Chapter 14
The Ocean Floor
The Blue Planet

- Nearly 71 percent of Earth’s surface is covered by the global ocean.

- Oceanography is a science that draws on the methods and knowledge of geology, chemistry, physics, and biology to study all aspects of the world ocean.
The World Ocean
Land hemisphere
46.4% Land
53.6% Water

Water hemisphere
11.6% Land
88.4% Water
The world ocean can be divided into four main ocean basins—
the Pacific Ocean, the Atlantic Ocean, the Indian Ocean, and the Arctic Ocean.
14.1 The Vast World Ocean
Geography of the Oceans

• The Pacific Ocean is the largest and has the greatest depth.
• The Atlantic Ocean is about half the size of the Pacific and not quite as deep.
• The Indian Ocean, largely a southern hemisphere body, is slightly smaller than the Atlantic.
• The Arctic Ocean is about 7 percent of the size of the Pacific.
The topography of the ocean floor is as diverse as that of the continents.

Bathymetry is the measurement of ocean depths and the charting of the shape or topography of the ocean floor.
The Topography of the Ocean
Today’s technology—particularly sonar, satellites, and submersibles—allows scientists to study the ocean floor in a more efficient and precise manner than ever before.
Sonar

- Sonar is an acronym for sound navigation and ranging. It is also referred to as echo sounding.
- Sonar works by transmitting sound waves toward the ocean bottom.
Sonar Methods
Satellites

- Satellites are able to measure small differences by bouncing microwaves off the ocean surface.
- Using this new technology, scientists have discovered that the ocean surface is not perfectly flat.
- Differences in the height of the ocean surface are caused by ocean-floor features.
Satellite Methods
Submersibles

- Submersibles are small underwater crafts used for deep-sea research.

- Today, many submersibles are unmanned and operated remotely by computers. These remotely operated vehicles (ROVs) can remain underwater for long periods.
14.2 Ocean Floor Features

Mapping the Ocean Floor

* The ocean floor regions are the continental margins, the ocean basin floor, and the mid-ocean ridge.
A continental margin is the zone of transition between a continent and the adjacent ocean basin floor.

In the Atlantic Ocean, thick layers of undisturbed sediment cover the continental margin. This region has very little volcanic or earthquake activity.
Continental Margins

In the Pacific Ocean, oceanic crust plunges beneath continental crust. This force results in a narrow continental margin that experiences both volcanic activity and earthquakes.
Continental Margins

◆ Continental Shelf

- A continental shelf is the gently sloping submerged surface extending from the shoreline.
- Continental shelves contain important mineral deposits, large reservoirs of oil and natural gas, and huge sand and gravel deposits.
14.2 Ocean Floor Features

**Continental Margins**

- **Continental Slope**
  - A continental slope is the steep gradient that leads to the deep-ocean floor and marks the seaward edge of the continental shelf.
Continental Margins

 Continent Slope

A submarine canyon is the seaward extension of a valley that was cut on the continental shelf during a time when sea level was lower—a canyon carved into the outer continental shelf, slope, and rise by turbidity currents.
14.2 Ocean Floor Features

Continental Margins

◆ Continental Slope

• A submarine canyon is the seaward extension of a valley that was cut on the continental shelf during a time when sea level was lower—a canyon carved into the outer continental shelf, slope, and rise by turbidity currents.
Submarine Canyons

Submarine canyons

Turbidity current

Turbidity current
A Turbidity Current

- Tail
  - Deposition of fine-grained sediments
- Main sediment mass (Head)
  - Deposition of coarse-grained materials
- Water flow
- Erosion of bottom

Turbidite

- Graded beds
  - Surfaces eroded by passage of head of current
  - Fine-grained deposits
  - Coarse-grained deposits
Storegga Undersea Landslide
Continental Margins

- **Continental Rise**

  - A continental rise is the gently sloping surface at the base of the continental slope.
The ocean basin floor is the area of the deep-ocean floor between the continental margin and the oceanic ridge.

Deep-Ocean Trenches

- Trenches form at the sites of plate convergence where one moving plate descends beneath another and plunges back into the mantle.
14.2 Ocean Floor Features

Ocean Basin Floor

◆ Abyssal Plains

• An abyssal plain is a very level area of the deep-ocean floor, usually lying at the foot of the continental rise.

