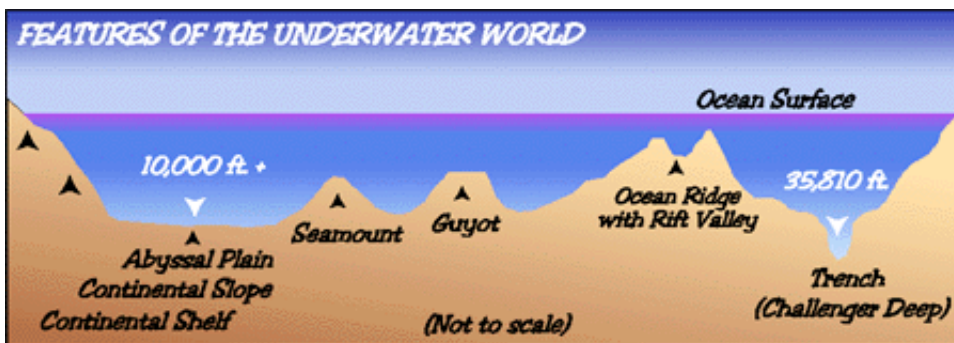
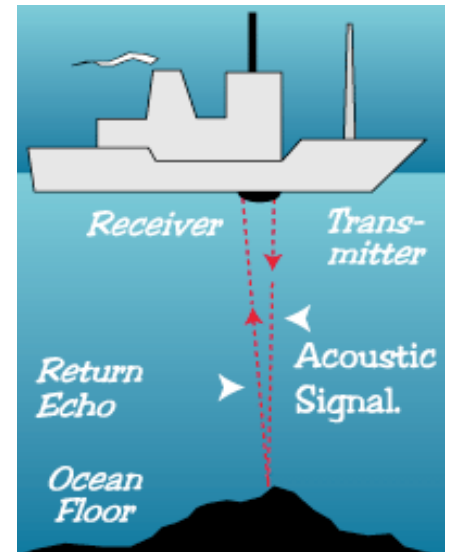


THE UNDERWATER WORLD

Most ocean bottom features are large in comparison to those found on land.

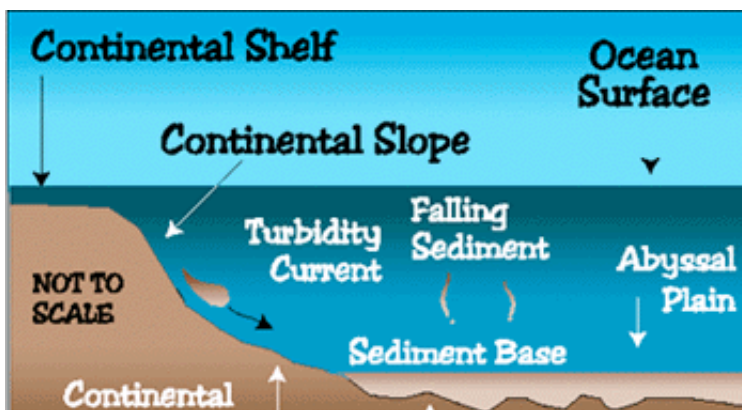
The introduction of the echo sounder early this century provided the ability to compare these features. The echo sounder calculates water depth by measuring time between emission of a sound signal directed toward the ocean floor and the return echo. From echo-sounder data and bottom samples, marine geologists and hydrographers have gathered sufficient information to produce charts of the ocean bottom features.

Terms used to describe features of the underwater world are very similar to terms used to identify features on land. Oceanic ridges are similar to mountain ranges, and oceanic trenches are the Grand Canyons of the seabed. The abyssal plain (the term abyssal refers to the large, deep parts of the ocean) is the feature that constitutes the largest portion of the ocean floor. It has been compared to the great flat prairie lands of mid America.



ABYSSAL PLAINS: Abyssal plains are found next to the continental slopes at depths greater than 9 - 10,000 feet. They are areas of near freezing water temperatures where there is no season or sunlight. The Abyssal plain is regarded as the true ocean floor.

The few marine inhabitants found in the region survive only because they have adapted to the hostile environment of bitter cold and immense pressure. Abyssal plains are among the smoothest surfaces on the planet, with less than five feet of vertical variation for every mile. These level plains are the result of a constant rain of sediments. These sediments, ranging from the remains of marine life to fine, clay-sized particles, drift slowly downward filling in depressions on the irregular rocky ocean floor.



