GY 402: Sedimentary Petrology

Lecture 22:
Reefs

Instructor: Dr. Douglas W. Haywick
Last Time

Shelves

- Definition and a bit of history
- Factors controlling shelf sedimentation
- Carbonate Shelves
Continental Shelves

By definition: shelves are: “oceanic environments characterized by moderate water depths (10m to 150/200m) in which a variety of shallow marine and moderate depth facies occur”

Continental Shelves

We currently recognize 6 types of shelves (5 of which are “depositional”).

1. **Siliciclastic**/detrital (sand, silt, clay)
2. **Biogenic** (carbonate sediment, shells, etc.)
3. **Residual** (*in situ* weathering of rocky substrates)
4. **Volcanic** (recent volcanic rocks)
5. **Authigenic** (chemical precipitates like glauconite, phosphate, dolomite)
6. **Relict** (which we will now ignore)

Time does not allow us to examine all these types of shelves, so we will only consider the first 2.
Factors influencing shelf sedimentation

Six factors are recognized as influencing shelf sedimentation. The last three are designated as “biggie” factors.

1) **Sea level fluctuations** (controls distribution of relict sediments, barrier reefs etc.)
2) **Animal-sediment interactions** (modifies the substrate)
3) **Chemistry** (produces authigenic minerals)
4) Type and **rate of sedimentation**
5) **Climate**
6) Type and intensity of **shelf hydraulic regime** ("energy")

Biggies
Continental Shelves

Hydraulic regime

Three dominant processes are responsible for transporting, reworking and sorting sediment on shelves (including relict areas).

1) Tide-dominated shelves (17% of pericontinental shelf areas)
2) Ocean current-dominated shelves (3% of pericontinental shelves)
3) Storm-dominated shelves (80% of pericontinental shelf areas)

We will only consider tide- and storm-dominated shelves
Tide-dominated Shelves

- Macrotidal environment (+/- 4m tides)
- Induces strong bidirectional currents
- Produces elongated bedforms (ridges)

From Reading (1975)
Storm-dominated Shelves

HCS (hummocky cross-stratification)

From: Harms et al. (1975)

From Walker and James (1992)

Remember HCS?

http://course1.winona.edu/csumma/images/sedstrux/hcs8a.jpg
Temperate vs Tropical Carbonate Shelves

http://www.pal.uni-erlangen.de/uploads/pics/cwcb3b.jpg
Carbonate Shelves

- Area: 700 x 300 km
- Depth: 0 m to 200m (mostly < 3 m)
- Tongue of Ocean: 3500m deep
- Mesotidal (2 to 4 m tidal range)
- Also storm-dominated
- 3.5 to 4 m of Recent sediment
- Sedimentation rate ≈1000mm/1000yrs

From Bathurst (1975)
Carbonate Shelves

The Grand Bahama Bank can be divided up into a series of facies. The type depends on your discipline.

Lithofacies

1) reef (reef + coralgal)
2) oolitic (oolite + grapestone)
3) mobile oolite
4) mud
Today’s Agenda

Reefs

- Types of reefs
- Reef facies/characteristics
- Reef growth
Coral Reefs

Reefs are biochemical sedimentary rocks consisting of corals and other calcite and aragonite-secreting organisms.
Coral Reefs

They come in several varieties:
1) Barrier
2) Fringing
3) Pinnacle
4) Atolls
Coral Reefs

Atolls are isolated coral reefs that form on shelves or in much deeper water.
Coral Reefs

Atolls are isolated coral reefs that form on shelves or in much deeper water.
Coral Reefs

Usually have lots of *in situ* framework facies…
Coral Reefs

Coral Reefs


…but with lots of “holes” in which to find sediment
Reefs are a type of sedimentary environment and as such, are characterized by distinct facies

Coral Reefs

But as “biologically-produce facies”, expect to see bio-influences on facies character (e.g., coral morphology zonation)

## Coral Reefs

<table>
<thead>
<tr>
<th>Growth Form</th>
<th>Environment</th>
<th>Wave Energy</th>
<th>Sedimentation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Delicate, branching</td>
<td></td>
<td>low</td>
<td>high</td>
</tr>
<tr>
<td>Thin, delicate, plate-like</td>
<td></td>
<td>low</td>
<td>low</td>
</tr>
<tr>
<td>Globular, bulbous, columnar</td>
<td></td>
<td>moderate</td>
<td>high</td>
</tr>
<tr>
<td>Robust, dendroid, branching</td>
<td></td>
<td>mod-high</td>
<td>moderate</td>
</tr>
<tr>
<td>Hemispherical, domal irregular, mass</td>
<td></td>
<td>mod-high</td>
<td>low</td>
</tr>
<tr>
<td>Encrusting</td>
<td></td>
<td>intense</td>
<td>low</td>
</tr>
<tr>
<td>Tabular</td>
<td></td>
<td>moderate</td>
<td>low</td>
</tr>
</tbody>
</table>
Coral Reefs

Coral reefs (e.g., GBR) also record sea level changes particularly with respect to mineral variations.

Past studies suggest that reefs go through 4 stages of growth linked to sea level change:

<table>
<thead>
<tr>
<th>STAGE</th>
<th>TYPE OF LIMESTONE</th>
<th>SPECIES DIVERSITY</th>
<th>SHAPE OF REEF BUILDERS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Domination</td>
<td>bindstone to framestone</td>
<td>low to moderate</td>
<td>Laminate encrusting</td>
</tr>
<tr>
<td>Diversification</td>
<td>framestone (bindstone) mudstone to wackestone matrix</td>
<td>high</td>
<td>domal massive lamellar branching encrusting</td>
</tr>
<tr>
<td>Colonization</td>
<td>bafflestone to floatstone (bindstone) with a mud stone to wackestone matrix</td>
<td>low</td>
<td>branching lamellar encrusting</td>
</tr>
<tr>
<td>Stabilization</td>
<td>grainstone to rudstone (packstone to wackestone)</td>
<td>low</td>
<td>skeletal debris</td>
</tr>
</tbody>
</table>

Coral Reefs

Lastly, reefs have not always been part of the rock record.

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Coral Reefs

And aragonite has not always been the dominate mineralogy of corals

http://www.unc.edu/~jries/research.html
Upcoming Stuff

Homework
1) Moscow Landing trip!
2) Write 6 (ML background) due today

Lab this Week
Non skeletal Limestones

Friday 4:00 PM depart to Moscow Landing
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