GY 111: Physical Geology

Lecture 15: Sedimentary Rocks Part 3: Deltas, Beaches, Shelves, Evaporite Basins

Instructor: Dr. Douglas W. Haywick
1) Depositional environments in general
2) Alluvial fans and their rocks
3) Meandering Rivers
4) Deltas

Web notes 14a: Alluvial Fans
Web notes 14b: Rivers and Deltas:
Lab Manual Chapter 3
Depositional Environments

Depositional (or sedimentary) environments: Places where sediment is deposited (i.e., sediment sinks).

They are numerous.

Sedimentologists study sedimentary rocks to reconstruct past environments of deposition.
Alluvial Fans

Fan-shaped deposits of siliciclastic sediment deposited at the base of mountains

- Gravel to clay sized
- Angular to sub rounded
- Immature
Alluvial Fans

breccia

arkose

Red shale
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

Sediment eroded from the cutbank is transported onto the point bar where the current is slower.
Meandering Rivers

The bottom of the channel is frequently characterized by a channel lag of gravel and/boulders (conglomerate)
Meandering Rivers

Apart from deposition in channels, rivers periodically flood resulting in sedimentation on flood plains. Red shale

[Image: meandering_river.jpg]

[Image: mississippi_flood_NASA.jpg]
Today’s Agenda

Sedimentary Environments Part 2

1) Deltas
2) Types of modern beaches, waves and beach dynamics
3) Shelves (Biochemical and Chemical Rocks)
4) Reefs, atolls and oolites
5) Evaporites and evaporite basins

Web notes 15A: Beaches
Web notes 15B: Shelves
**Deltas**

**Delta**: siliciclastic depositional environments formed at the point where rivers meet bodies of water

[Image: http://www.tulane.edu/~sanelson/images/delta.gif]
Deltas come in several different morphologies that are controlled by the interaction between 3 major processes:

1) Wave Energy
2) Tidal Energy
3) River Input
Delta Morphology

Wave-dominated

River-dominated

Tide-dominated
When sediment-laden river water flows into the sea, it floats because freshwater is less dense than seawater.
Deltaic Processes

When sediment-laden river water flows into the sea, it floats because freshwater is less dense than seawater.
Deltaic Processes

However, sediment, being denser, still settles out of the water column. Coarse stuff (sand) is deposited close to the shoreline. Fine stuff (mud) is deposited further seaward.
Deltaic Processes

The result is a fan-shaped, laterally-fining deposit…
Deltas

Deltas consist of several key components

• Prodelta
• Distributary Mouth Bar
• Channel
• Levees
• Crevasse Splays
• Flood Plain

Deltas

Distributary Mouth Bar
(Lithic Sandstone)

http://clasticdetritus.com/category/delta/

Deltaic Facies

Flood plain

*(shale, green or black)*

http://clasticdetritus.com/category/delta/

One of the coolest things about deltas is that centers of deposition (active delta lobes), periodically shift.
Types of Beaches

A. MAINLAND - ATTACHED BEACH
B. BEACH STRAND PLAIN
C. REGRESSIVE BARRIER ISLAND
D. TRANSGRESSIVE BARRIER ISLAND
Shoreline attached beach, NSW, Australia
Barrier Island Beach, e.g., Dauphin Island, Alabama
Beach Terminology

Shelf

To 150 m water depth

10 m water depth

Beach
Beach Terminology

Shelf to 150 m water depth

10 m water depth
Beach Terminology

- Wave base

VERTICAL SCALE GREATLY EXAGGERATED

FAIRWEATHER WAVE BASE

STORM WAVE BASE

WAVES BEGIN TO BUILD UP
SPILLING BREAKERS
SHOALING WAVES

LONGSHORE BARS

FORESHORE

SURF ZONE

TIDE

LOW

HIGH

LOWER  MIDDLE  UPPER

SHOREFACE

MUDDY SUBSTRATE

SANDY SUBSTRATE

Cruziana

Skolithos

Ichnofacies

Zoophycos

L / 2

5 - 15 M
Waves and Beach Dynamics

Wind
Beach Morphology

Diagram:
- Dunes (Aeolian)
- Primary Dune (Storm Ridge)
- High tide terrace (Beach)
- Low tide terrace
- High tide
- Longshore drift
- Longshore bar
Storm detritus, and good terrace development, Waihi Beach, New Zealand
Storm detritus, and good terrace development, Waihi Beach, New Zealand
Storm detritus, and good terrace development, Waihi Beach, New Zealand
Storm detritus, and good terrace development, Waihi Beach, New Zealand
Swash zone, Waihi Beach, New Zealand

Quartz sand (quartz Arenite sandstone)
Dunes, Waihi Beach, New Zealand
Dunes, Waihi Beach, New Zealand
The Shelf

The “shallow” marine, flat area surrounding continents
The Shelf

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The Shelf

The “shallow” marine, flat area surrounding continents
The Shelf

Most near shore sediment is derived from mountains on land.

Siliciclastic sediment (beaches, deltas)
The Shelf

But biochemical sediment may be deposited further out on shelves.

Siliciclastic sediment (beaches, deltas)
The Shelf

Little Abaco

Grand Bahama

Great Abaco

Eleuthera

Biochemical “sand”
The Shelf

Western Edge of Great Bahama Bank

Changes in Deposition Orientation

Biochemical “sand”
The Shelf

Oolitic limestone
The Shelf

Ooid formation
Coral Reefs

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

They are best described as **fossiliferous limestones**
Coral Reefs

Atolls are isolated coral reefs that form on shelves or in much deeper water.
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Evaporite Basins

If evaporation is extreme, shallow sea water (e.g., in tidal flats) can completely dry up precipitating dissolved “salts”. These areas are called evaporite basins or sabkhas.
Evaporite Basins

Evaporite minerals are precipitated in these depositional environments.

Halite
Evaporite Basins

Calcite (oooids)  Dolomite  Gypsum  Anhydrite  Halite  Sylvite*

\[ \text{Evaporite Basin} \]

\[ \begin{align*}
\text{Ca}^{2+} + \text{CO}_3^{2-} & \rightarrow \text{Calcite} \\
\text{Ca}^{2+} + \text{Mg}^{2+} + \text{CO}_3^{2-} & \rightarrow \text{Dolomite} \\
\text{Ca}^{2+} + \text{SO}_4^{2-} & \rightarrow \text{Anhydrite/Gypsum} \\
\text{Na}^{+} + \text{Cl}^{-} & \rightarrow \text{Halite}
\end{align*} \]
Today’s Homework

1. Download and read Web Lecture 15A, B
2. Assignment 1: Contour Maps (due next Tuesday)
3. Invent a better mouse trap

Next Time

Fall Break