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**Quiz Four** (9:30-9:35 AM)

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UNIVERSITY OF SOUTH ALABAMA

# GY 112: Earth History

## Fossils Part 1:

### Telling Time

Instructor: Dr. Douglas W. Haywick

# Last Time

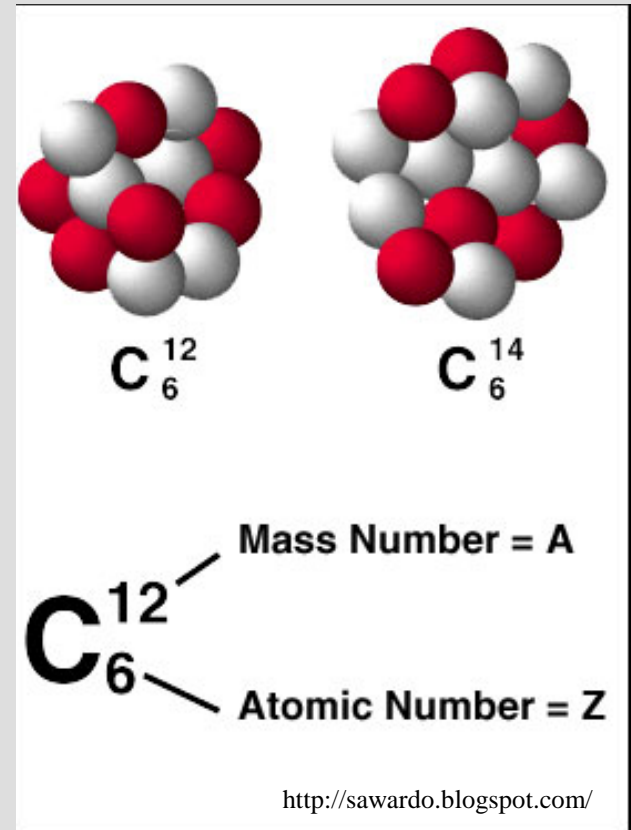
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- A) Stable isotopes of use to geology (fractionation)
- B) Delta values and isotopic standards
- C) Delta Oxygen applications (sea level change)

Web notes: 8a

# Isotopes

Elements with the same number of protons, but different numbers of neutrons



# Stable Isotope Geochemistry

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**Fractionation:** The ratio of stable isotopes in a substance before and after the process.

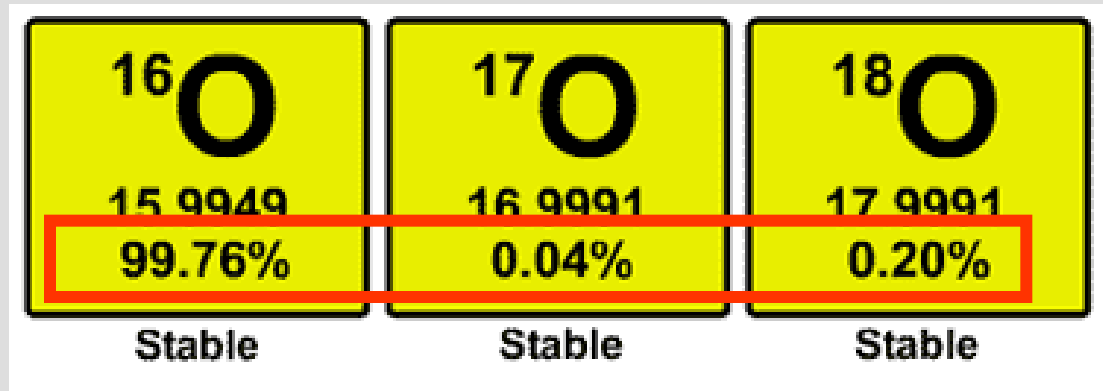
The amount of fractionation is expressed via the fractionation factor ( $\alpha$ ):

$$\alpha = \frac{\text{H}^2/\text{H}^1 \text{ (cloud)}}{\text{H}^2/\text{H}^1 \text{ (water)}}$$

# Stable Isotope Geochemistry

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There is a minor problem with this type of analysis. The abundance of  $^{18}\text{O}$  to  $^{16}\text{O}$  is very low, and the amount of fractionation is minute (but still measurable).....



<http://www.sahra.arizona.edu/programs/isotopes/images/oxygen.gif>

... but the resulting data are really, really, really small numbers (and this is annoying!)

