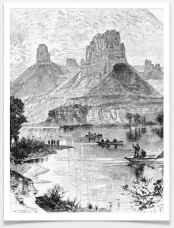
Geologic Time

The Fourth Dimension



1

Geologic Time

- Relative Geologic Time
- Absolute Geologic Time

2

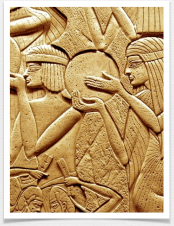
Relative Geologic Time

3

The Language of Time

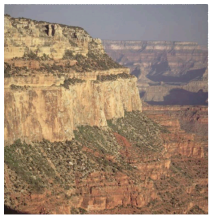
If we are going to unravel the story of the earth's history, we need to understand the languages in which that history is written.

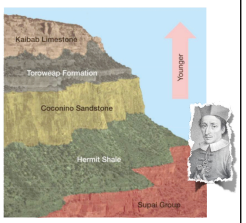
Just as if we want to reconstruct Egyptian history we need to understand Egyptian written language, their architectural styles (architectural 'language') and so on.



4

Steno (1660s) - Law of Superposition





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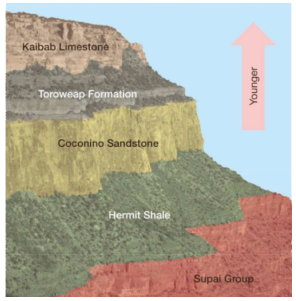

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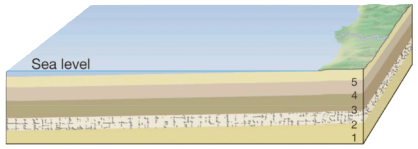
Steno (1660s) - Law of Original Horizontality

7



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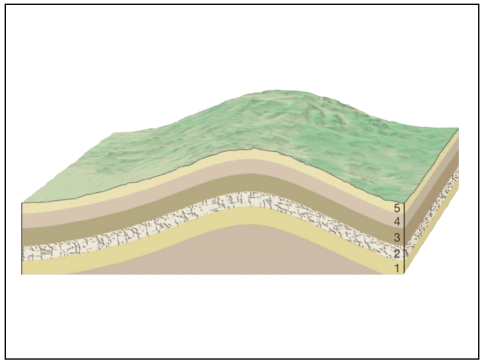
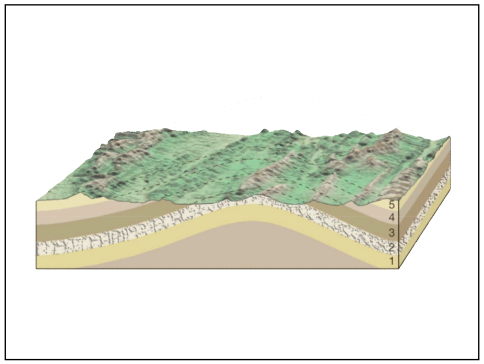

5
4
3
2
1

9


5
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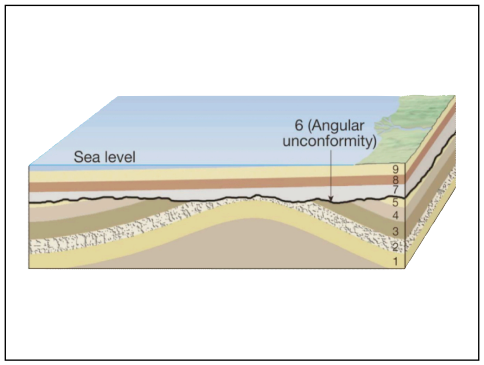
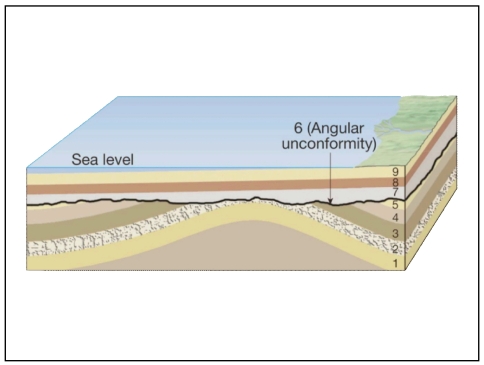