• The sediments that make up abyssal plains are carried there by turbidity currents or are deposited as suspended sediment settles out.
14.2 Ocean Floor Features

Ocean Basin Floor

◆ Seamounts and Guyots

• A seamount is an isolated volcanic peak that rises at least 1000 meters above the deep-ocean floor, and a guyot is an eroded, submerged seamount.
Abyssal Plain Cross Section

Ocean

Abyssal plain

Volcanic peak

Oceanic crust

Layers of sediment
Mid-Ocean Ridges

A mid-ocean ridge is found near the center of most ocean basins. It is an interconnected system of underwater mountains that have developed on newly formed ocean crust.
Extending out from a continent's edge is a gently sloping, shallow area called the continental shelf (F). At the edge of the shelf, the ocean floor drops off in a steep incline called the continental slope (A). The continental slope marks the true edge of the continent, where the rock that makes up the continent stops and the rock of the ocean floor begins. Beyond this slope is the abyssal plain (C), a smooth and nearly flat area of the ocean floor. In some places, deep, steep-sided canyons called trenches (G) cut into the abyssal plain. A continuous range of mountains called the mid-ocean ridge (D) winds around Earth. There are mountains on the abyssal plain, too. Some reach above the ocean surface to form volcanic islands (E). Others, called seamounts (B), are completely under water.
Seafloor Spreading

Seafloor spreading is the process by which plate tectonics produces new oceanic lithosphere at ocean ridges.

New ocean floor is formed at mid-ocean ridges as magma rises between the diverging plates and cools.
A. Period of normal magnetism

B. Period of reverse magnetism

C. Period of normal magnetism
Age of Sea Floor
Mid-Ocean Ridges

◆ Hydrothermal Vents

- Hydrothermal vents form along mid-ocean ridges. These are zones where mineral-rich water, heated by the hot, newly-formed oceanic crust, escapes through cracks in the oceanic crust into surrounding water.
Ocean-floor sediments can be classified according to their origin into three broad categories: terrigenous sediment, biogenous sediment, and hydrogenous sediment.
14.3 Seafloor Sediments

◆ Terrigenous Sediment

- Terrigenous sediments consist primarily of mineral grains that were eroded from continental rocks and transported to the ocean.
Biogenous Sediment

- Biogenous sediments consist of shells and skeletons of marine animals and algae.
14.3 Seafloor Sediments

Types of Seafloor Sediments

◆ Biogenous Sediment

- Calcareous ooze is thick, common biogenous sediment produced by dissolving calcium carbonate shells.

- Siliceous ooze is biogenous sediment composed of silica-based shells of single-celled animals and algae.
Calcareous ooze
Hydrogenous Sediment

Hydrogenous sediment consists of minerals that crystallize directly from ocean water through various chemical reactions.
Biogenous Sediments

Radiolaria

Foraminifera
MULTIPLE FACTORS INTERACT TO CREATE SEDIMENTARY ENVIRONMENTS

THE EARTH SYSTEM

Atmosphere
Hydrosphere
Lithosphere
Climate System
PLATE TECTONIC SYSTEM
ASTHENOSPHERE
Deepee mantle
Geodynamic System
Outer core
Inner core

1. Lake
2. Desert lake
3. Rivers
4. Glacier
5. Delta
6. Beach
7. Tidal flat
8. Continental shelf
9. Continental shelf
10. Organic reef
11. Continental margin

Geographic location and plate tectonic setting
Transport agent and medium
Organic processes and organisms that modify sediments
Climate

Sediments deposited
Oil and natural gas are the main energy products currently being obtained from the ocean floor.

Gas Hydrates
- Gas hydrates are compact chemical structures made of water and natural gas.
- Most oceanic gas hydrates are created when bacteria break down organic matter in ocean-floor sediments.
Types of Methane Hydrate Deposits

**Ocean Deposits**
Impermeable solid hydrate embedded in sediment

**Biogenic methane**
Generated in shallow ocean sediment to a depth of 3,000 feet

**Trapped methane gas**

**Arctic Deposits**
Bands and lenses in permafrost relatively close to surface

**Depth greater than 1,500 feet**

**Sediment deep**
Perhaps 4 miles deep

**Slow seepage of thermogenic methane gas**
From below

**Frozen ground surface**

**Hydrate deposits**
Can be 1,000-2,000 feet thick and cover large horizontal areas
Gas Hydrates
Other major resources from the ocean floor include sand and gravel, evaporative salts, and manganese nodules.

Sand and Gravel

- The offshore sand-and-gravel industry is second in economic value only to the petroleum industry.
Manganese Nodules

Manganese nodules are hard lumps of manganese and other metals (like cobalt, copper, and iron) that precipitate around a small object.
Manganese Nodules
Evaporative Salts

• When seawater evaporates, the salt increases in concentration until it can no longer remain dissolved. When the concentration becomes high enough, the salts precipitate out of solution and form salt deposits.

• The most economically important salt is halite—common table salt.