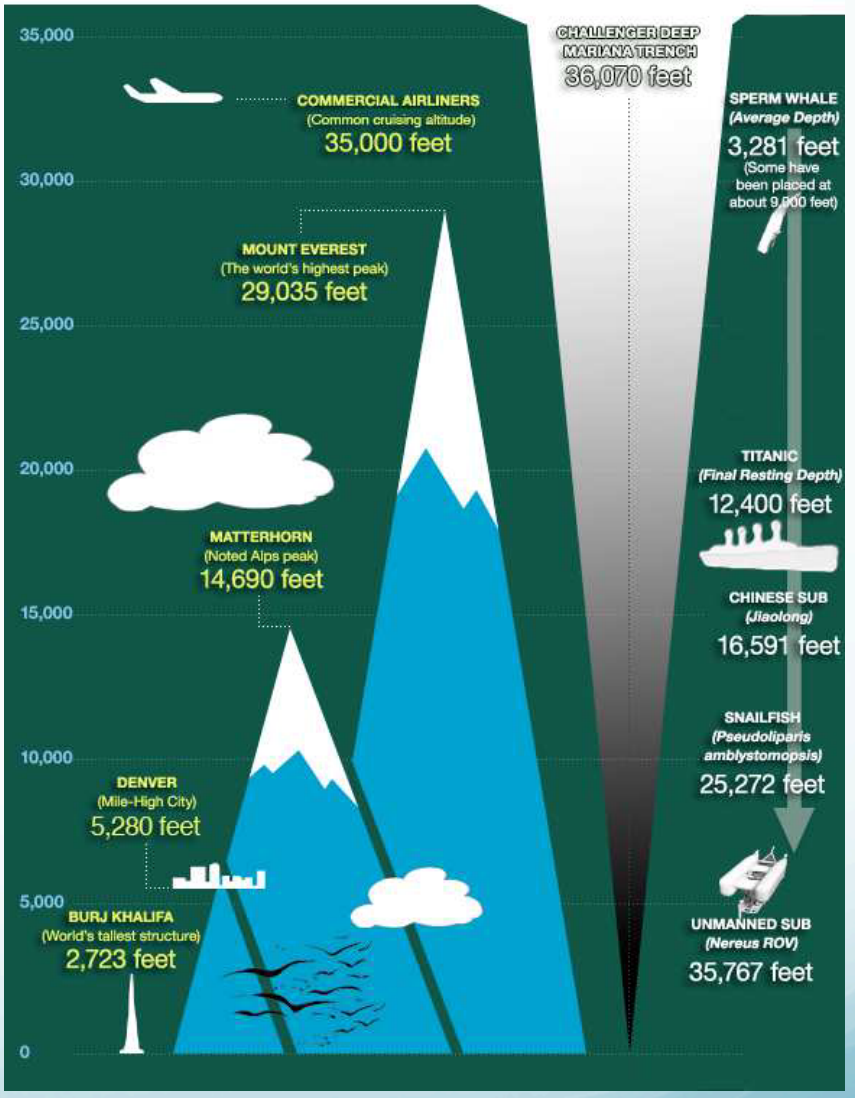
Oceanography

- Oceanography is the scientific study of oceans
- Oceans make up over 70% of the Earth's surface
- An ocean must be large and have features which set it apart from other oceans (currents, water masses, submarine boundaries, land masses)

Five Major Oceans

1. **Pacific Ocean** (largest ocean, over 30% of Earth's surface)
2. **Atlantic Ocean** (2nd largest)
3. **Indian Ocean** (3rd largest, mostly in Southern Hemisphere)
4. **Arctic Ocean** (north pole, smallest ocean)
5. **Antarctic Ocean** (south pole)

- The average depth of the oceans is approximately 4X greater than the average elevation of the continents
- Mt. Everest, the highest peak on land would completely disappear in the Marianas Trench, the deepest place in the ocean



Salinity of Sea Water

- **Salinity is a measure of the dissolved solids in sea water (the main solid is common salt: sodium chloride)**
- **On average 1000 grams of sea water contain 35 grams of salts and is written as 35‰ (note that 35‰ is also 3.5%)**

Areas of low salinity

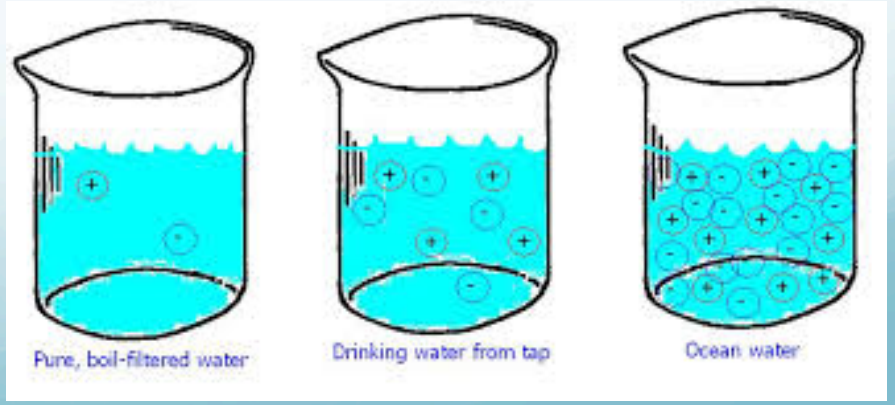
1. Areas where fresh water enters the oceans (mouths of rivers)
2. Areas of heavy rainfall (e.g., equator)
3. Areas where glaciers enter the oceans