# Stable Isotope Geochemistry

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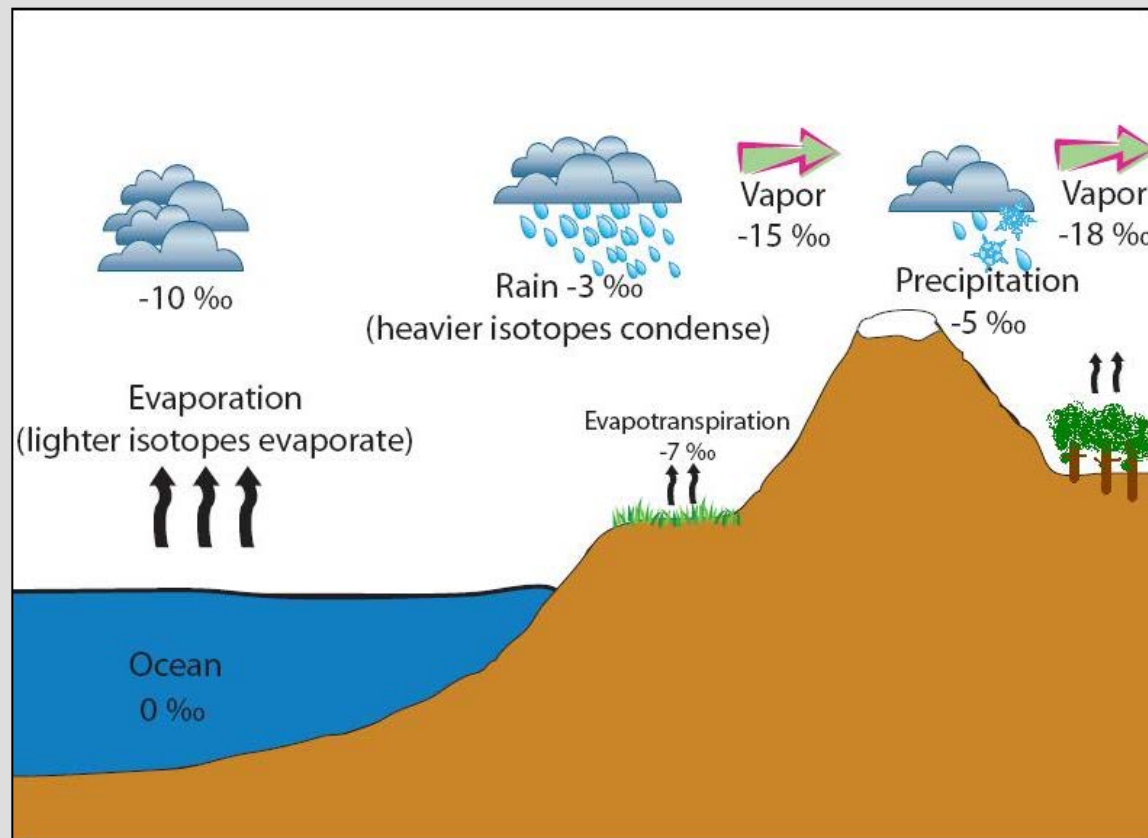
Isotopic data are usually presented using the **delta value** ( $\delta$ )

$$\delta^{18}\text{O} = \left[ \frac{\text{O}^{18}/\text{O}^{16}_{\text{(sample)}} - \text{O}^{18}/\text{O}^{16}_{\text{(standard)}}}{\text{O}^{18}/\text{O}^{16}_{\text{(standard)}}} \right] \times 1000$$

and are reported in parts per thousand (ppt or ‰)

# Stable Isotope Geochemistry

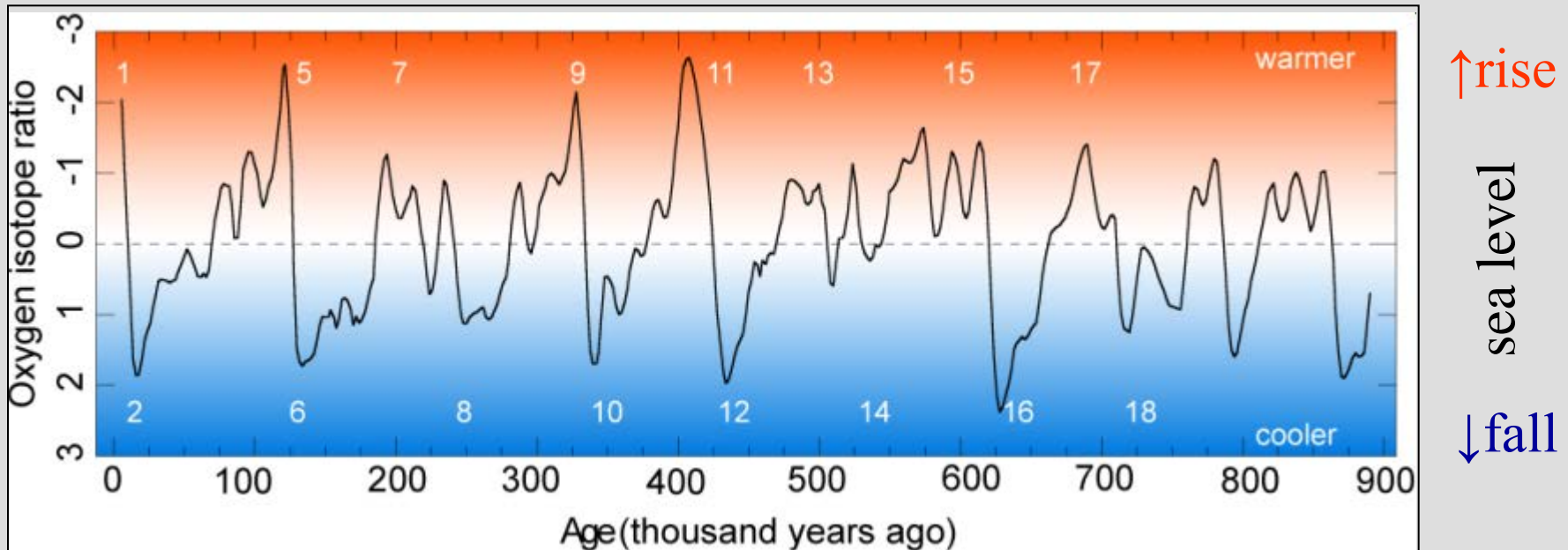
## Isotopic fractionation of oxygen in the hydrologic cycle





# Eustatic Sea level Rise

Stable isotopes provide information about world wide (eustatic) sea level change



# Today's Agenda

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1. Chronostratigraphy versus biostratigraphy
2. Paleontological correlations
3. Index fossils

