# OCEANOGRAPHY

## 10. Beaches, Shoreline Processes and the Coastal Ocean (part 3)

notes from the textbook, integrated with original contributions

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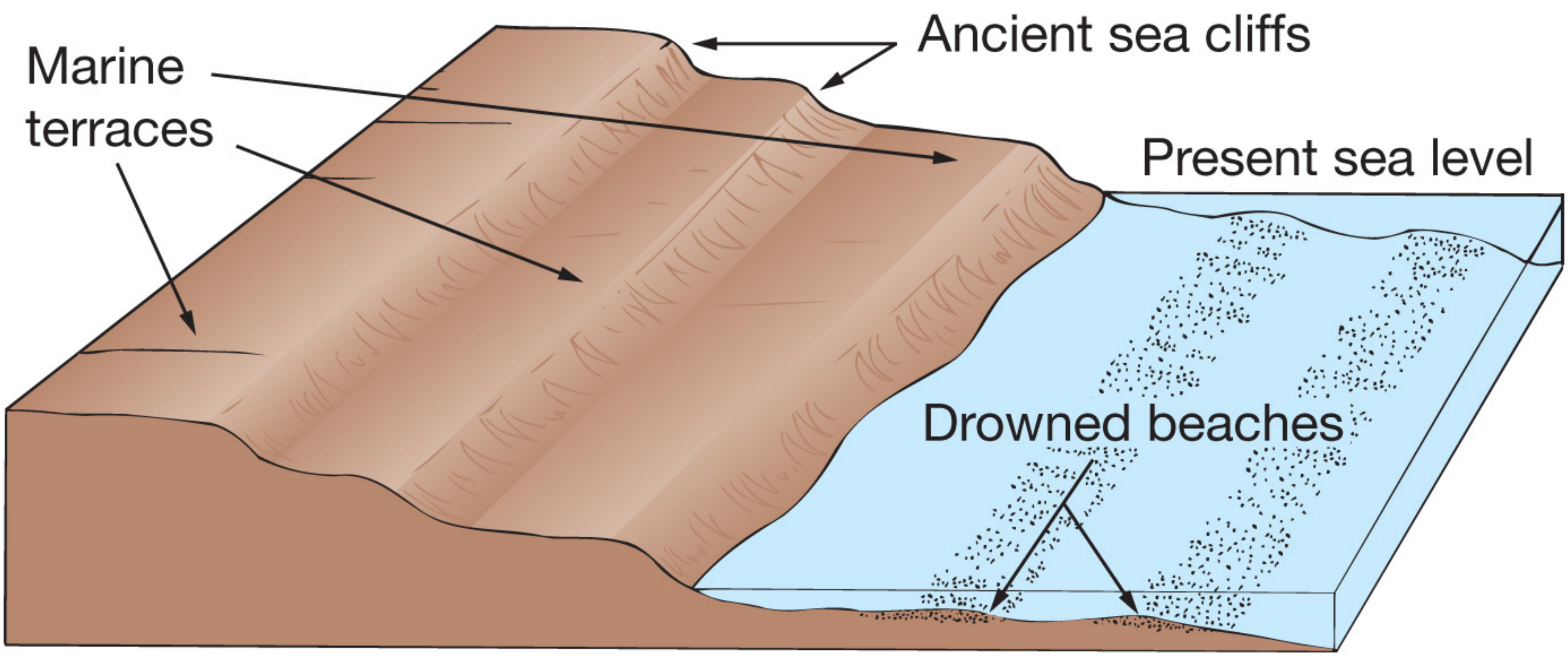
## 10.4 – How Do Changes in Sea Level Produce Emerging and Submerging Shorelines?

