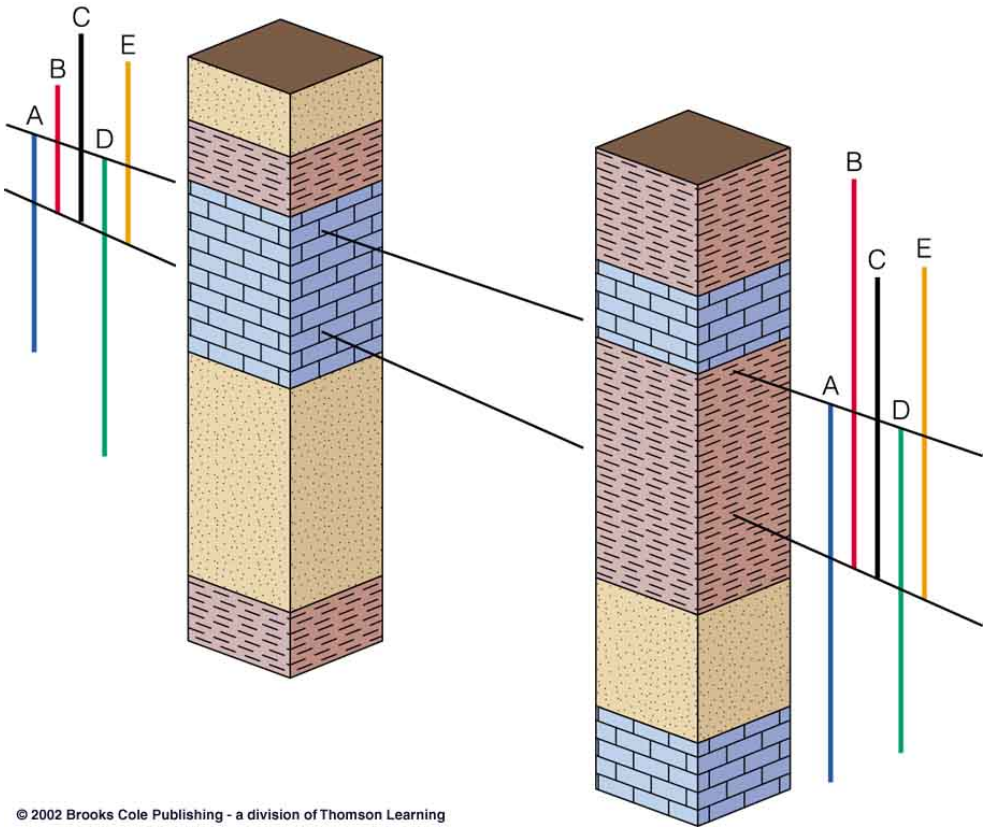
Biostratigraphy

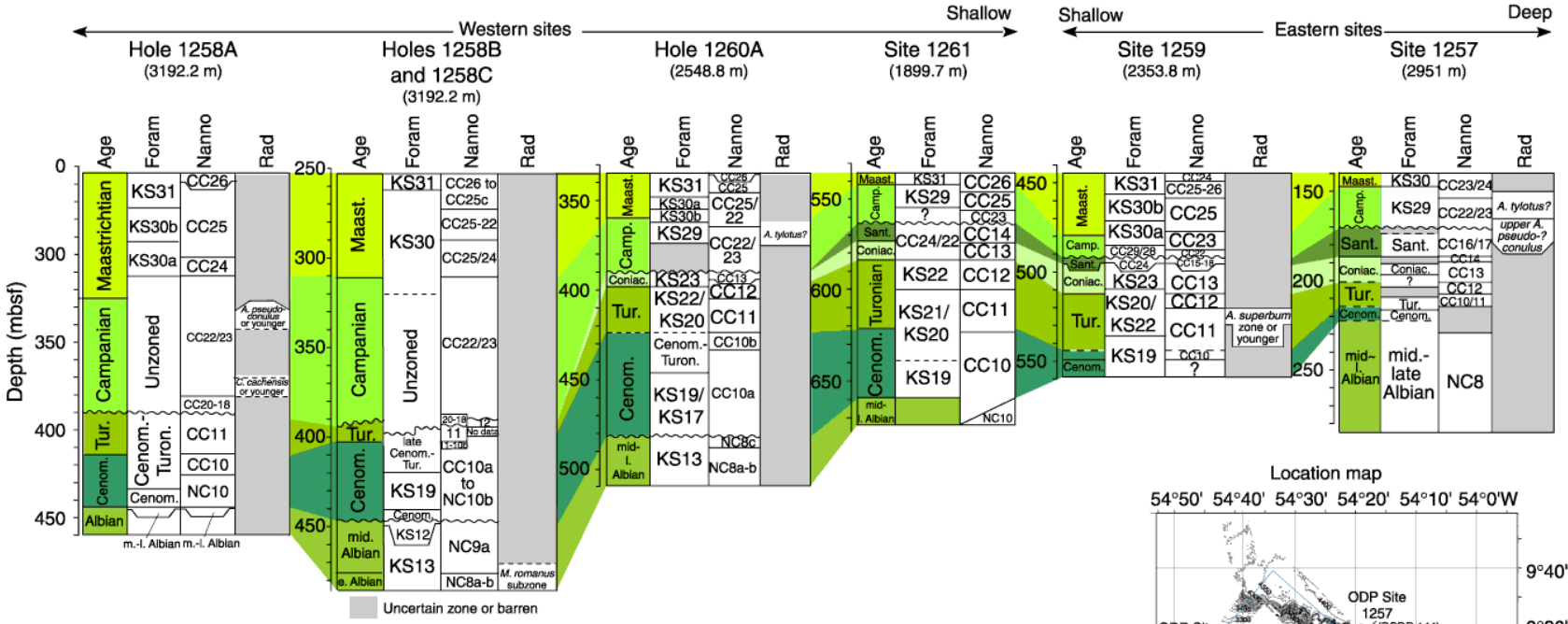


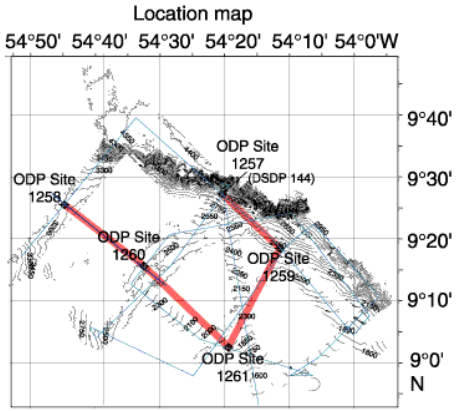


Biostratigraphy



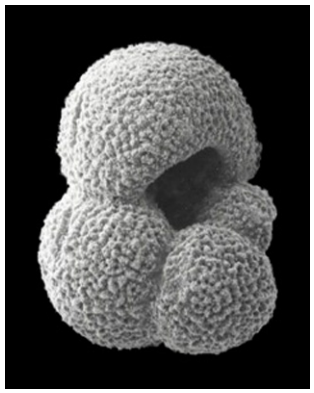


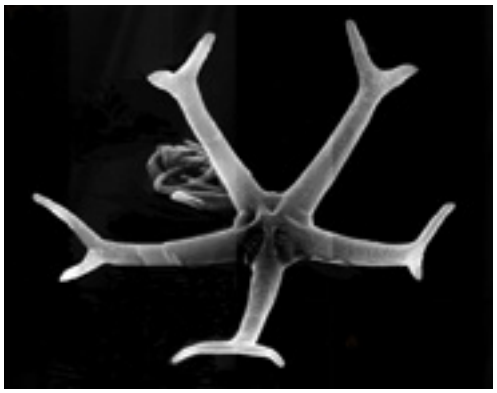


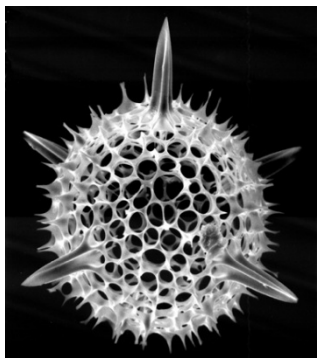


Biostratigraphy for several wells off the coast of Suriname, South America.

Correlation based on foraminifera, calcareous nannofossils and radiolarians.