Areas of high salinity

1. Hot, dry climates (oceans lose water by evaporation leaving the salts behind). The Mediterranean Sea and the Red Sea can be as high as 40‰ (‰ = parts per thousand)
2. In polar waters near sea ice (when sea water freezes, only freshwater ice forms thus saltier water is left behind)

Why is Salinity Important

- We can find salinity by evaporating and measuring the amount of salt left behind
- A quicker method is to measure the electrical conductivity of the water (the greater the quantity of dissolves salts, the more easily current flows)
- Salinity is important in identifying water masses : a body of water that has certain properties due to conditions at its place of origin



Composition of Sea Water

- The percentages shown are the same for all sea water anywhere in the world.
- The relative amounts of the different dissolved ions do not change even though the salinity does change.

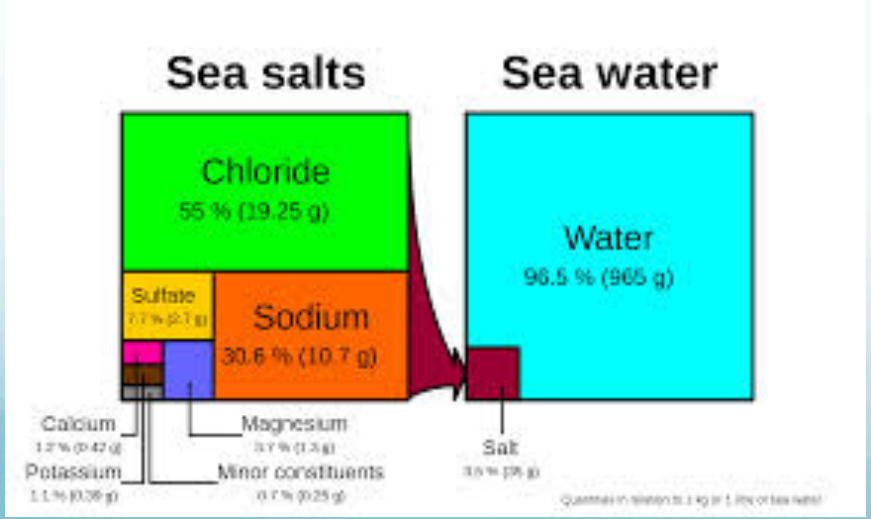
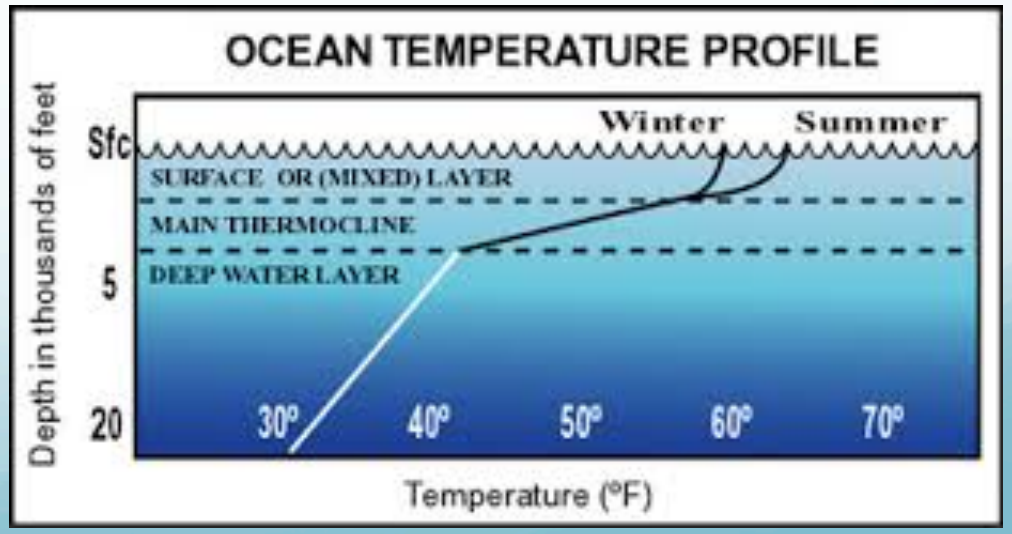


Table 9.2 The Major Dissolved Constituents of Seawater

Ion	Cl = 19‰	Percent
Cl	18.980	55.05
Br	0.065	0.19
SO_4	2.649	7.68
HCO_3	0.140	0.41
F	0.001	0.00
H_3BO_3	0.026	0.07
Mg	1.272	3.69
Ca	0.400	1.16
Sr	0.008	0.03
K	0.380	1.10
Na	10.556	30.61
Total	34.477	99.99