- Sea level can change over geological time
  - land can sink (subsidence) or rise (uplift)
  - water can sink (regression) or rise (transgression)

- Shorelines that are rising above sea level are called emerging shorelines
- Shorelines that are sinking below sea level are called submerging shorelines

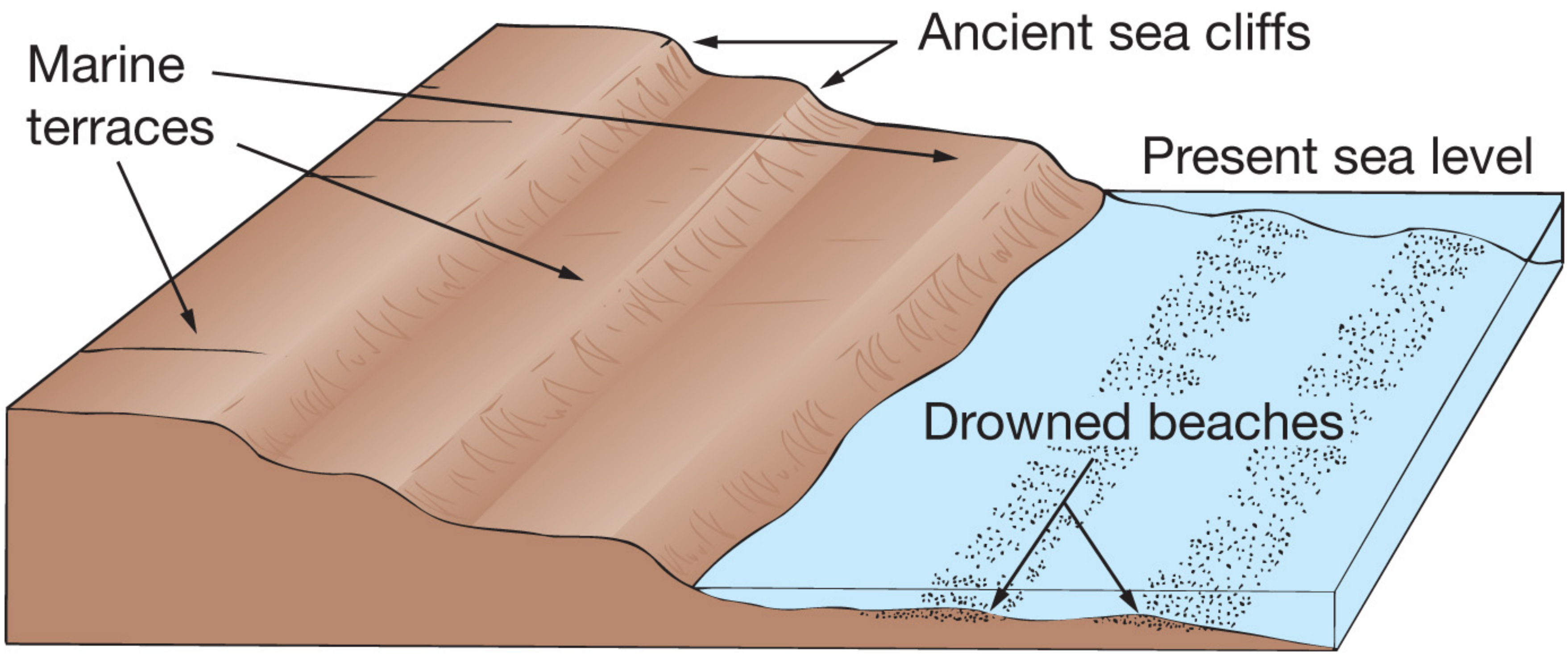
# features of emerging shorelines

- marine terraces
  - seen earlier around Palos Verdes, California
  - flat platforms backed by cliffs formed when wave-cut benches are exposed above sea level
- stranded beach deposits
  - ancient beaches that can be found above the present shoreline



# features of submerging shorelines

- wave-cut benches below sea level
  - contain drowned beaches
- submerged dune topography
- drowned river valleys
  - example: Chesapeake Bay, east coast U.S.A.



# Changing Sea Level

Two major processes can change sea level:

- Local tectonic processes
  - land can go up or down
- Global (eustatic) changes in sea level
  - the amount of water increases or decreases
  - the volume of water can expand or shrink
  - the shape of the oceans can change, reducing or increasing the space for water

# Changing Sea Level

- Local tectonic processes
  - Example: the Pacific coast of the United States is currently being uplifted.
  - Isostatic adjustments – rebound of Earth's crust after removal of heavy loads or sinking with application of heavy loads
    - Ice-loading from glaciers during ice ages

# Changing Sea Level

- Global (eustatic) changes in sea level
  - Sea level changes worldwide due to
    - Change in amount of available sea water
      - water locked up as ice during cooler climate phases
      - water released into oceans during warmer climate phases
    - Change in ocean basin capacity
      - controlled by expansion rates at mid-ocean ridges
    - Change caused by thermal expansion and contraction of seawater
      - Warmer water expands and cooler water contracts
      - Sea level rises and falls in response to seawater temperature
      - This is roughly 2 meters (6.6 feet) per 1°C (1.8°F) change in temperature.