6 (Angular
unconformity)
Sea level
9
8
7
5
4
3
2
1

11

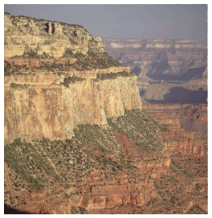

6 (Angular
unconformity)
Sea level
9
8
7
5
4
3
2
1

12

Erosional
Unconformities

13

14



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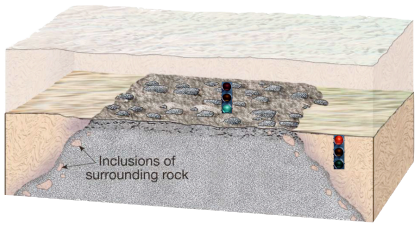

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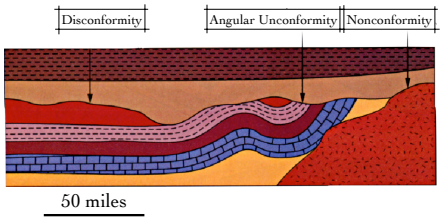

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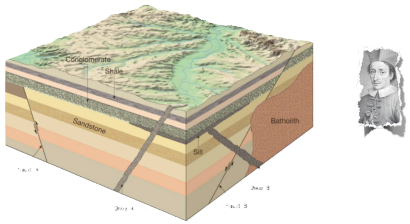
Steno - Law of Cross-Cutting Relationships



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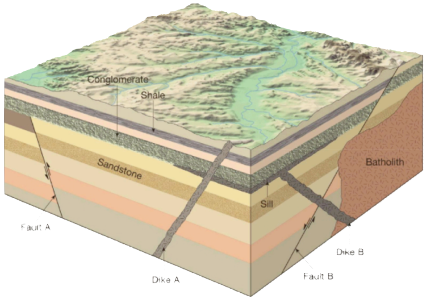
Geologic History



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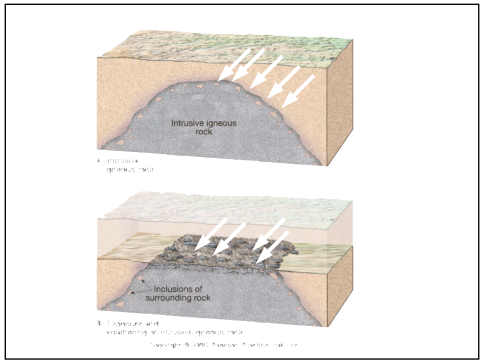
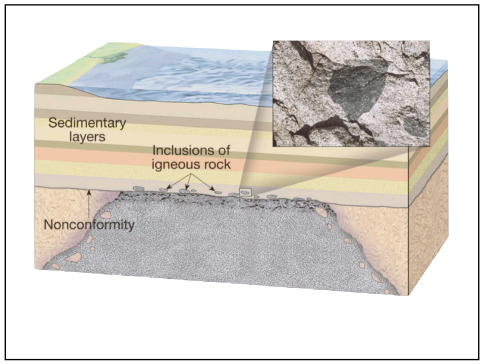
Law of Included Fragments

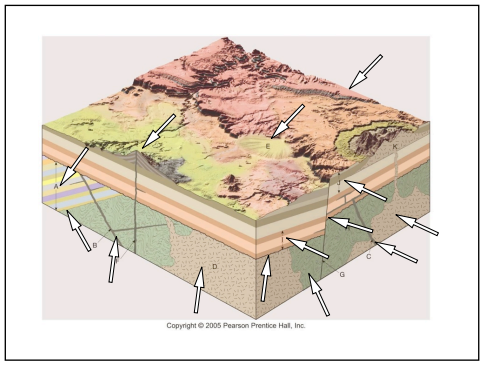
20


Intrusive igneous rock
Inclusions of surrounding rock

21


Sedimentary layers
Inclusions of igneous rock
Nonconformity

22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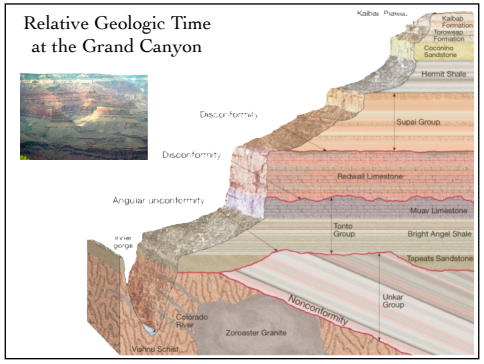
Relative Geologic Time at the Grand Canyon
Kaibab Plateau
Kaibab Formation
Toroweap Formation
Coconino Sandstone
Hermit Shale
Supai Group
Disconformity
Disconformity
Redwall Limestone
Angular unconformity
Muav Limestone
Tonto Group
Bright Angel Shale
Inner gorge
Tapeats Sandstone
Unkar Group
Nonconformity
Colorado River
Zoroaster Granite
Vishnu Schist