Web notes: 9

# Fossils & Time

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## Types of Stratigraphy

# Fossils & Time

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Lithostratigraphy: using rocks to correlate

# Fossils & Time

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## Types of Stratigraphy

Lithostratigraphy: using rocks to correlate

Chronostratigraphy: actual dates to correlate  
(absolute dating)

# Fossils & Time

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## Types of Stratigraphy

Lithostratigraphy: using rocks to correlate

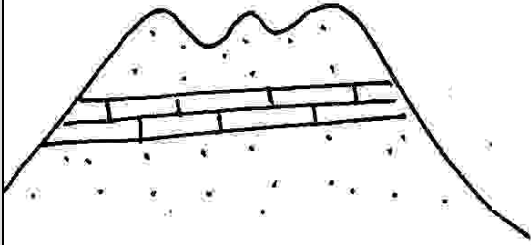
Chronostratigraphy: actual dates to correlate  
(absolute dating)

Biostratigraphy: using fossils to establish dates and correlate (relative dating)

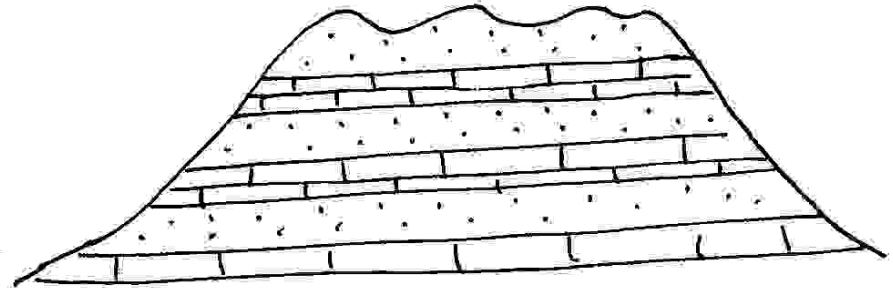
# Lithostratigraphy

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Mountain 1

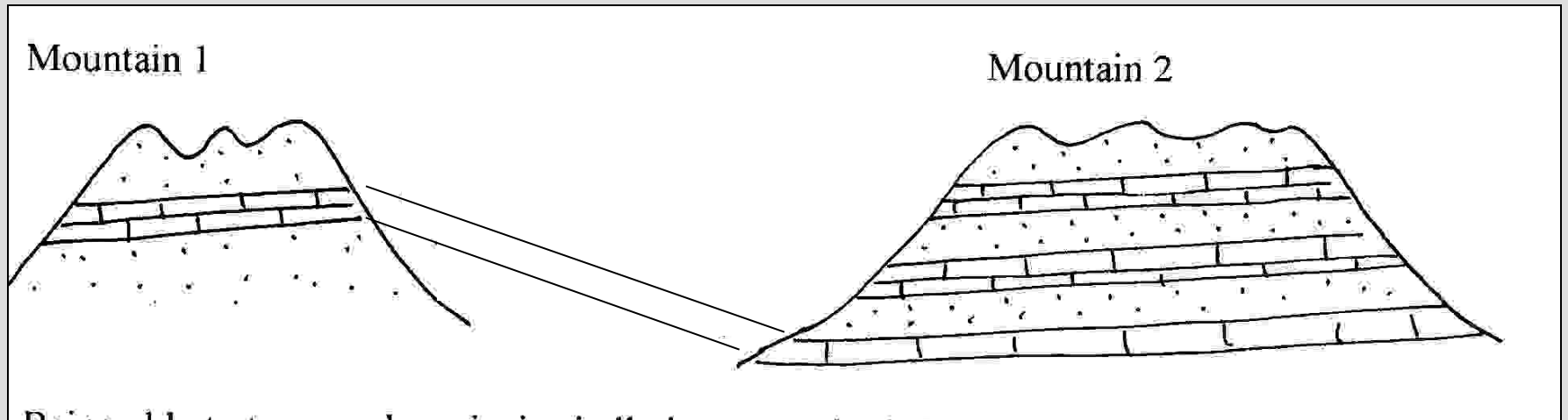


Mountain 2



# Lithostratigraphy

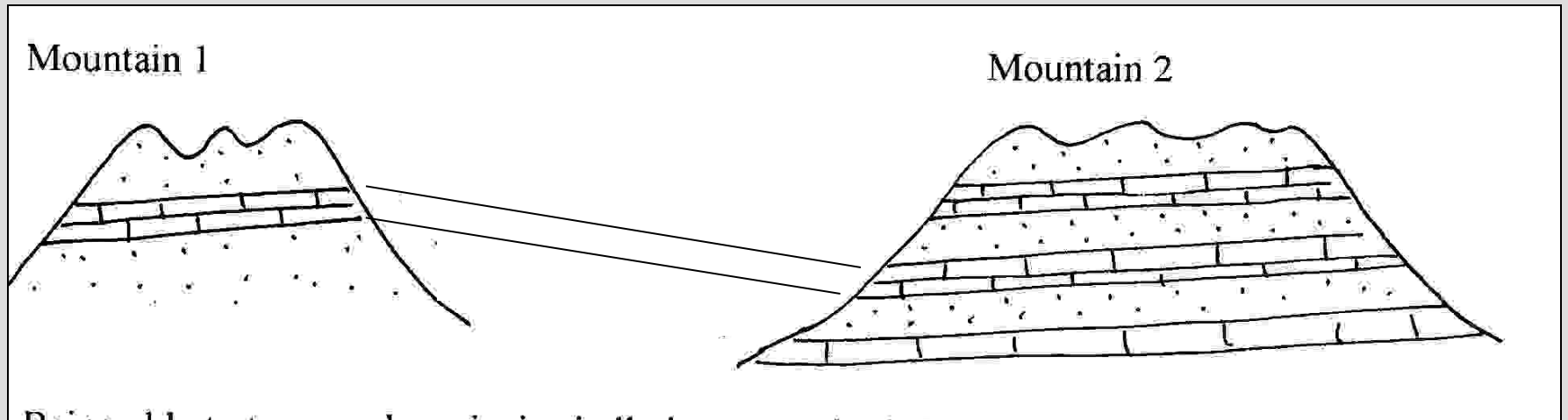
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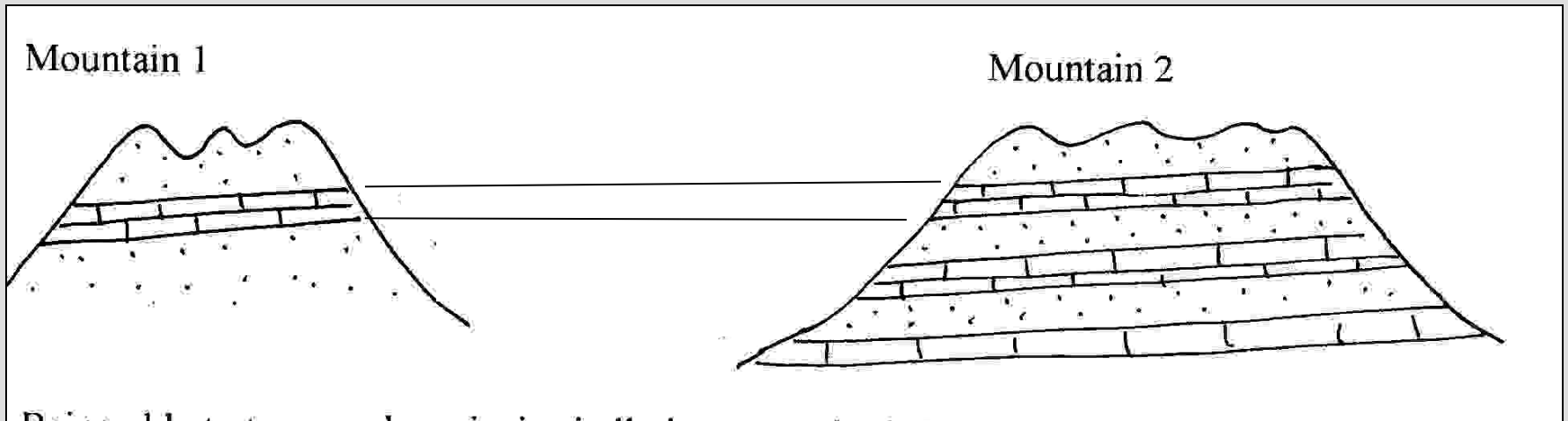
# Lithostratigraphy

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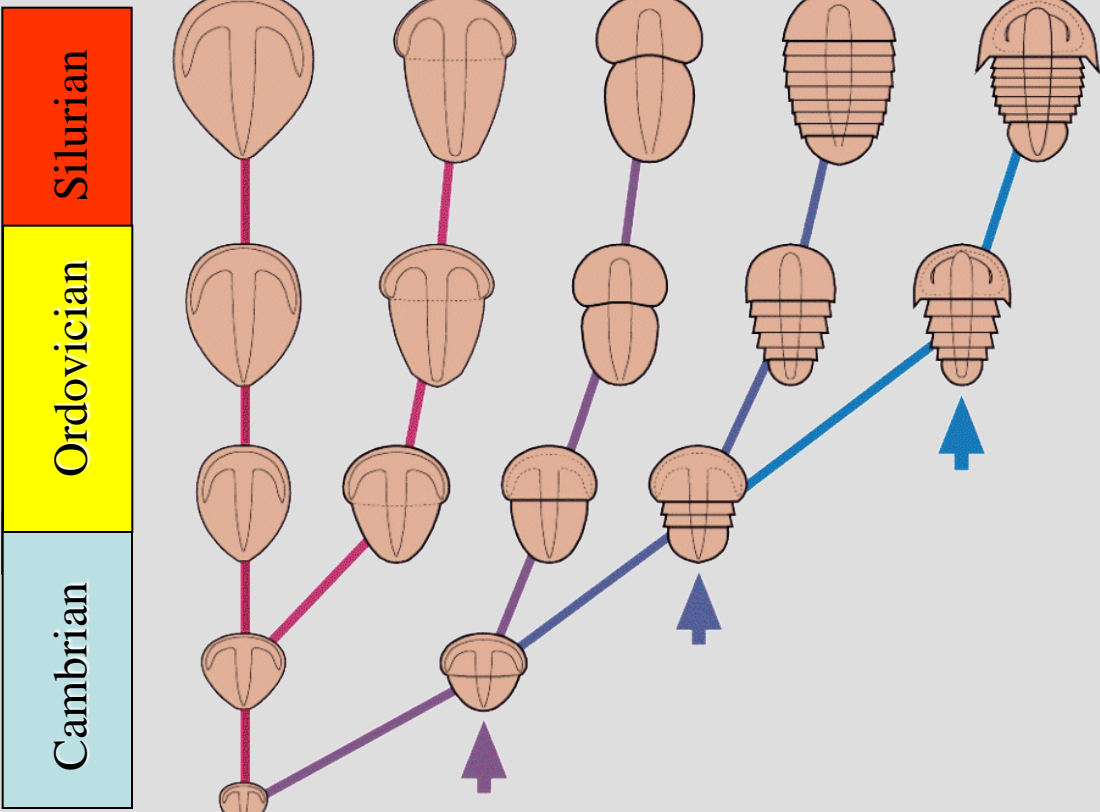
# Lithostratigraphy