# More or less water in the oceans?

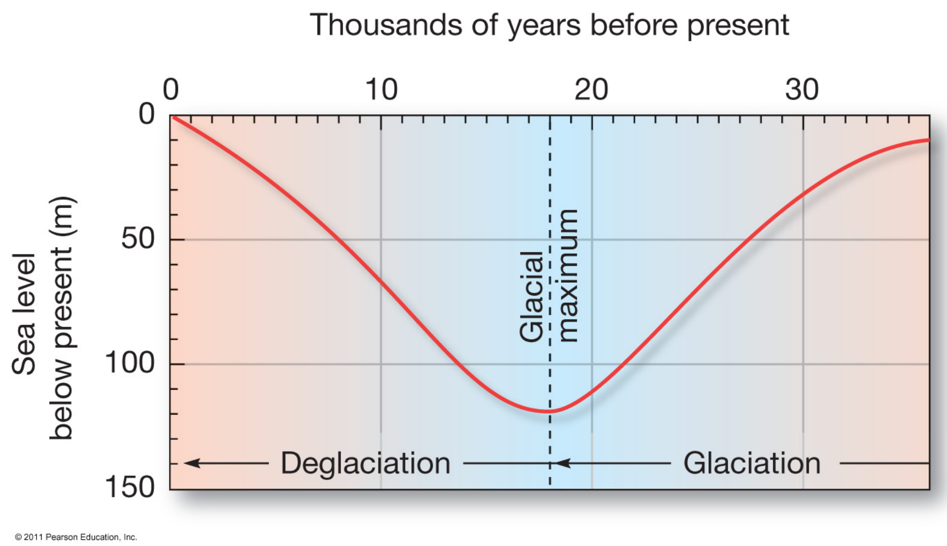
- During Greenhouse Times, there is no ice at sea level
  - Ice melts and flows into the ocean
  - Sea level rises (transgression)

- During Icehouse Times, there is ice at sea level
  - Snow does not melt and turns into ice, preventing water from going back into the ocean
  - Sea level drops (regression)

# Eustatic Changes in Sea Level

## Some Mechanisms

- Ice ages lock seawater up in ice (glaciation)
  - sea level goes down
- Ice melting after an ice age (deglaciation)
  - sea level rises



# Pleistocene Epoch and Today

- From about 2 million to 10,000 years ago, a series of four ice ages affected Earth.
- Sea level was at least 120 meters (400 feet) below today's sea level.
- If all remaining ice on Earth melted today, sea level would rise another 70 meters (230 feet).

# Isn't the space at the ocean bottom always the same?

- No, it depends on expansion rates at mid-ocean ridges
- A fast spreading ridge produces a lot of oceanic crust in a short amount of time
  - That would cause more oceanic crust to be at high temperature, that would be expand and be more buoyant
  - There would be less space for water, which would flood continents (transgression)
  - example: North America in the mid-Cretaceous

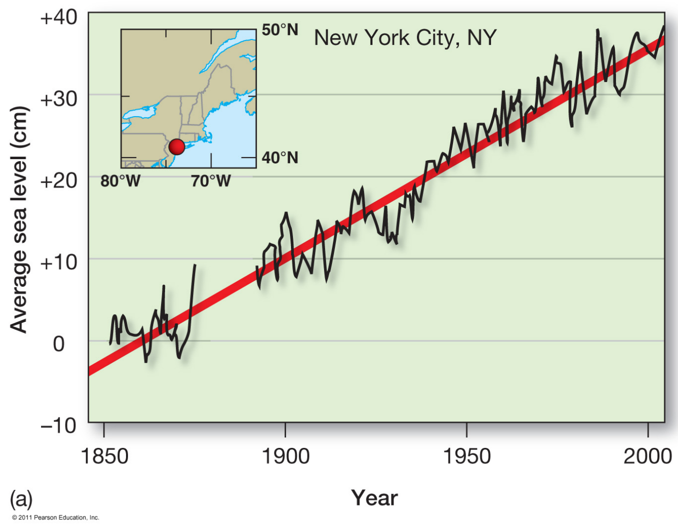
- A slow spreading rate would see a quickly cooling oceanic crust around mid-ocean ridges
  - The crust would then sink, or stay at a lower level
  - This would generate more space for the water, that would retreat from continents (regression)
  - example: North America in the Pleistocene