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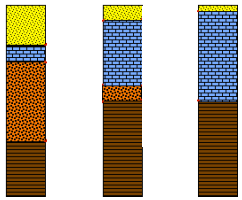
Correlation



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PROBLEM!!!

We now have a bunch of 'tools' for working out the relative geologic time event sequence for rocks in one area. But, what do we do if we want to work out relative geologic time over a large area, such as a state, a continent or the entire earth?

We need a relative geologic tool that will work across the entire world!!!!

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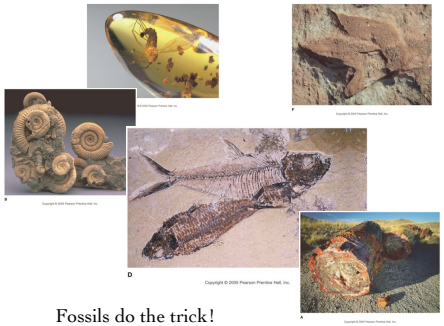

Fossils do the trick!

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Fossil

The remains of a formerly living organism. This can be a skeleton or even the tracks of trails that an animal can make.

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William 'Strata' Smith (ca. 1800)

29

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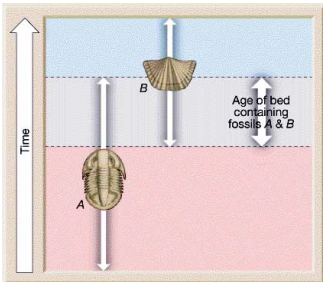

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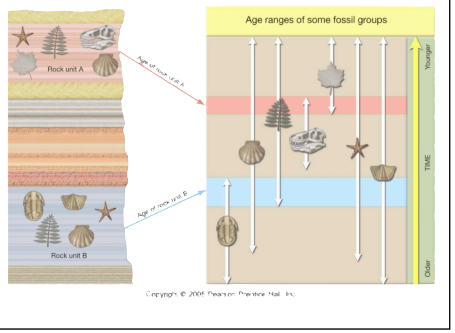

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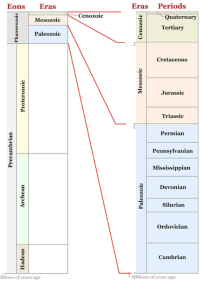
Geologic Time Scale



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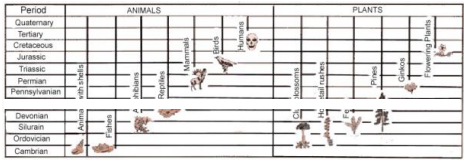

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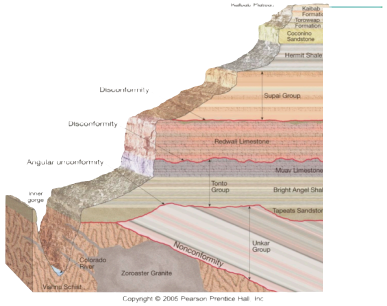

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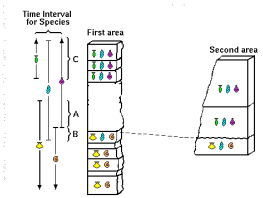
Correlation



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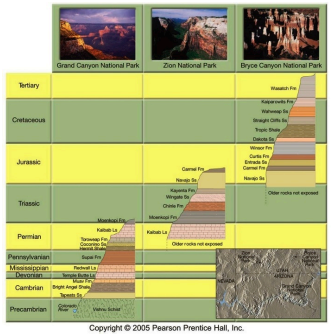

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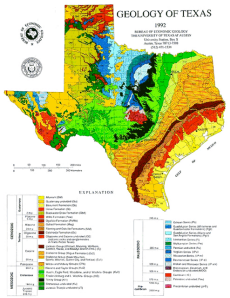

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If we are interested in unraveling the history of the earth we have part of our puzzle solved - we can work out sequences of local events and then correlate those events around the world.