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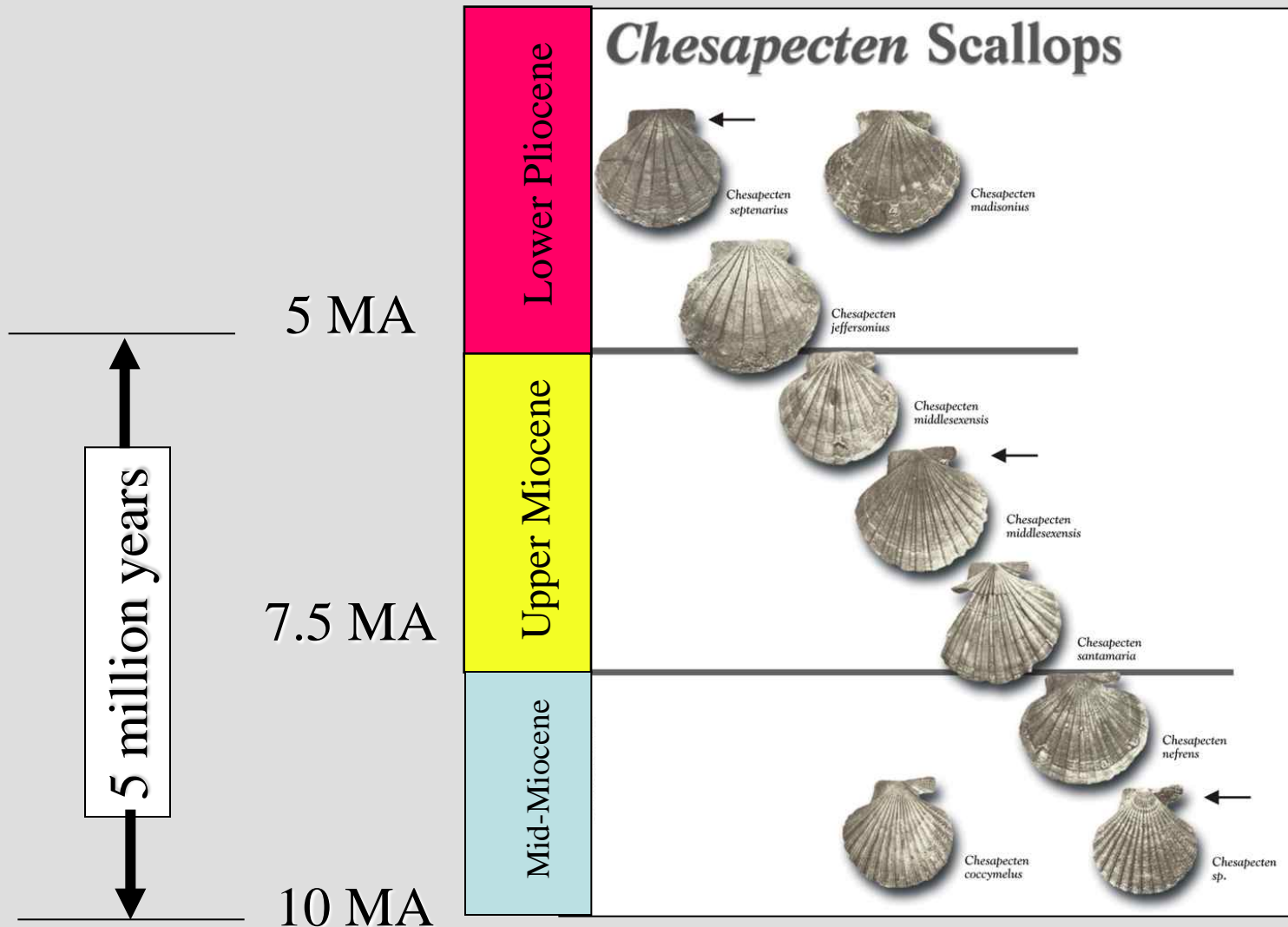


Lithostratigraphy only works if you have sufficiently different rock types or distinctive fossil content