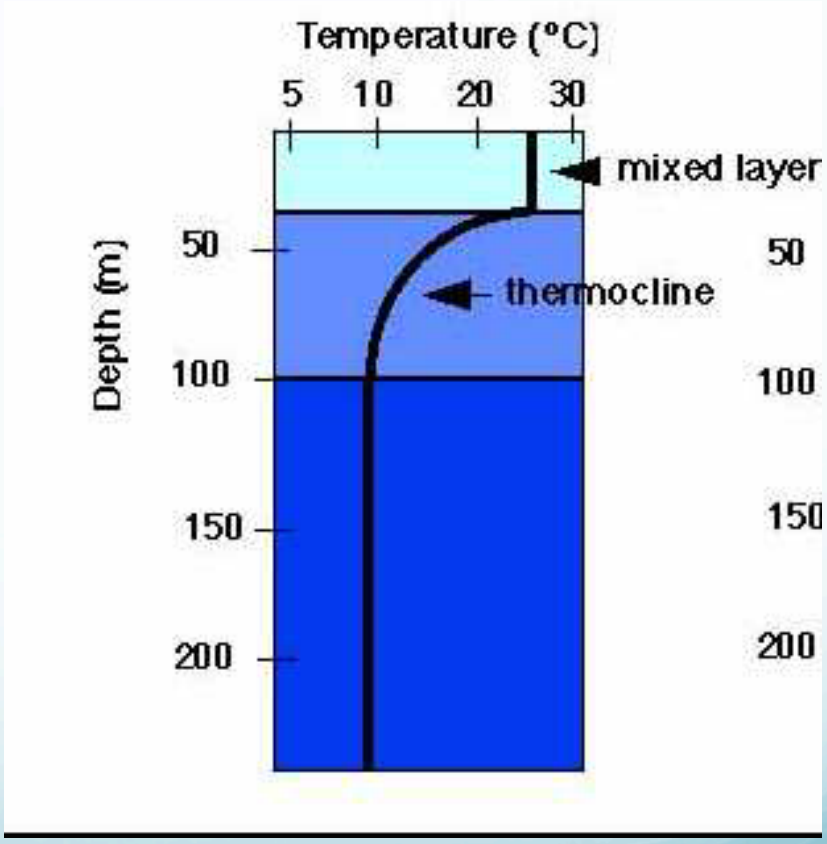
Temperature of Ocean Water

- Oceans don't heat readily
- Almost all energy comes from the sun (heat and light)
- Most solar radiation is absorbed in the top few meters only, thus ocean temperature decreases quickly with depth