But we STILL cannot say exactly when those events occurred - 1,000 years ago? a million? a billion?

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Absolute Geologic Time

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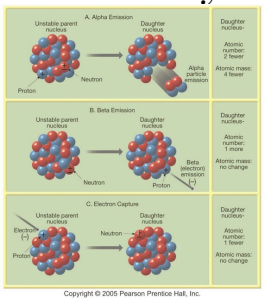
Radioactivity



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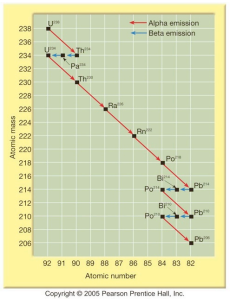

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Half-life	Parent	Daughter
0	100%	0%
1	50%	50%
2	25%	75%
3	12.5%	87.5%
4	6.25%	95.75%

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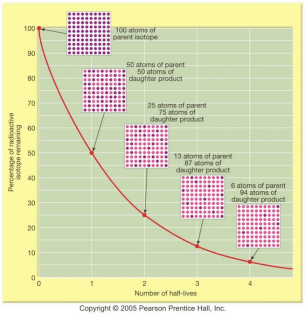
Radioactive Decay and Half-Lives



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There are many radioactive isotopes with long half-lives that are useful for radiometric dating.

Luckily almost any igneous rock contains several of those isotopes - each of which decays on its own path.

So most igneous rocks have the equivalent of 2 or more geologic clocks in them!

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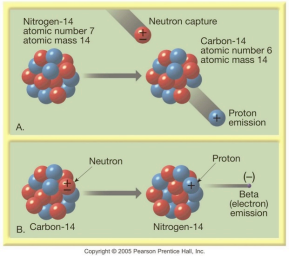
Since different isotopes have different half-lives they are useful for measuring different spans of time.



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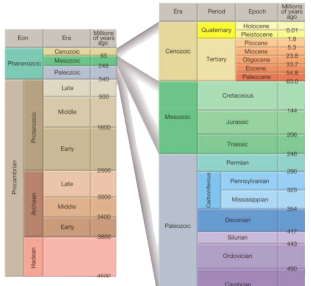

Geologic Time Scale with Dates

Names are based on fossil distributions and most were defined prior to 1860!

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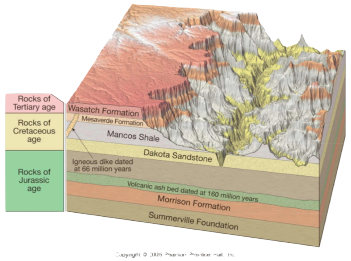
We can date sedimentary rocks by looking for igneous rocks that are associated with them.



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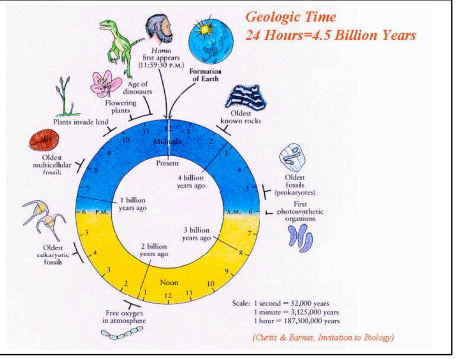

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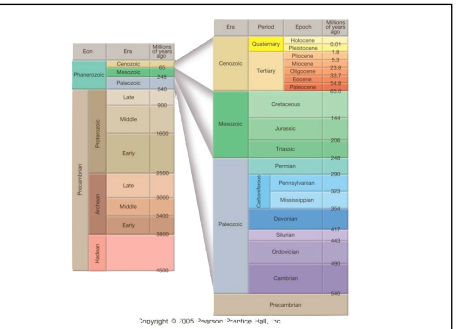

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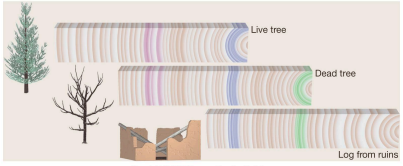
Dendrochronology

Absolute ages for the last few thousand years.



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Next Lecture

Mass Wasting