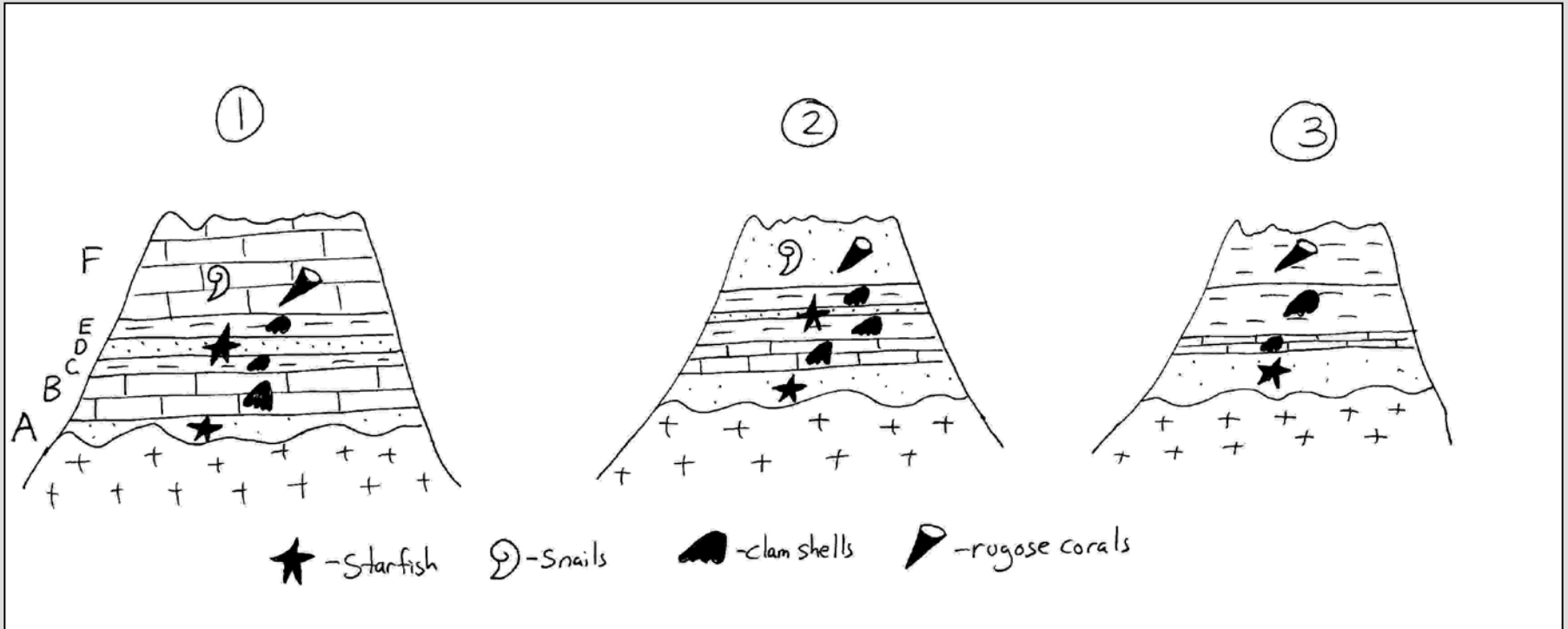
# Biostratigraphy



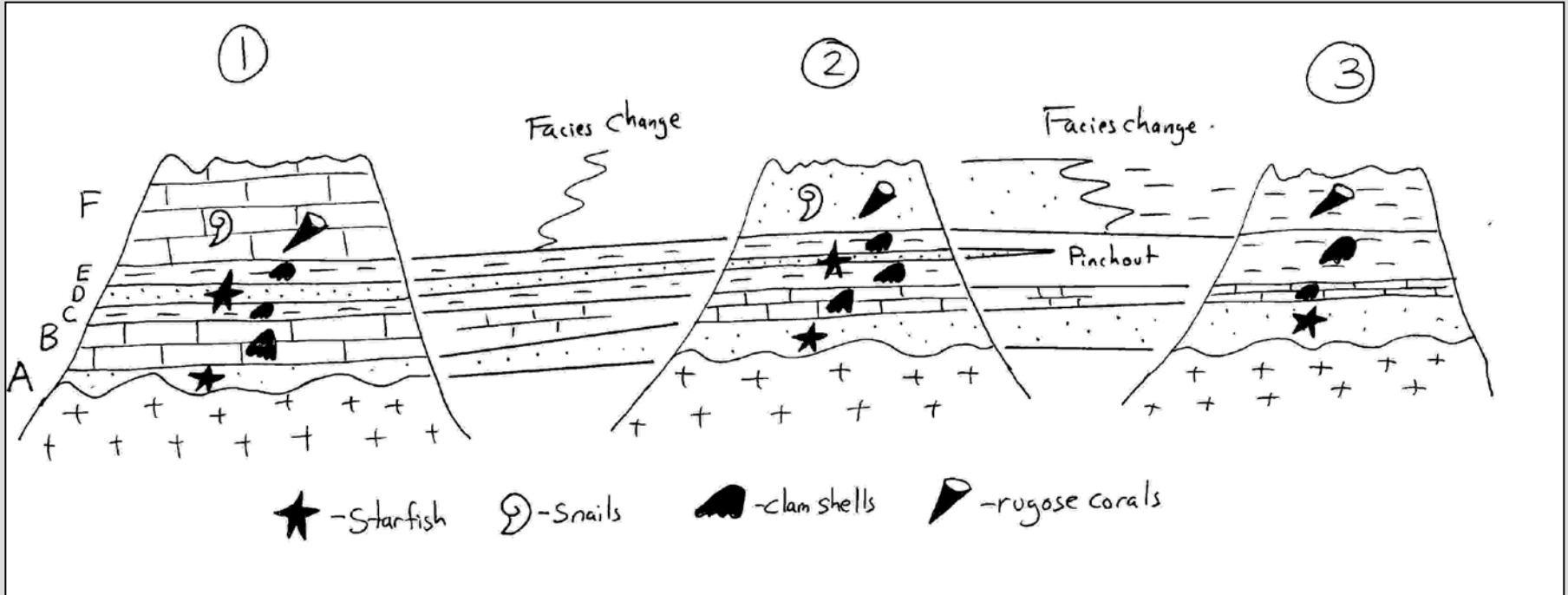
# Biostratigraphy



# Biostratigraphy



# Biostratigraphy



Note pinch outs and facies changes

# Biostratigraphy

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There are a lot of fossils in the rock record, but not all are useful for biostratigraphy.

# Biostratigraphy

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Some are too restricted (they only occur in one particular place or environment (Endemic Species)).



# Biostratigraphy

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There are a lot of fossils in the rock record, but not all are useful for biostratigraphy.

Some are too restricted (they only occur in one particular place or environment (Endemic Species)).