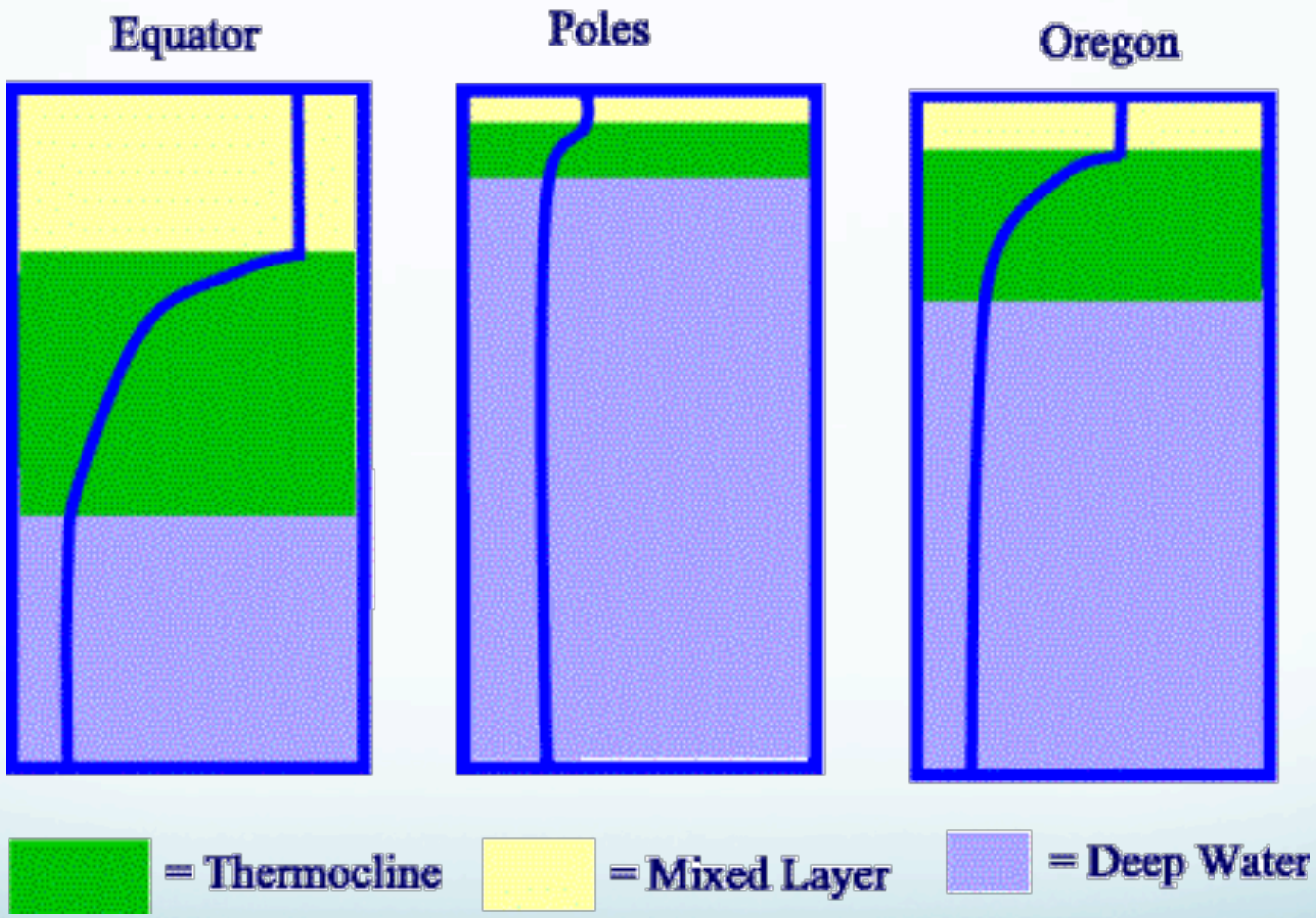
Ocean Temperature Zones: Three Layers

- Mixed Layer
- Thermocline
- Deep Water



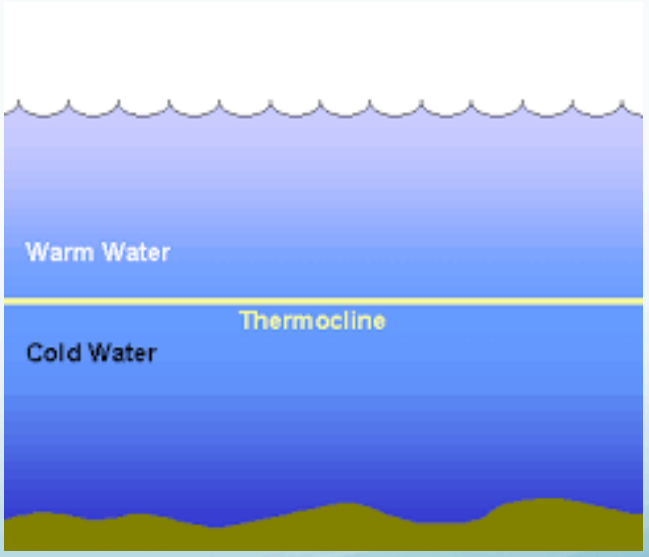
Mixed Layer:

- surface layer where wind and waved mix heat evenly throughout the zone
- warm-water layer (2% of oceans volume)
- Only place where light is present in enough quantity for plants to grow
  - High latitudes near the equator: this layer is about 100 meters deep and 30°C all year
  - Middle latitudes this layer can be 300 meter deep and have large temperature changes (10° change between summer and winter)
  - Near poles this layer may be -2° all year


Equator
Poles
Oregon
= Thermocline
= Mixed Layer
= Deep Water

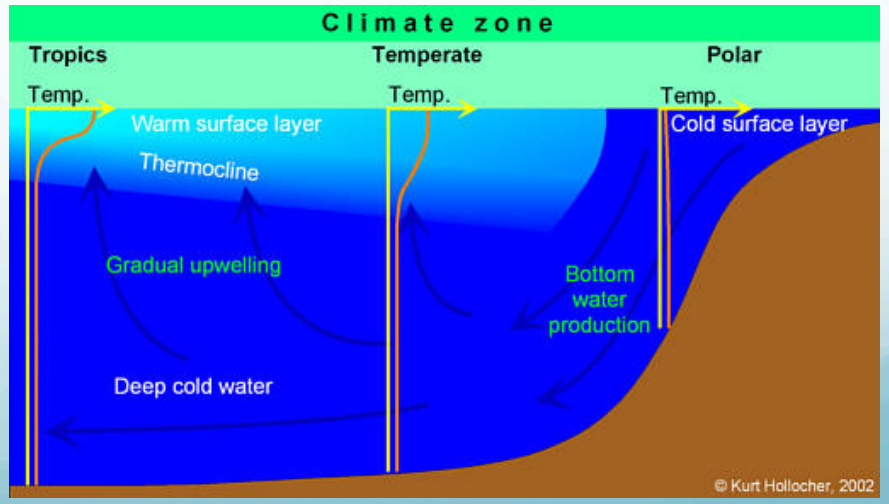
Thermocline:

- layer under the mixed layer
- temperature rapidly drops to about 5°C
- This layer goes to about 1000 meters deep

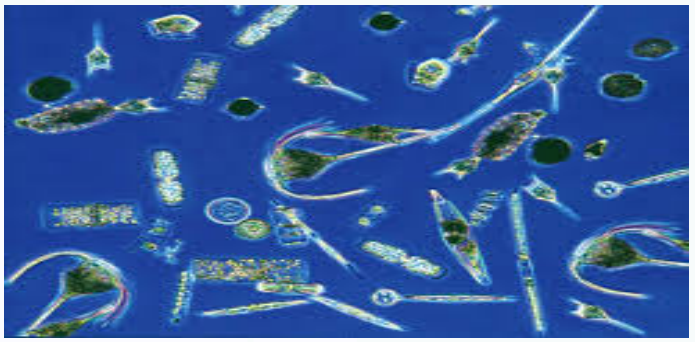


Deep Water:

- Approx 2° C
- Depth is around 1000 – 4000 meters
- In the polar areas the oceans are cold throughout and since cold water is denser it sinks and travels away from the polar regions and thus is found underneath other ocean water at almost all latitudes.



