GY 112: Earth History

Fossils Part:
Telling Time
Predicting Paleoenvironments

Instructor: Dr. Douglas W. Haywick
Last Time

1. Chronostratigraphy versus biostratigraphy
2. Paleontological correlations
3. Index fossils
4. Fossils and the Environment

Web notes: 9
Fossils & Time

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)
Biostratigraphy

- Lower Pliocene
- Upper Miocene
- Mid-Miocene

- Chesapeake Scallops

- Chesapeake septemarius
- Chesapeake malisomitus
- Chesapeake jefferoomitus
- Chesapeake middleescentris
- Chesapeake santermarius
- Chesapeake neffonis
- Chesapeake ocecyclus
- Chesapeake sp.

5 million years

5 MA

7.5 MA

10 MA
Biostratigraphy

Note pinch outs and facies changes
Biostratigraphy

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

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**
How to use fossils to tell time

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

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

This is called an assemblage zone and it is how most biostratigraphy is done.
Today

1. Fossils and the Environment
2. Fossils and Paleogeography
3. Fossils and Paleoclimate

Web notes: 10/11
Fossils & Environment

The Oceans today

Morphological (Bathymetrical) Zonation
Fossils & Environment

The Oceans today

Trophic (Beastie Habitat) Zonation
Fossils & Environment

Interpreting paleowater depth

On the shelf
Fossils & Environment

Interpreting paleowater depth

On the shelf

On the slope
Fossils & Environment

Interpreting paleowater depth

Sediment samples would only contain epipelagic and sublittoral beasties

Sediment samples would contain epipelagic, mesopelagic and bathyal benthic beasties
Fossils & Environment

But what about a finer estimate of paleowater depth? How good can you get?
Fossils & Environment

Introducing… the foraminifera

Pelagic

Benthic

0.25 mm
Fossils & Environment

One group of foraminifera from one small interval of the Tertiary Period
Consider 10 different species of forams and their paleowater depth ranges

<table>
<thead>
<tr>
<th>Species</th>
<th>Depth</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>25 to 75 m</td>
</tr>
<tr>
<td>B</td>
<td>25 to 75 m</td>
</tr>
<tr>
<td>C</td>
<td>50 to 100 m</td>
</tr>
<tr>
<td>D</td>
<td>50 to 250 m</td>
</tr>
<tr>
<td>E</td>
<td>0 to 100 m</td>
</tr>
<tr>
<td>F</td>
<td>25 to 250 m</td>
</tr>
<tr>
<td>G</td>
<td>150 to 250 m</td>
</tr>
<tr>
<td>H</td>
<td>0 to 50 m</td>
</tr>
<tr>
<td>I</td>
<td>10 to 1000 m</td>
</tr>
<tr>
<td>J</td>
<td>0 to 500 m</td>
</tr>
</tbody>
</table>
Fossils & Environment

Consider 10 different species of forams and their paleowater depth ranges

<table>
<thead>
<tr>
<th>Meters</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
</tr>
<tr>
<td>25</td>
</tr>
<tr>
<td>50</td>
</tr>
<tr>
<td>75</td>
</tr>
<tr>
<td>100</td>
</tr>
<tr>
<td>125</td>
</tr>
<tr>
<td>150</td>
</tr>
<tr>
<td>175</td>
</tr>
<tr>
<td>200</td>
</tr>
<tr>
<td>225</td>
</tr>
</tbody>
</table>

![Diagram showing depth ranges and species distribution]

- **Probable with depth**
- **G does not fit**
Fossils Adaptations to Environment

Sand dollar

Sea urchin
Fossils Adaptations to Environment

Sand dollar

Sea urchin

Question: Which beasties is best suited for living on a beach?

Which one is best suited for living on a reef? Why?
Fossils & Paleogeography

Wegener’s reconstruction of Pangaea was partially based on the distribution of fossils.

This is an example of a paleogeographic map.
Fossils & Paleogeography

Paleogeographic maps come in all sizes and scales.

Western North America

http://www.scn.org/~bh162/maas.html
Fossils & Paleogeography

And time intervals

http://geology.utah.gov/utahgeo/dinofossil/images/flaming_tracks/early_jurassic.jpg

SW USA
Early Jurassic Period
Fossils & Paleogeography

Late Cambrian 514 Ma

PANTHALASSIC OCEAN

IAPETUS OCEAN

North China
Laurentia
Alaska
Mexico
Siberia
Kazakhstan

GONDWANA
Pan-African Mts.

South China
Australia
Indonesia
Antarctica

Gondwana

New England and Nova Scotia

Ancient Landmass
Modern Landmass
Subduction Zone (triangles point in the direction of subduction)
Sea Floor Spreading Ridge
Fossils & Paleogeography

Late Cambrian  514 Ma

PANTHALASSIC OCEAN

APETUS OCEAN

North China
Laurentia
Alaska
Mexico
GONDWANA

Ancient Landmass
Modern Landmass
Subduction Zone (triangles point in the direction of subduction)
Sea Floor Spreading Ridge

New England and Nova Scotia
South America
Florida
Pan-African Mts.

Africa
England and Wales
Arabia
India
Antarctica
South China
Australia
Indonesia
Kazakhstan
Baltica
South America
Gondwana

North China
Laurentia
Alaska
Mexico
GONDWANA
Fossils & Paleogeography

Diagram:
- "North America"
- "Hudson's Bay"
- "Seaway"
- Toronto
- New York
- Mobile
- Reefs
- Equator

(510 Ma)
Fossils & Paleogeography
Consider 4 stratigraphic (fictitious) sections that you examine near Hudson’s Bay today
Consider 4 stratigraphic (fictitious) sections that you examine near Hudson’s Bay today
Fossils & Paleogeography
Fossils & Paleogeography

Step 1: Lithostratigraphy
Fossils & Paleogeography

Step 2: Chronostratigraphy or biostratigraphy
Step 2: Chronostratigraphy or biostratigraphy
Fossils & Paleogeography

The final interpretive cross-section for 510 MA would look like this.

510 million years ago
And if you get more sections spaced laterally, well then you get a paleogeographic map (e.g., our fictitious 510 MA example)
Fossils & Paleoclimate

Today *C. delicatula* it only lives in Antarctica waters in temperatures less than 5 °C (south of New Zealand)

*Chlamys delicatula*
Today *C. delicatula* it only lives in Antarctica waters in temperatures less than 5 °C (south of New Zealand).

You can find it in rocks in Northern New Zealand that are 2 million years old.

Why?
Today’s Homework

1) Download and read web notes 11, 12
2) Review the sample lecture test & word list 1
3) Study! (Lecture this Thursday!)

Next Time

Lecture Test 1
GY 112: Earth History

Lectures 10 & 11: Fossils: Paleoenvironment & Paleogeography

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