GY 402: Sedimentary Petrology

Lecture 18:
Carbonate Petrography 1:
Non-skeletal Allochems

Instructor: Dr. Douglas W. Haywick
Last Time (before the break)

Sandy Fluvial Siliciclastic Environments

• Meandering river dynamics
• Sedimentary facies
• The model (vertical sections)
Meandering Rivers

- Are characterized by a distinct suite of facies and processes
  - Oxbow lakes
  - Levees
  - Floodplains
  - Cut banks
  - Point bars
  - Yazoo streams
  - Cutoffs
Meandering Rivers

• Water velocity is greatest where the channel is deepest resulting in a “corkscrew” flow pattern.
Meandering River Facies

- The result is a classic fining upwards trend in point bars.

Meandering River Facies

- Apart from deposition in channels, rivers (meandering and braided alike) periodically flood resulting in sedimentation on flood plains.
Meandering River Facies

- Flood plain deposits are mostly laminated shales with plant fossils
- Sometimes paleosol horizons can be found
Meandering River Model

Today’s Agenda

Carbonate Petrography 1

- Carbonate Classification Schemes
- Staining Techniques
- Thin Section petrography
- Carbonate “grains” (skeletal versus non-skeletal)
- Non-skeletal allochems
Carbonate Sedimentary Rocks

Come in many different “flavors”:

• Originally unconsolidated “bioclastic” (gravel to mud-sized grains)
• Cemented frameworks (e.g., reef structures)
• Chemically precipitated materials (incl. evaporites)
• “diagenetically” altered rocks
## Carbonate Sedimentary Rocks

<table>
<thead>
<tr>
<th>Allochthonous Limestone</th>
<th>Less than 10% &gt;2 mm components</th>
<th>Greater than 10% &gt;2 mm components</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Contains lime mud (&lt;0.03 mm)</td>
<td>No lime mud</td>
</tr>
<tr>
<td>Mud-supported</td>
<td>Greater than 10% grains</td>
<td>Grain-supported</td>
</tr>
<tr>
<td>Less than 10% grains (&gt;0.03 mm &lt;2 mm)</td>
<td>Matrix-supported</td>
<td>Supported by grain components coarser than 2 mm</td>
</tr>
</tbody>
</table>

| Mudstone | Wackestone | Packstone | Grainstone | Floatstone | Rudstone |

### Carbonate Sedimentary Rocks

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<td>Original components not organically bound during deposition</td>
<td>Original components organically bound during deposition</td>
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<td>Rudstone</td>
</tr>
<tr>
<td>Framestone</td>
<td>Bindstone</td>
</tr>
<tr>
<td>Bafflestone</td>
<td></td>
</tr>
</tbody>
</table>

By organisms that build a rigid framework
By organisms that encrust and bind
By organisms that act as baffles

Carbonate Sedimentary Rocks

Biogenic Carbonate Rocks

Reefs & bioherms

Biogenic Carbonate Rocks

Biogenic Carbonate Rocks

Algal bindstones (typical for algal flats)

Carbonate Staining

Combination of potassium ferricyanide and Alizarin red-S ...

... it’s a surface stain.

Done because carbonate rocks are “mono-minerallic” (mostly composed of CaCO₃ - albeit in different polymorphs), and staining provides additional geochemical information.
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Carbonate Staining

Combination of potassium ferricyanide and Alizarin red-S

Blue: resolves Fe$^{2+}$ content of phases
Carbonate Staining

Combination of **potassium ferricyanide** and **Alizarin red-S**

*Red/Pink:* distinguishes CaCO$_3$ from other minerals
# Carbonate Staining

<table>
<thead>
<tr>
<th>Mineral</th>
<th>Geochemistry</th>
<th>Stain color</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aragonite</td>
<td>CaCO$_3$</td>
<td>Pink to red (brown highlights)</td>
</tr>
<tr>
<td>Calcite (non-ferroan)</td>
<td>CaCO$_3$</td>
<td>Pink to red</td>
</tr>
<tr>
<td>Calcite (ferroan)</td>
<td>Ca(Fe$^{2+}$)CO$_3$</td>
<td>Purple to blue</td>
</tr>
<tr>
<td>Magnesium calcite</td>
<td>Ca(Mg$^{2+}$)CO$_3$</td>
<td>Pink to red (yellow with Clayton Yellow)</td>
</tr>
<tr>
<td>Dolomite</td>
<td>CaMg(CO$_3$)$_2$</td>
<td>Not stained</td>
</tr>
<tr>
<td>Ferroan Dolomite</td>
<td>CaMg(Fe$^{2+}$)(CO$_3$)$_2$</td>
<td>Turquoise</td>
</tr>
</tbody>
</table>
Carbonate Thin sections

(calcite)

PPL

note

1 mm
Carbonate Thin sections
Carbonate Thin sections

zoned cement!
Tidal Flat Petrography
Tidal Flat Petrography

Cryptalgal laminations

ppl

3 mm
Tidal Flat Petrography

Calcite (in fenestrae)

Dolomite

ppl

1.5 mm
Tidal Flat Petrography

Calcite

Coarse “saddle” dolomite

Fine dolomite

ppl

0.5 mm
Tidal Flat Petrography

Primary (depositional) laminations

ppl  3 mm
Tidal Flat Petrography

mudcrack

ppl

3 mm
Tidal Flat Petrography
Tidal Flat Petrography

Dolomite?

Calcite

ppl 1 mm
Tidal Flat Petrography

No!

Anhydrite & gypsum
The moral of the story is that you still have to check your thin sections under crossed polars too!
Carbonate ”Grains”

**Allochems:** A collective term introduced by Robert Folk (1959) for a variety of discrete and organized carbonate aggregates (or grains) that serve as the coarser constituents in limestones.

This separates the “grains” from fine carbonate matrix (“micrite”) and diagenetic cements (“spar”).
Carbonate "Grains"

**Allochems:** Come in many different “flavors”, but we can group them into two broad divisions,

- **Skeletal** — the remains of once living beasties (body fossils)
- **Non-Skeletal** — chemically precipitated or inorganically produced components
Non-skeletal Allochems

The Great Bahamas Bank
Non-skeletal Allochems
Non-skeletal Allochems

http://strata.geol.sc.edu/Bahamas/pages/035-North-of-Joulters-Key-Ooids-Bahamas.html
Non-skeletal Allochems
Non-skeletal Allochems

**Ooids**: a concentrically coated, spherical allochem that forms through “inorganic” cementation on the sea floor in a wave agitated environment (0.25 to 2.0 mm)
Non-skeletal Allochems

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**Peloids (or Pellets):** a generic allochem composed of carbonate mud (micrite) irrespective of size, shape (but they are usually round to ovoid) or origin (they are commonly fossilized fecal pellets)
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**Grapestone:** another allochem composed of composite grains, but these are restricted to multiply coated groups of ooids (also implies cementation on the sea floor)
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Large nucleus
Non-skeletal Allochems

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http://userpage.fu-berlin.de/~voelker
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Upcoming Stuff

**Homework**
Perdido section *Due Friday March 24th*

**Lab this week:**
Tidal Flat thin sections *Due Thursday March 23th*

**Online Lecture:**
Lecture 19: tidal flats