Life in the Sea



- Most in Mixed Layer (sunlight can penetrate)

Phytoplankton:

- microscopic plants
- basic food source for ocean life (almost all life in the ocean depend on them) eg. Diatoms
- able to produce their own food (photosynthesis)
- Phytoplankton are eaten by Zooplankton whom are eaten by everything from tiny fish to giant whale

Oxygen

- Almost all living things need oxygen to convert their food into energy
- Oxygen comes from either the air mixing with ocean water or it is given off by plants living in the water
- Therefore, the mixed layer has the most oxygen
- The deep ocean accumulates carbon dioxide since no plants are found here to consume carbon dioxide (no photosynthesis)

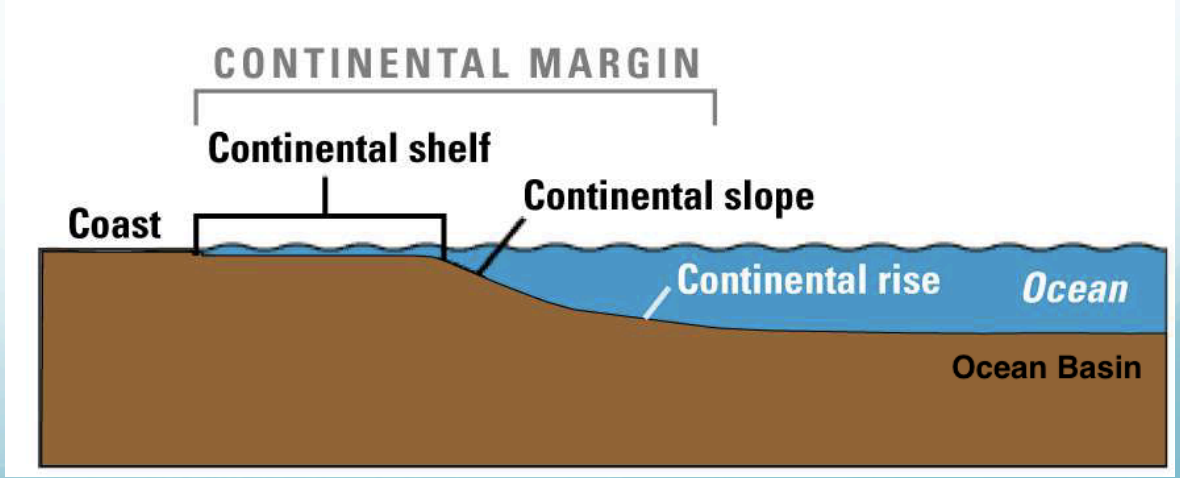
Ocean Floor Vents (eg. Black Smokers)

- Some animals can live here (2.5 km below the oceans surface)
- They don't require sunlight for energy or phytoplankton for food
- Certain bacteria thrive on the hydrogen sulfide produced here and they become food for larvae and other organisms (barnacles, giant clams, white crabs, giant tube worms) living near the vents

Ocean Floor

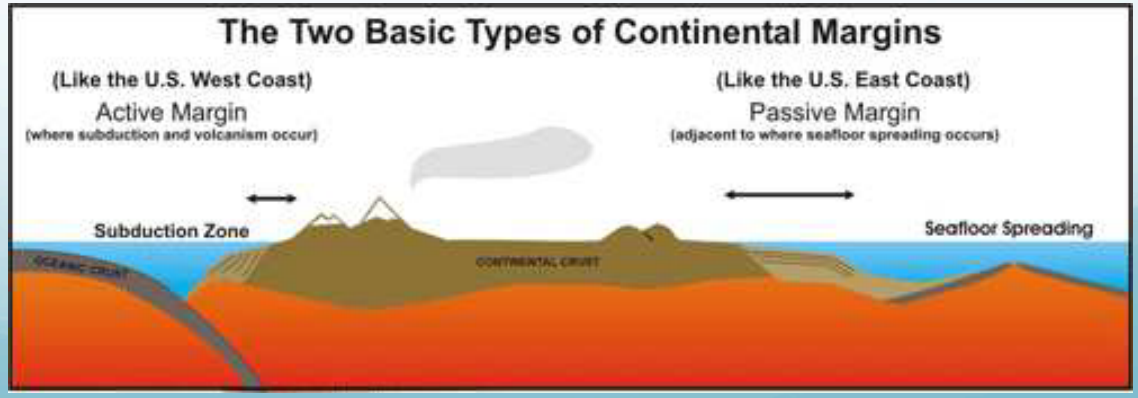
The ocean floor is divided into two major regions

