Chapter 4
Continental Margins and Ocean Basins

- Bathymetry of Sea Floor
- Continental Margins and Ocean Basins
- Submarine Canyons
- Hydrothermal Vents
- Trenches

Bathymetry: a map of the ocean floor
Early bathymetric studies were often performed using a weighted line to measure the depth of the ocean floor.

- Echo sounding
- Multibeam Systems
- Satellite Altimetry

Echo sounders bounce sound off the seabed.

Vw ≈ 1500 m/s (Pres, Temp, Salinity)
Va ≈ 344 m/s (Pres, Temp, other)

Review:

Echo sounders sense the contour of the seafloor by beaming sound waves to the bottom and measuring the time required for the sound waves to bounce back to the ship.

If the round-trip travel time and wave velocity are known, distance to the bottom can be calculated. This technique was first used on a large scale by the German research vessel Meteor in the 1920s.
Multi-beam echo sounder

Using satellite measurements to map the ocean floor

Gravitational Anomalies: Bathymetry of ocean floor-ridges, shelves

Topography of Ocean Floors

Cross section of the Atlantic ocean basin and the continental United States, showing the range of elevations. Ocean depth is clearly greater than the average height of the continent, but general range of contours is similar.
The ocean floor can be classified as
(a) **Continental Margins** - the submerged outer edge of a continent
(b) **Ocean Basin** - the deep seafloor beyond the continental margin

There are two types of continental Margins
(a) **passive or trailing margins**: margin of continent that moves away from spreading center - Atlantic-style margins (also Arctic Ocean, Antarctica and Indian Ocean). Very little volcanic or earthquake activity is associated with passive margins.
(b) **active or leading margins**: plate boundary located along a continental margin - ocean trenches where there is subduction of oceanic lithosphere - narrow, steep, with volcanic mountains (West Coast of the Americas). Active margins are the site of volcanic and earthquake activity.

- Atlantic = Passive Margin
  little/no geologic activity
- Pacific = Active Margin
  geologic activity
**Continental Shelves**

- Gently sloping (~0.5 degrees)
- Depositional environments
- Average width 65 km (40 miles)
- Average depth 130 m (430 feet)
- Narrow along Active margins
- Wide along Passive margins

**Continental Shelves:**
- Broad shallow extension of the continents (~75 km wide)
- Regions of deposition (rivers, glaciers, scrapped marine deposits, calcium carbonate)
- Large bedform features, reworked by tides, storms, waves

**Anatomy of a passive margin**

**Continental Margins**

- **Shelf Break**
  - Edge of the continental shelf
  - Change in slope
- **Continental Slope**
  - Extends from break to ocean basin
  - Steep (3 - 6 degrees)
  - As high as 25 degrees
  - Little/no deposition
Continental Slopes:
continental crust thins into oceanic crust
steep (~20km, 1-25 degrees), 5deg Pacific, 3deg Atlantic
extend to depths between 1500-4000 m

Submarine Canyons Form at the Junction between Continental Shelf and Continental Slope

These are features of some continental margins. They cut into the continental shelf and slope, often terminating on the deep-sea floor in a fan-shaped wedge of sediment.

Submarine Canyon

- Steep V shape channel, incised in the continental slope (and shelf)
- Created by
  - Rivers during the last low stand (some)
  - Turbidity currents

Turbidity Currents

- Fast moving avalanches of mud and sand scour slopes
- Form turbidite deposits
- 90 km/hr (56 mi/hr)

Turbidite bed
ancient deposit, exposed to erosion, graded deposits: largest particles at bottom
Continental Margins

- Continental Rise
  Base of the continental slope
  slope 0.5 - 1 degree
  Depositional environment

  Formed by:
  Turbidity currents
  Underwater landslides

Features of the Sea floor

Oceanic Ridges
Hydrothermal Vents
Abyssal Plains and Abyssal Hills
Seamounts and Guyots
Trenches and Island Arcs

Seafloor: 4000 - 6000 m water depth, 30% of the Earth's surface

Abyssal Plain: vast, flat plain extending from the base of the continental slope.
Ocean Basins: sections of the abyssal plain separated by continental margins, ridges, and rises.
Basins → sections of the abyssal plain separated by continental margins, ridges, and rises.

Sea floor features

Flattopped seamounts eroded by wave action are called guyots.

Abyssal hills are small, extinct volcanoes or rock intrusions near the oceanic ridges.

Seamounts are volcanic projections from the ocean floor that do not rise above sea level. Flat-topped seamounts eroded by wave action are called guyots.

Abyssal hills are flat areas of sediment-covered ocean floor found between the continental margins and oceanic ridges. Abyssal hills are small, extinct volcanoes or rock intrusions near the oceanic ridges.

Hydrothermal vents are sites where superheated water containing dissolved minerals and gases escapes through fissures, or vents. Cold water (blue arrows) is heated as it descends toward the hot magma chamber, leaching sulfur, iron, copper, zinc, and other materials from the surrounding rocks. The heated water (red arrows) returning to the surface carries these elements upward, discharging them at hydrothermal springs on the seafloor. http://www.divediscover.whoi.edu/vents/index.html
Mid-Ocean Ridges and Rises

An oceanic ridge is a mountainous chain of young, basaltic rock at an active spreading center of an ocean.

Major ocean trenches

Trenches are arc-shaped depressions in the ocean floor caused by the subduction of a converging ocean plate. Most trenches are around the edges of the active Pacific. Trenches are the deepest places in Earth’s crust, 3 to 6 kilometers (1.9 to 3.7 miles) deeper than the adjacent basin floor. The ocean’s greatest depth is the Mariana Trench where the depth reaches 11,022 meters (36,163 miles) below sea level.

Chapter 4 – Summary

• Bathymetric devices used to study seabed features include multibeam echo sounder systems and satellites that use sensitive radar for altimetry.
• Seafloor features result from a combination of tectonic activity and the processes of erosion and deposition.
• Near shore, the features of the ocean floor are similar to those of the adjacent continents because they share the same granitic basement. The transition to basalt marks the edge of the continent and divides ocean floors into two major provinces. The submerged outer edge of a continent is called the continental margin. The deep-sea floor beyond the continental margin is called the ocean basin.
• Features of the continental margins include continental shelves, continental slopes, submarine canyons, and continental rises.
• Features of the deep-ocean basins include oceanic ridges, hydrothermal vents, abyssal plains and hills, seamounts, guyots, trenches, and island arcs.