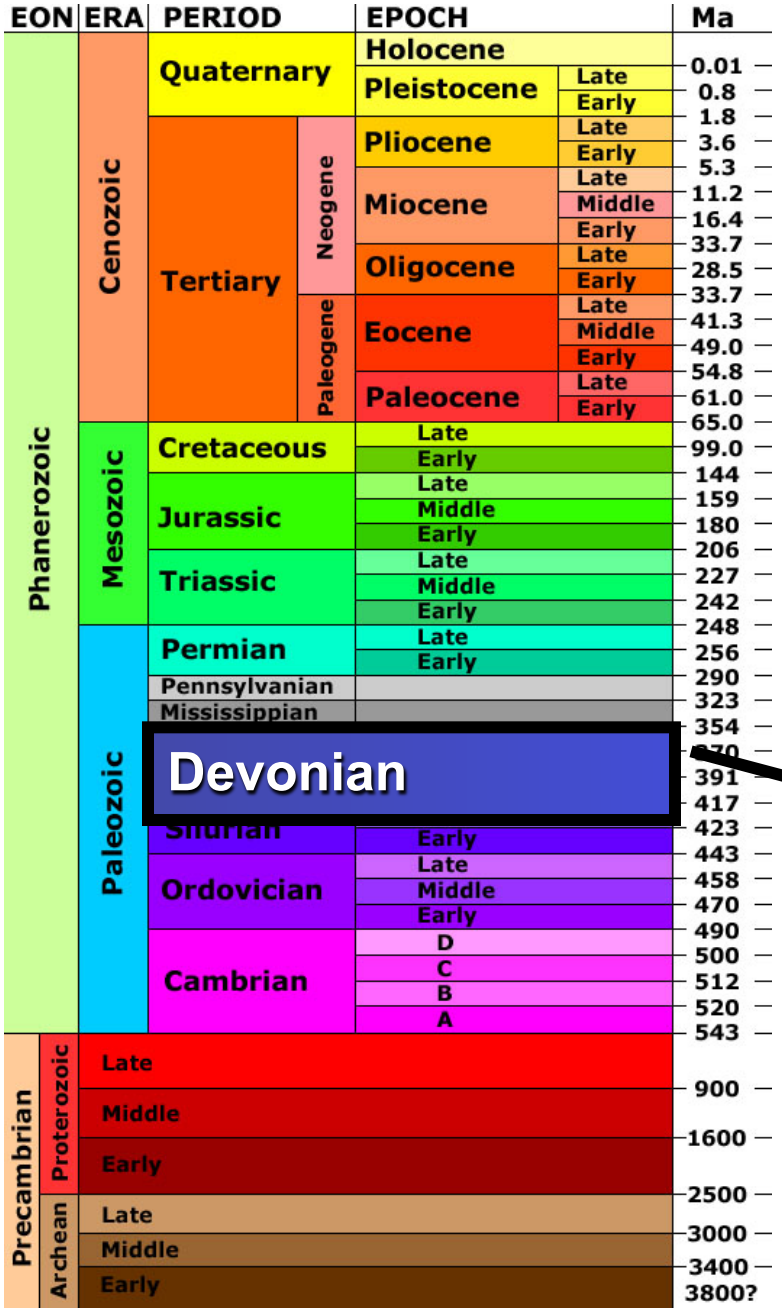






http://www-odp.tamu.edu/

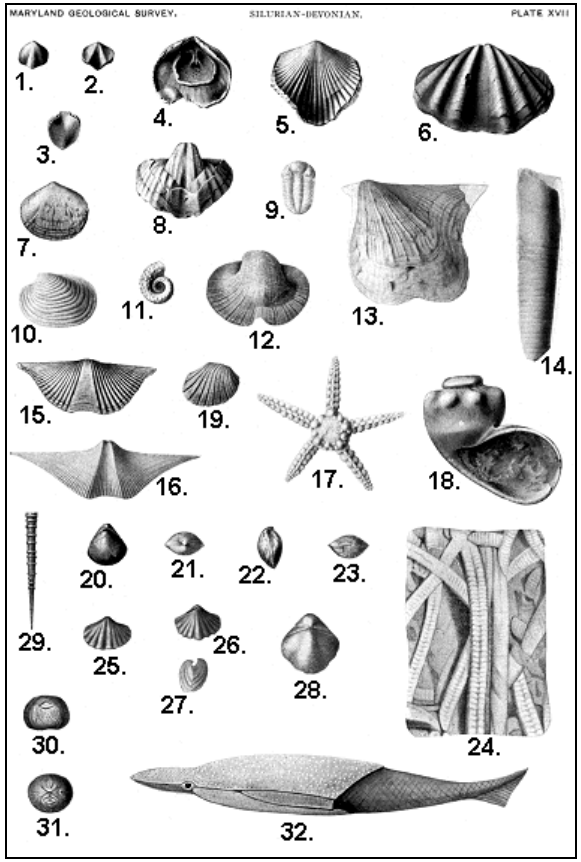
Geologic Time Scale



http://3dparks.wr.usgs.gov/coloradoplateau/images/timescale.jpg