1. Continental Margins
   - Continental shelves
   - Continental slope
   - Continental rise
2. Ocean Basins



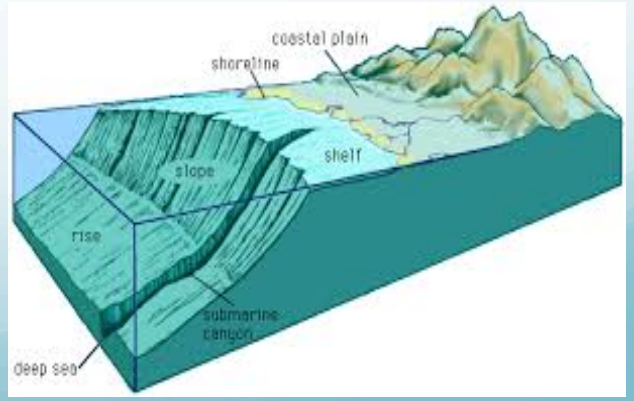
Continental Shelf

- Part of the continent that is underwater (about 130 m)
- Extends from the shoreline to the shelf edge
- An active continental margin: very narrow and bordered by an ocean trench, has coastal mountains along the shoreline (subduction zone)
- A passive continental margin: broad shelf some can be 300km wide, bordered by a coastal plain (seafloor spreading)



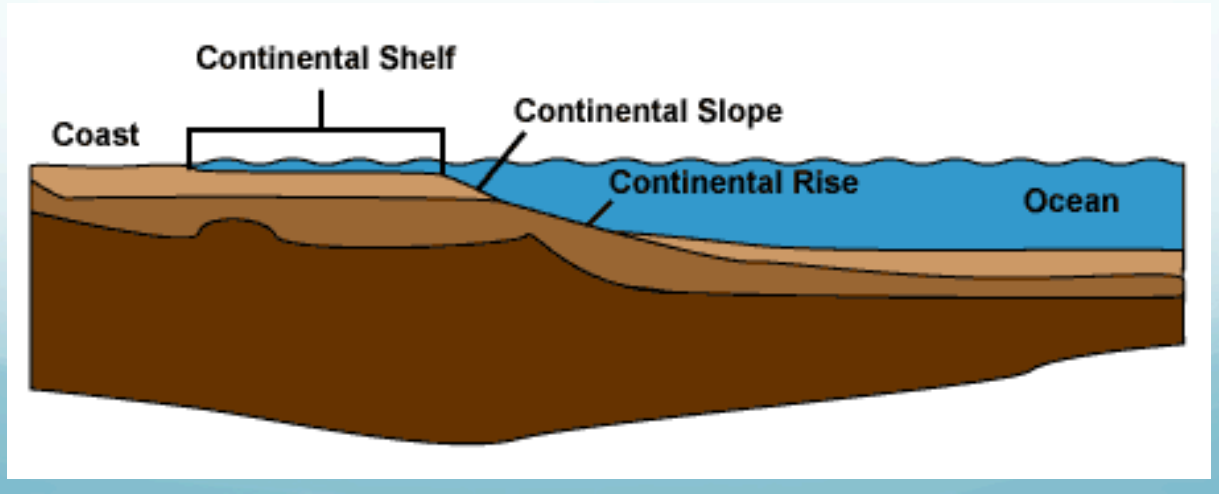
Continental Slope

- Begins at the shelf edge where water depth starts to increase rapidly (it slopes down toward the deep ocean)
- Changes from continental crust to oceanic crust
- About 200km wide and 3km deep and has many gullies and small valleys
- Undersea landslides = turbidity currents (powerful current of mud and sand with water, causing erosion)
- Gigantic gully = submarine canyon



Continental Rise

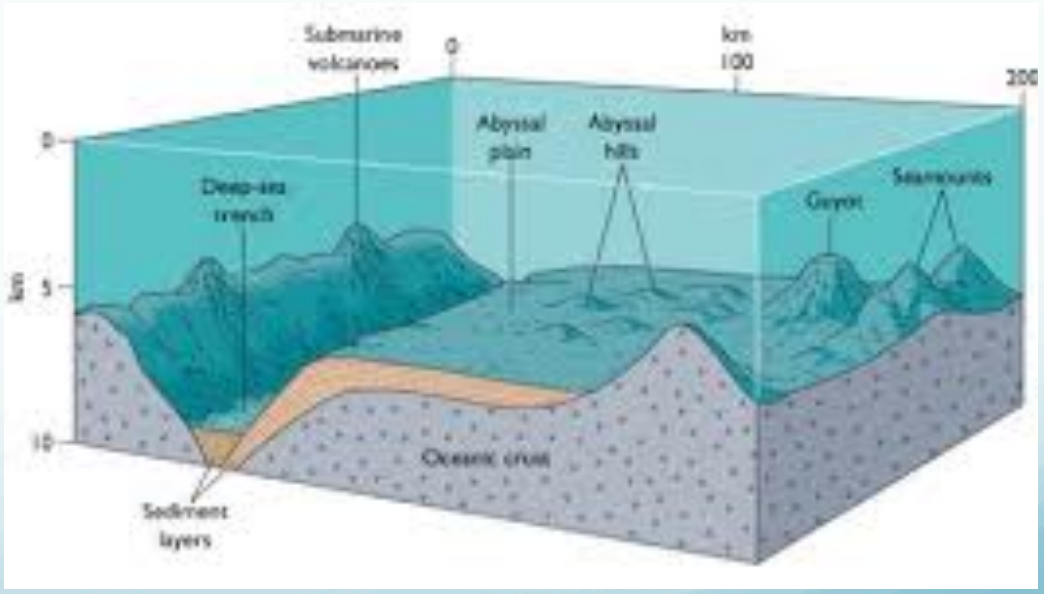
- Gently sloping region between the continental slope and the ocean basin
- Deposition of sediment several kilometers thick
- Only found at passive continental margins
- Can be up to 1000km wide with a very gentle slope