Often, coastal sediments are washed down the continental slope as turbidity currents. (A turbidity current is a downward flow of suspended mud-like sediments. The descent is caused by gravity.) Sediments from large rivers reach the ocean floor primarily by way of submarine canyons.

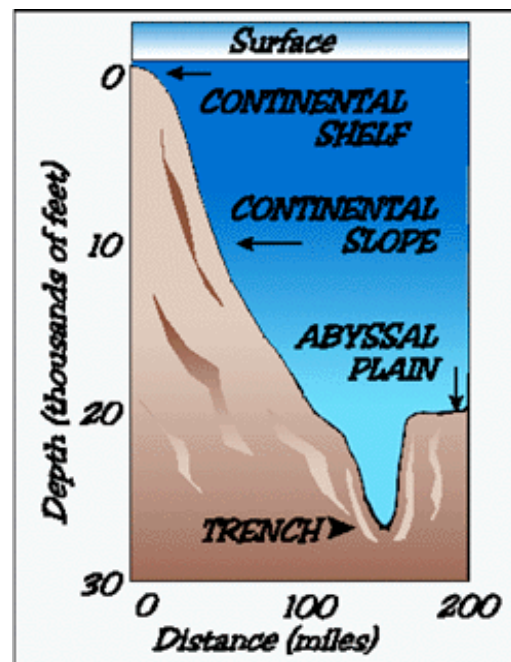
MID-OCEAN RIDGES: Several mid-ocean ridges are longer than the longest mountain ranges on Earth. They are tall, as well, rising to 12,000

Rise

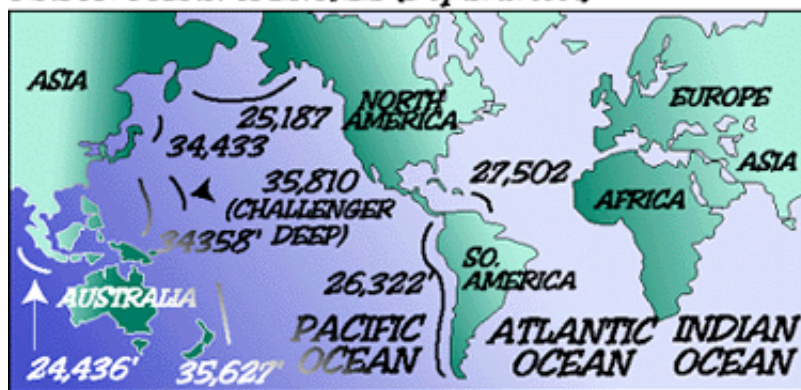
Ocean Floor

feet above the ocean floor, and their peaks penetrate the ocean's surface to form islands, such as Iceland and the Azores in the Atlantic Ocean and the Galapagos Islands in the Pacific Ocean. Most of the ridges crest at a depth of about 8,000 feet and their width varies from 500 to 1,500 miles. Unlike typical continental mountain ranges that have a singular pronounced line of peaks, oceanic ridges have two, separated by a prominent depression known as a rift valley. The valley ranges from 15 to 30 miles in width and cradles an active seismic belt.

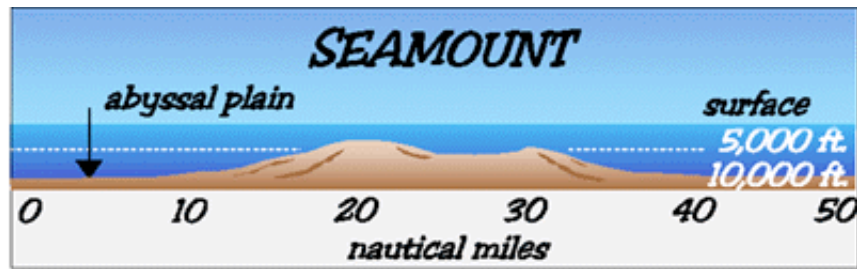
TRENCHES: Trenches are found adjacent and parallel to continents and island chains. At least 22 trenches have been identified although not all are classified as major. Of this number, 18 are in the Pacific Ocean, three in the Atlantic Ocean, and one (the Java Trench) in the Indian Ocean. Depths of major trenches exceed 18,000 feet, and vary from 10 to 22 miles in width. The deepest is the Challenger Deep, 35,810 feet deep, in the Marianas Trench. The depths of many trenches are greater than the elevation of the world's highest mountain. Mount Everest (29,028 feet) would be less imposing if dropped into the Challenger Deep. Trenches are not uniform in depth or width. The Peru-Chile Trench off the west coast of South America is nearly 1,100 miles long. The Japan Trench is 150 miles long and is the shortest. The Tonga Trench, located between New Zealand and Samoa, is the narrowest and straightest. The Kurile Trench between Japan and Kamchatka is the widest.