The best fossils for biostratigraphy are Cosmopolitan species (wide ranging)

# Biostratigraphy






















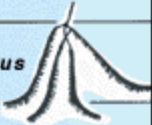


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Cosmopolitan species that occur over a very narrow time range (e.g., less than 1 million years) can be used to tell time.

They are called **Index Fossils**

# Biostratigraphy

Examples of Index Fossils from the USGS website

CENOZOIC ERA (Age of Recent Life)	Quaternary Period	<i>Pecten gibbus</i>		<i>Neptunea tabulata</i>	
	Tertiary Period	<i>Calyptrophorus velatus</i>		<i>Venericardia planicosta</i>	
MESOZOIC ERA (Age of Medieval Life)	Cretaceous Period	<i>Scaphites hippocrepis</i>		<i>Inoceramus labiatus</i>	
	Jurassic Period	<i>Perisphinctes tiziani</i>		<i>Nerinea trinodosa</i>	
	Triassic Period	<i>Trophites subbullatus</i>		<i>Monotis subcircularis</i>	
PALEOZOIC ERA (Age of Ancient Life)	Permian Period	<i>Leptodus americanus</i>		<i>Parafusulina bosei</i>	
	Pennsylvanian Period	<i>Dictyoclostus americanus</i>		<i>Lophophyllidium proliferum</i>	
	Mississippian Period	<i>Cactocrinus multibrachiatus</i>		<i>Prolecanites gurleyi</i>	
	Devonian Period	<i>Mucrospirifer mucronatus</i>		<i>Palmatolepus unicornis</i>	
	Silurian Period	<i>Cystiphyllum niagarensis</i>		<i>Hexamoceras hertzeri</i>	
	Ordovician Period	<i>Bathyrurus extans</i>		<i>Tetragraptus fructicosus</i>	
	Cambrian Period	<i>Paradoxides pinus</i>		<i>Billingsella corrugata</i>	
	PRECAMBRIAN				

# How to use fossils to tell time

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Consider trilobites, which lived during the Paleozoic era



Source: <http://www.ideofact.com/archives/trilobite.jpg>

# How to use fossils to tell time

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Species A (Late Ordovician to Earliest Silurian)



Species A



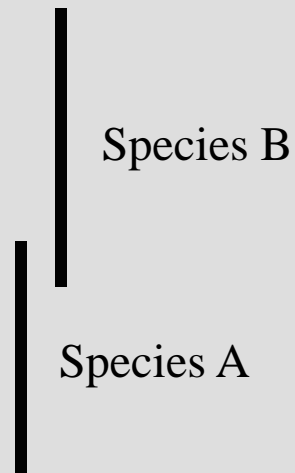
Source: <http://www.ideofact.com/archives/trilobite.jpg>



# How to use fossils to tell time

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Species B (Early Silurian to Middle Silurian)

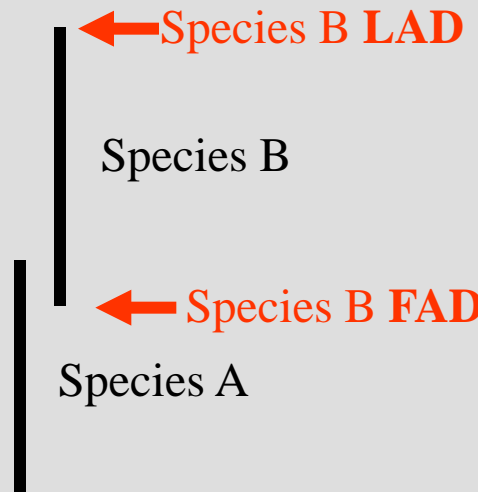


Source: <http://www.ideofact.com/archives/trilobite.jpg>

# How to use fossils to tell time

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Species B (Early Silurian to Middle Silurian; a good index fossil if it's cosmopolitan)

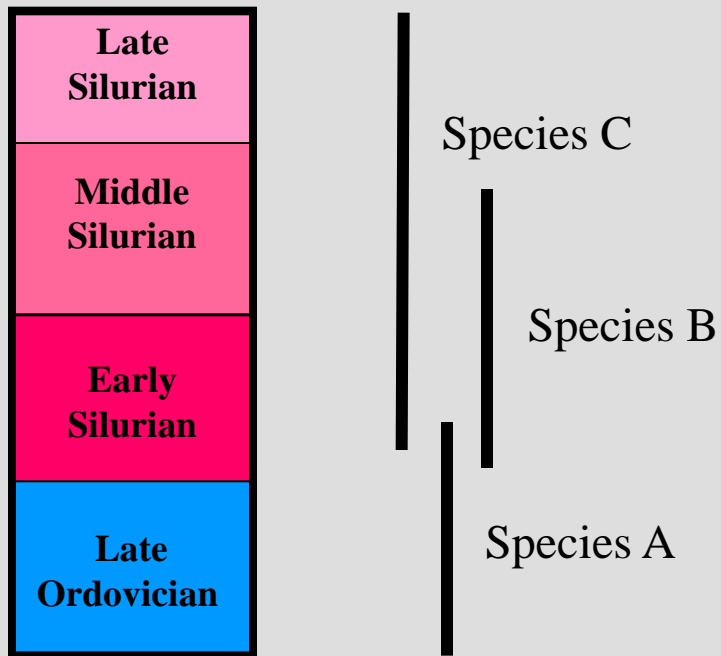


Source: <http://www.ideofact.com/archives/trilobite.jpg>

# How to use fossils to tell time

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Species C (Early Silurian to Late Silurian)