Ocean Basins

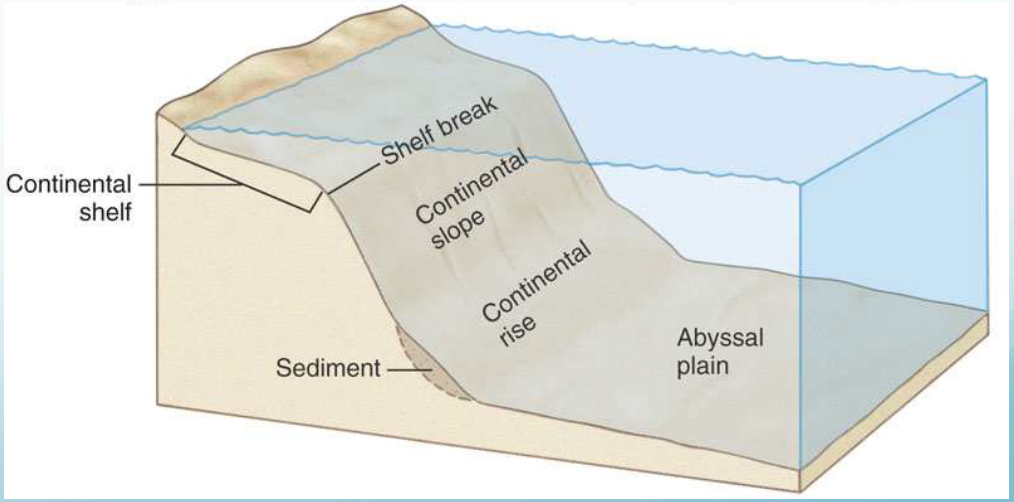
Features of the floor of the deep sea include

- Abyssal plains
- Abyssal hills
- Seamounts
- Guyots
- Coral Atolls
- Trenches
- Mid-Ocean Ridges
- Fracture Zones



Abyssal Plains

- 3000-6000m deep
- They are so flat that they are the flattest areas on the Earth's surface
- Made of sediments from the continents carried by turbidity currents



Abyssal Hills:

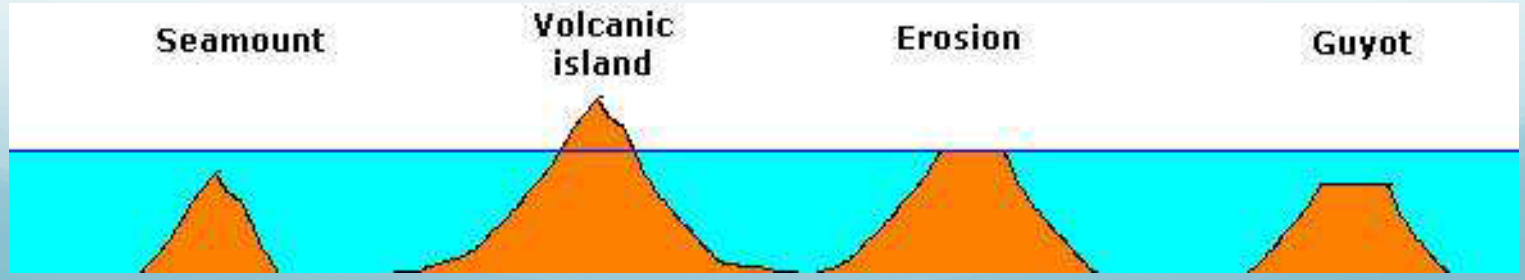
- small rolling hills, 1-10 km wide and a few hundred meters high

Seamounts:

- cone-shaped mountain peaks, volcanic in origin and seem to be related to plate boundary activity (and/ or hot spots)

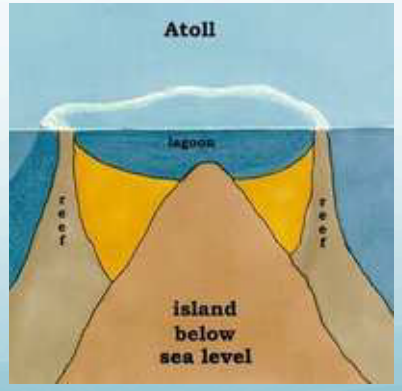
Guyots:

- look like seamounts with their tops sliced off (flat-topped seamounts), tops were originally above sea level but removed by wave action (erosion)