MAJOR OCEAN TRENCHES (Depth in feet)



SEAMOUNTS: Seamounts are isolated mountains rising from 3,000 to 10,000 feet above the surrounding seabed. Shaped like a cone, they have a characteristic depression similar to a crater at the summit. Samplings gathered from over 50 seamounts found evidence that indicates they are of volcanic origin. Seamounts are found in all oceans, but are more numerous in the Pacific Ocean, with over 2,000 identified. They are especially abundant in the Gulf of Alaska.

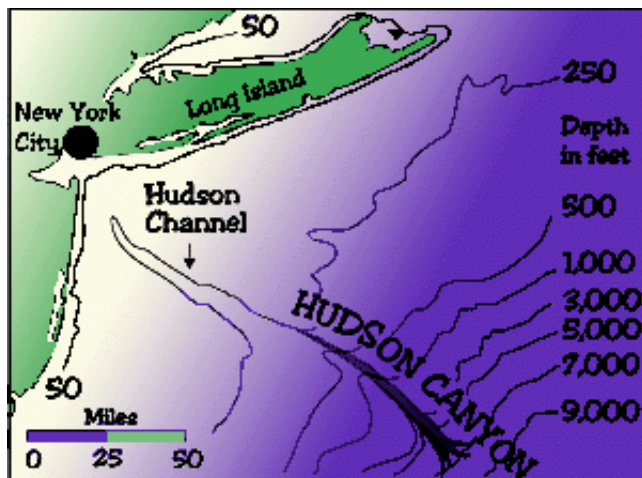


The Cobb Seamount, discovered in 1950, is in a chain of seamounts that extend into the Gulf of Alaska. Located just 270 miles off the coast of Washington, it is one of the most thoroughly explored of all seamounts. Cobb rises from a depth of nearly 9,000 feet to within 124 feet of the surface. Because of relatively shallow depth and good lighting conditions, divers have explored and mapped most of the 23 acre flat top. The closest land feature similar to the seamount is a volcano that rises upwards from surrounding flatlands.

CONTINENTAL SLOPES AND CANYONS: The continental slope gradually rises from the abyssal plains but climbs as much as 45 degrees as it approaches land. In some areas the slope is interrupted by broad wedges of sediment deposits called a continental rise. Slopes are often gouged by deep valleys or submarine canyons, many with the same proportions as the Grand Canyon. While most canyons were originally formed during the last Ice Age, some are the result of earthquakes.

Canyons found off the East and West coasts of the United States are similar in one respect, they both have the classic "V" profile with steep walls and rock outcropping. East Coast canyons of the United States begin at the very edge of the landward side of the continental slope and extend to seaward in an almost straight

line. The Hudson Canyon off Long Island, New York, is the best known and studied canyon on the East Coast. It was first identified in 1864. The canyon begins as a shallow valley crossing the continental shelf. The axis of the canyon then trails down the continental slope for a distance of about 50 miles. The greatest wall height is about 4,000 feet at a depth of 6,000 feet.



West Coast submarine canyons are noticeably different from those on the East Coast. They are extremely rugged, twisted and begin less than 1,000 feet offshore. This is due to the exceedingly narrow continental shelf. Monterey Canyon is the deepest, largest and most thoroughly studied canyon on the West Coast. It starts near Moss Landing,

California at a depth of 50 feet. The canyon, with walls up to 6,000 feet, extends seaward for more than 60 miles. It terminates at a depth of about 10,000 feet.