# past North America

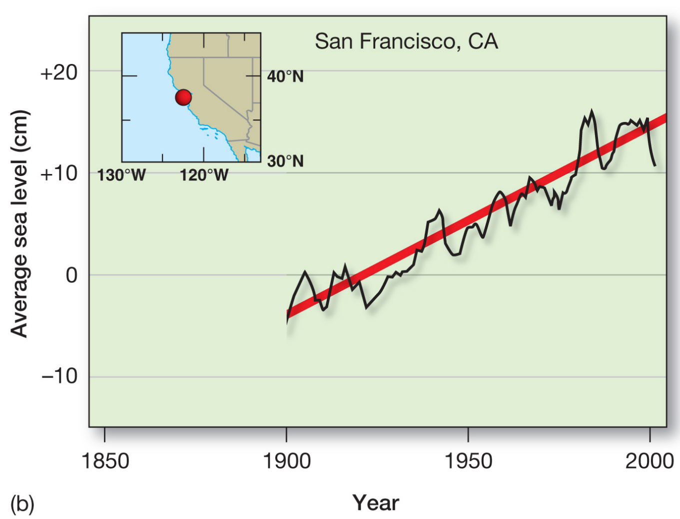
peak Greenhouse: Cretaceous

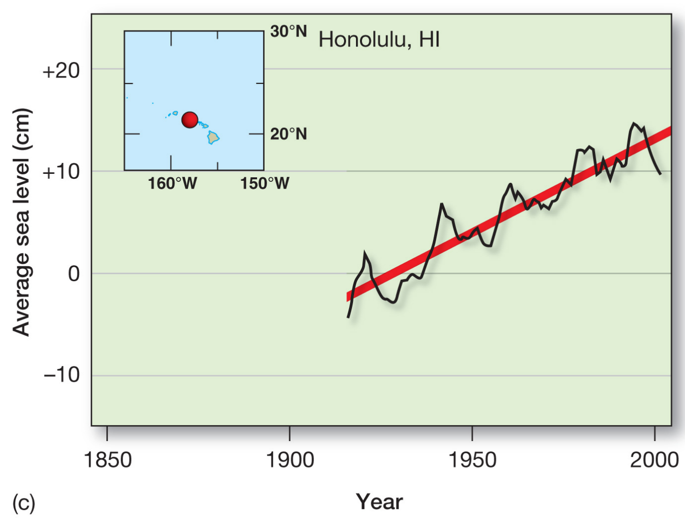
peak Icehouse: Pleistocene

# Global Warming and Changing Sea Level




- Globally averaged temperatures – about 0.6°C (1.1°F) warmer over last
  130 years
- Sea level rose 10-15 cm
  (4-10 in) over past
  100 years
- As global warming continues, we will see a higher sea level.