http://pubs.usgs.gov/gip/geotime/

Devonian Life



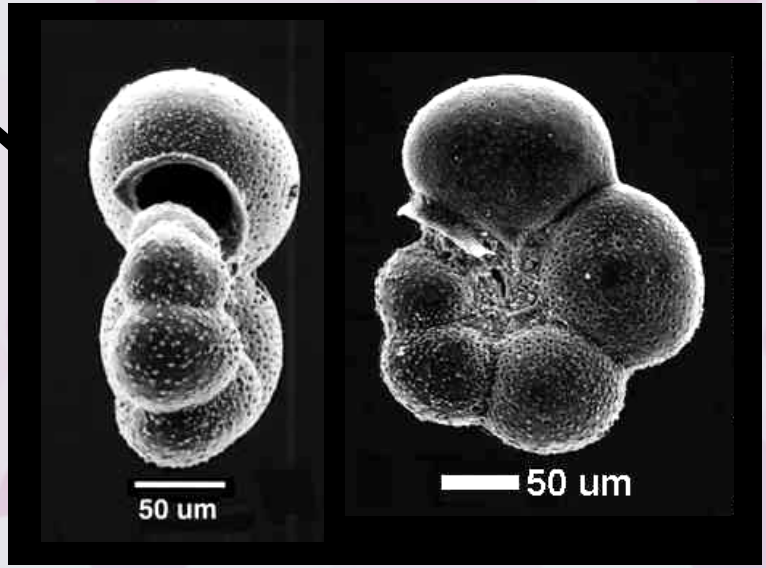
http://www.mgs.md.gov/esic/brochures/fossils/devofos.html