CONTINENTAL SHELF: The continental shelf, the region from the coastline to the edge of the continental slope, covers about eight percent of the global seafloor area. The continental shelf is a national asset for most nations. It is a source of fish, both commercial and sport, and in some areas, oil and natural gas. Shelves are not of uniform width. They vary considerably in size off the coasts of the United States. They are almost negligible along Southern California and Florida's southeast coast. Off Florida's west coast

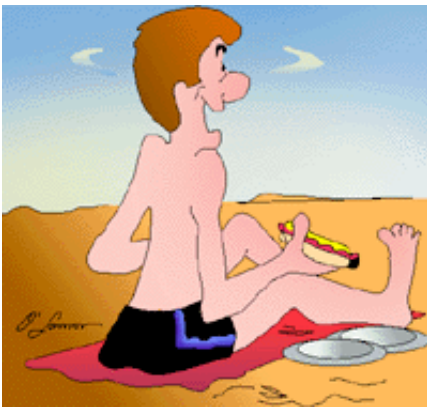
however, the shelf extends 200 miles into the Gulf of Mexico. The average width worldwide is about 40 miles.

Shelves look like the adjacent land. Coastal areas that are mountainous will have a continental shelf with similar features, which is the case off Southern California. Coastal areas dominated by low hills or plains are likely to have a shelf of nearly flat plains or low hills. This is observed along most of the U.S. Atlantic and Gulf Coasts. Shelves off the mouths of larger rivers such as the Mississippi, are usually broad with a large mud base of continental sediments.

Continental shelves along the coasts of the United States cover an area of about 891,000 square miles. Alaska's continental shelf alone occupies over 591,000 square miles. The Atlantic Coast continental shelf covers 140,000 square miles, about equal to the land mass areas of New York, New Jersey, Ohio, and Pennsylvania. The shelf covers 135,000 square miles in the Gulf of Mexico, nearly the same area as Nebraska and Iowa combined. It covers 25,000 square miles off the coasts of California, Oregon and Washington.

BEACHES: A beach is an expanse of sand or pebbles along a seashore, that is washed by the tide and waves. They are divided into three zones: Offshore, foreshore and back shore. Summer time residents of each zone usually include surfers, waders, and sun bathers.

It is in the offshore zone that incoming waves feel bottom and curl over as breakers or surf. The foreshore zone is regularly exposed to high and low tides. On the landward edge of the foreshore is the beach scarp, usually a rise of several feet caused by the eroding action of stronger waves. The backshore zone extends from the water line to the inland area where the sea does not influence vegetation. The principal feature of the backshore is the berm that marks the ordinary limit of a high tide. Action of the sea creates the berm. Usually there is one, but depending on beach topography there may be two. The width is dependent on surf conditions.

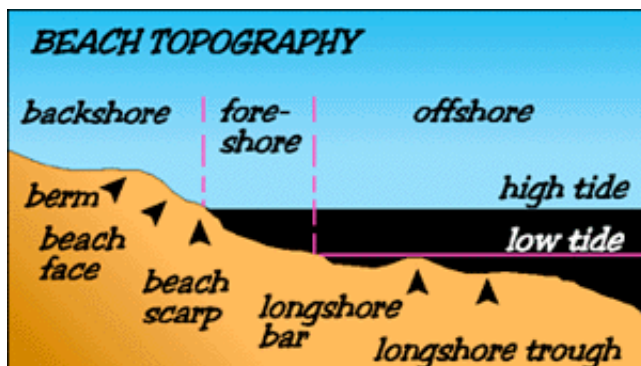


Erosion often reduces beach width in winter when wind and wave action are more powerful and frequent. In summer, gentle wave action transports sediments that replenish the beach with sand and create a wider berm.

Most beach sand consists of light-colored quartz and feldspar sand grains, the result of weathering and erosion of rocks such as granite.

Some beach sand comes directly from shoreline erosion, but much is created by the action of rivers flowing to the sea. Most beach sand contains fragments of smoothed and rounded clam shells, and the shells of other marine creatures. Tropical beaches often consist entirely of shell and coral fragments. Beaches in areas of volcanic activity can be black, its sand created by erosion of volcanic rock.

There are several types of beaches found along the coasts of the United States. Common to Northern California and Oregon is the narrow stretch of sand bounded by rolling surf and a rocky cliff mainland. These beaches are located



where waves break upon a coast of hard bedrock with little available sediment. The swash (wave uprush) and return backwash carry pebble size fragments ashore, while finer sand is washed to sea. Numerous beaches on the Atlantic Coast are of the spit type, such as New York's Coney Island where a narrow shoal extends seaward. This type of beach is created by wave action over a lengthy period.

Beaches are a major attraction for coastal living. About two-thirds of the world's population lives within a narrow coastal belt that extends landward from the ocean's edge. In the United States, many large cities are located near or on an ocean shoreline or alongside one of the Great Lakes.



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