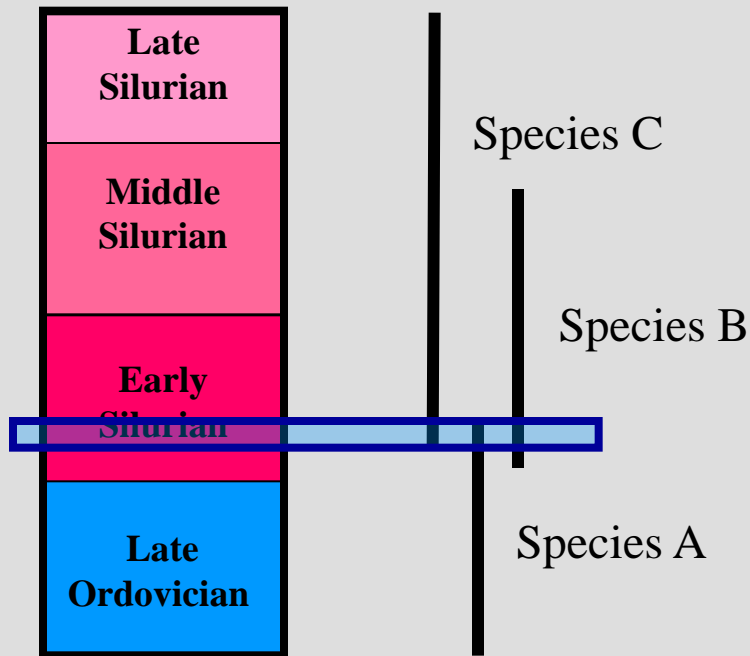
Source: <http://www.ideofact.com/archives/trilobite.jpg>



# How to use fossils to tell time

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The age of the interval shown in blue can be relatively well constrained. It is the only time all 3 beasts were alive at the same time – sometime during the Early Silurian

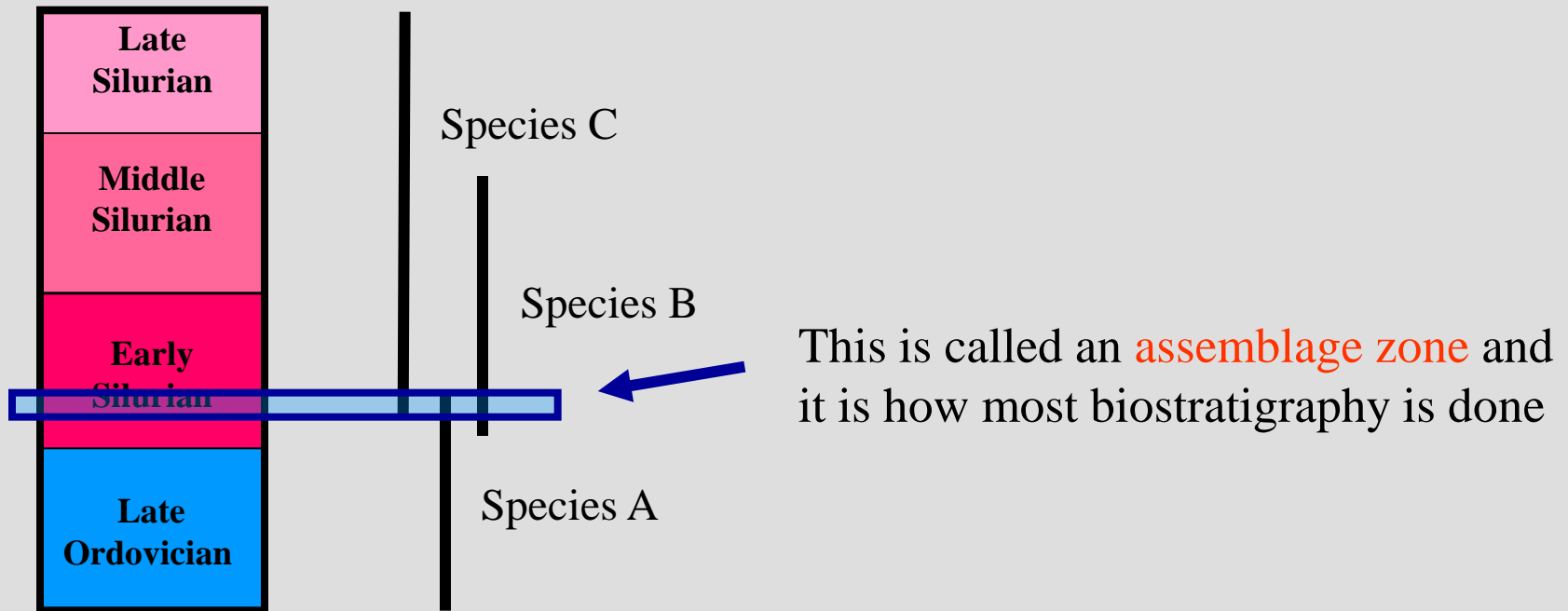


Source: <http://www.ideofact.com/archives/trilobite.jpg>

# How to use fossils to tell time

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The age of the interval shown in yellow can be relatively well constrained. It is the only time all 3 beasts were alive at the same time – sometime during the Early Silurian



# Today's Homework

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- 1) Study! Lecture test is coming up!

## Next Time

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Tuesday: Lectures 9/10: More fossils!

# GY 112: Earth History

## Lecture 9 : Fossils: Time & Environment

Instructor: Dr. Doug Haywick

[dhaywick@southalabama.edu](mailto:dhaywick@southalabama.edu)

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