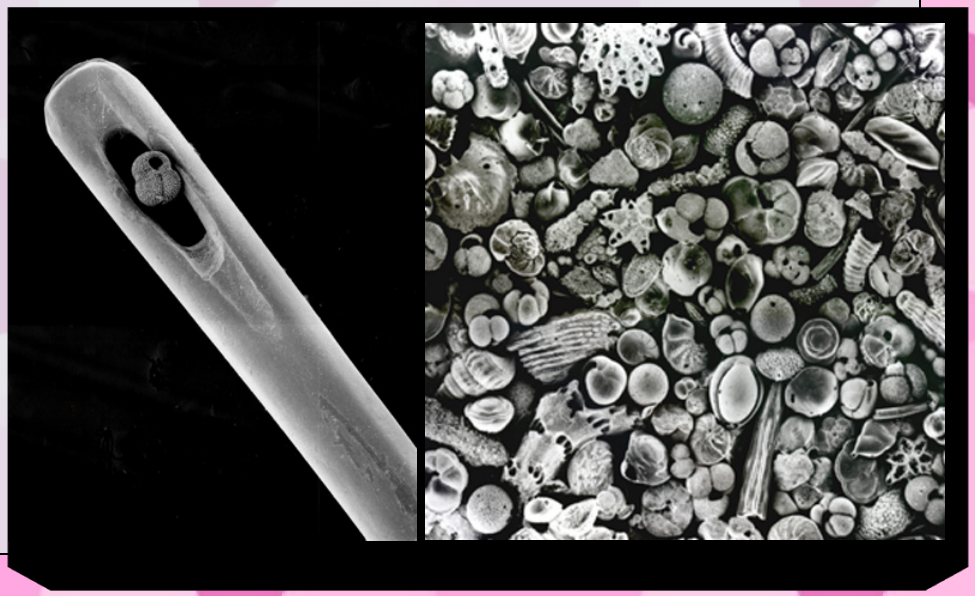
http://paleoprep.com/

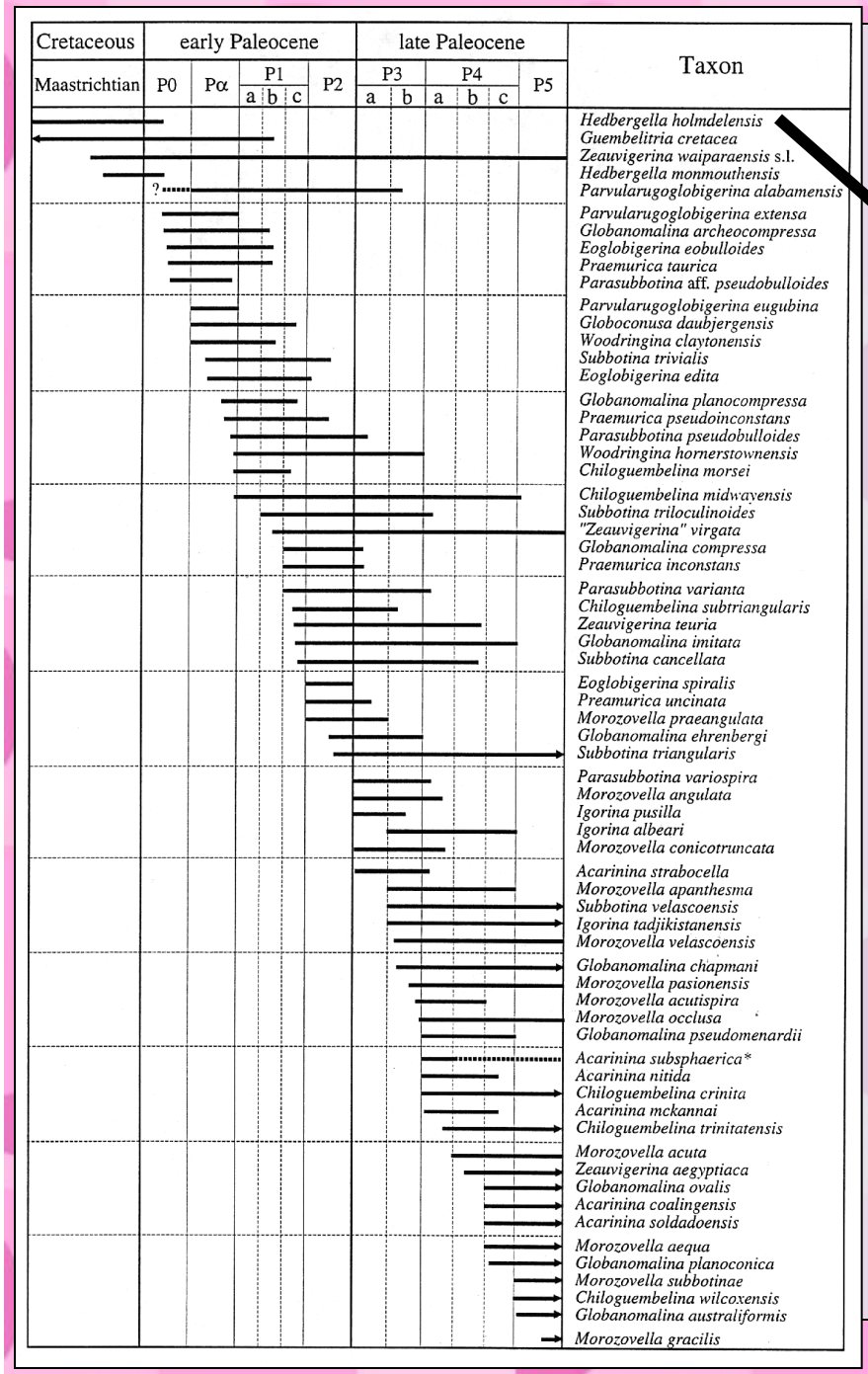
Pleistocene

Molluscan Assemblage

Foraminifera



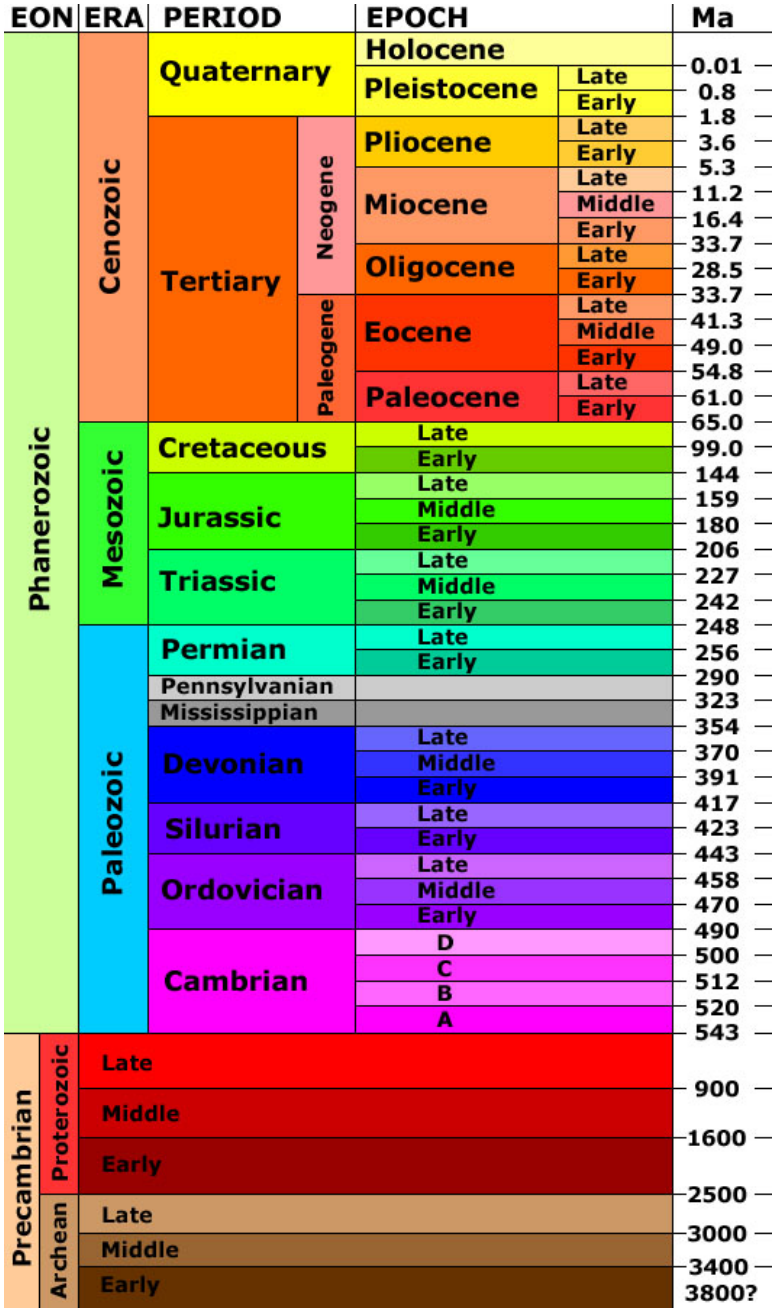




http://services.chronos.org/foramatlas/pages/rcfo.htm

http://www.ucmp.berkeley.edu/people/klf/MicroGallery.htm

Geologic Time Scale



The Geologic Time Scale subdivides the history of the Earth based on biostratigraphy and other dating techniques into:

4 Eons (Hadean, Archean, Proterozoic, Phanerozoic), each of which contains

Eras (e.g., Paleozoic, Mesozoic, Cenozoic) which are further subdivided into

Periods (e.g., Triassic, Jurassic and Cretaceous), Epochs and smaller time divisions

http://3dparks.wr.usgs.gov/coloradoplateau/images/timescale.jpg