# United States Coasts

erosion vs. deposition

# Atlantic Coast

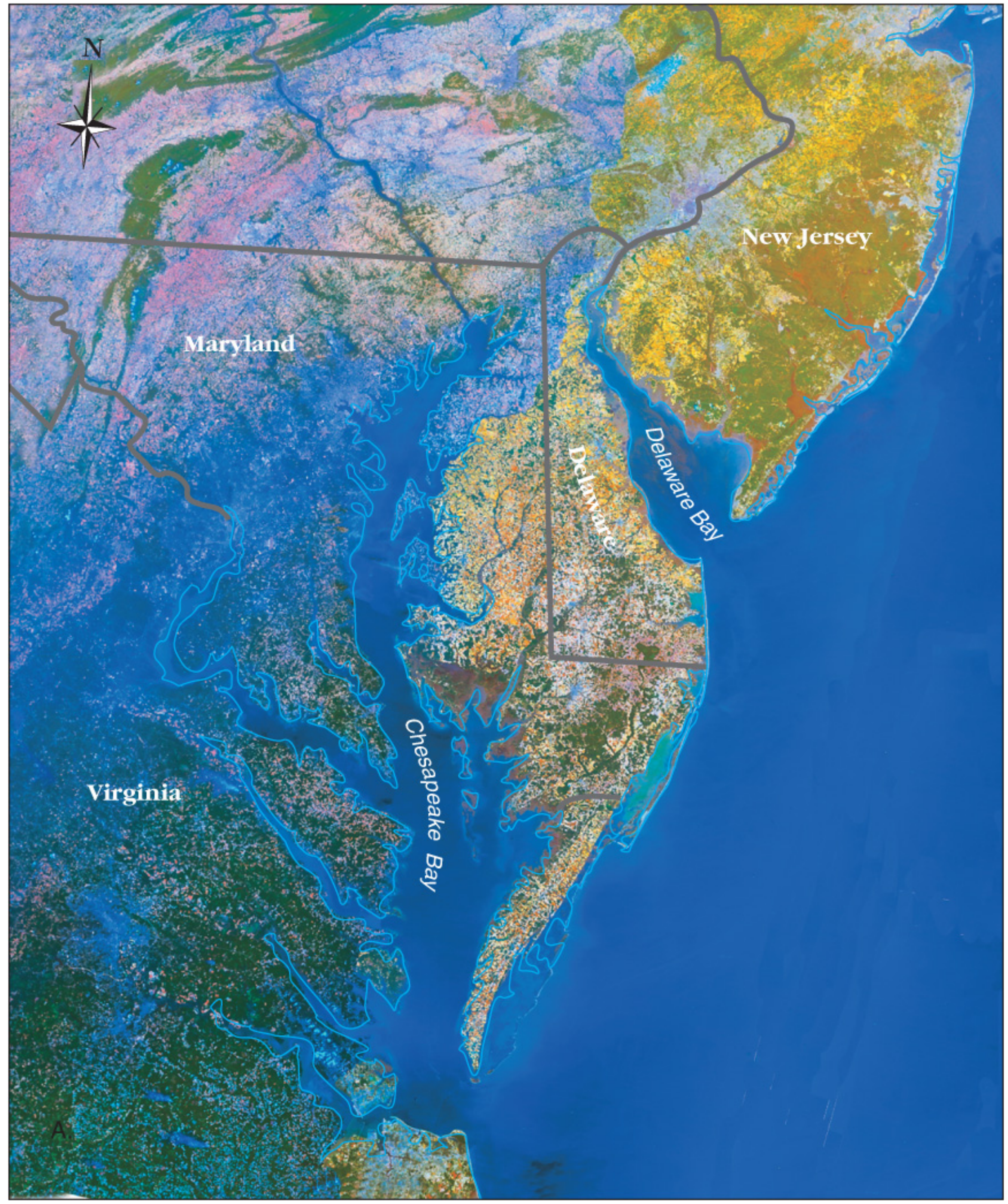
- Most coasts open to storm wave attack
- Barrier islands common from Massachusetts southward
- Bedrock
  - Florida bedrock is resistant limestone.
  - Northward through New Jersey is comprised of recent deposits that can be easily eroded
  - New York through Maine has glacier-affected rocks.

# Atlantic Coast

- Strong storms called nor'easters can damage the coast north of Cape Hatteras, NC.
- Nor'easters can generate storm waves up to 6 meters (20 feet).
- Drowned river valleys common
- Average erosion is 0.8 meter (2.6 feet) per year; sea is migrating landward
- Delaware, New York, and Georgia have the most serious erosion problem.

# Atlantic Coast

- Barrier islands
- Drowned river valleys



# Gulf Coast

- Low tidal range
- Generally low wave energy
- Tectonically subsiding
- Mississippi delta dominates
  - Locally sea level rises due to compaction of delta sediments
- Average rate of erosion is 1.8 meters (6 feet) per year

# Pacific Coast

- Tectonically rising
- Experiencing less erosion than Atlantic or Gulf coasts
- Open exposure to high energy waves
- Average rate of erosion 0.005 meter (0.016 feet) per year