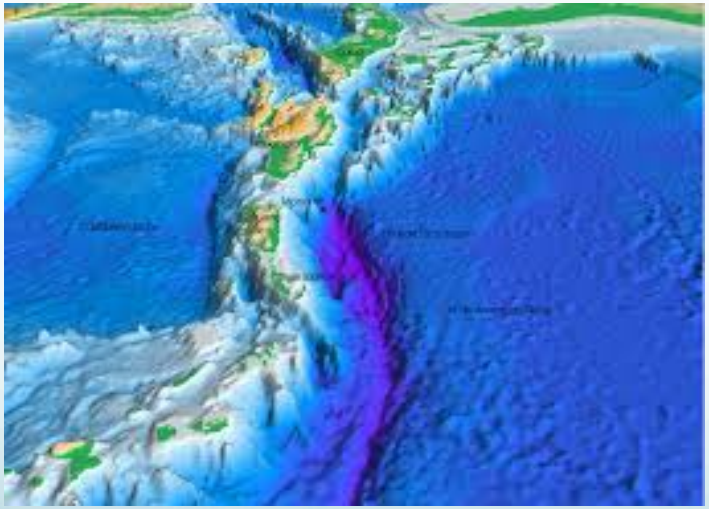
Atolls:

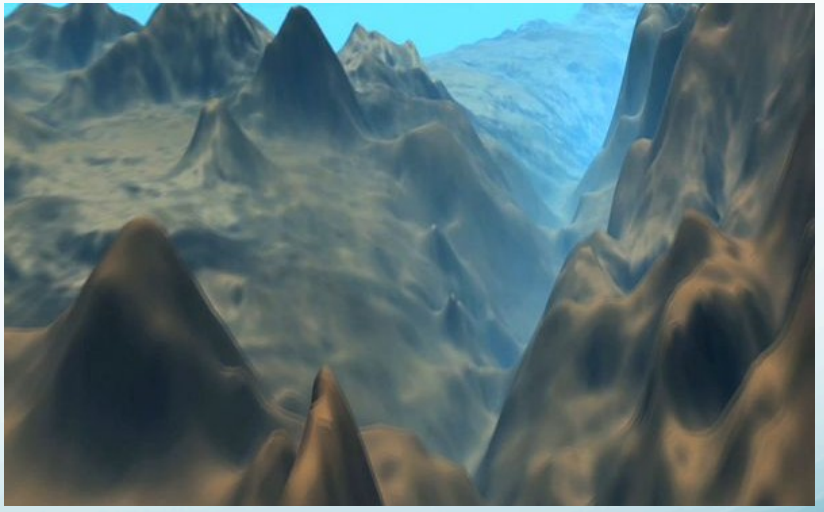
- ring shaped coral islands
- Begins to form when a coral reef forms around a volcanic island
- as the seafloor around the island sinks, the coral sinks with it but new corals grow on top of the old coral
- Eventually the volcanic mountain is completely below sea level but the circular reef (atoll) is left with a central lagoon.



Trench:

- long narrow steep-sided troughs that runs parallel to either a continental margin or chains of volcanic islands (almost all in Pacific Ocean)
- Areas where crust subducts under another plate

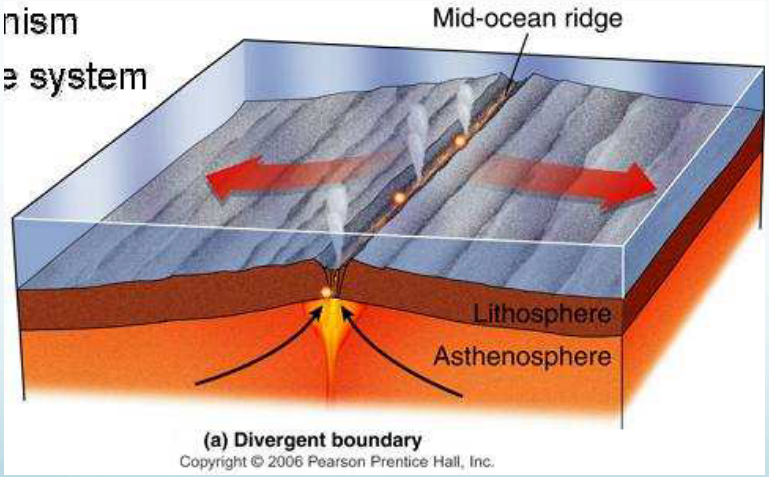


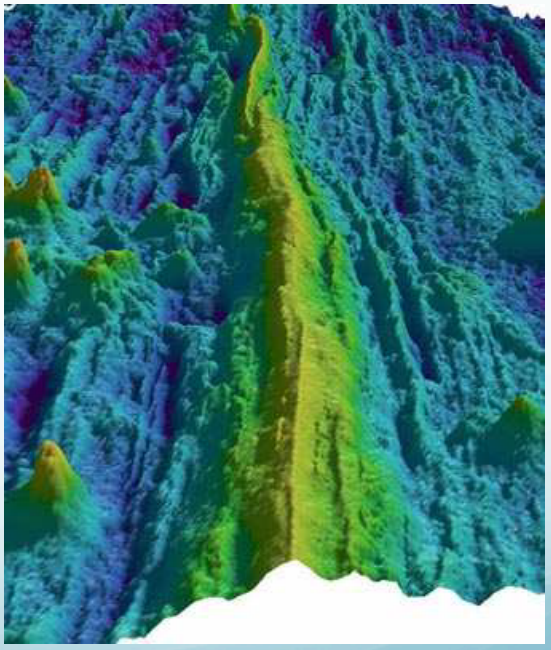


Mid-Ocean Ridges:

- found at divergent plate boundaries, area where new oceanic crust forms as two lithospheric plates move apart
- Huge undersea mountain ranges

e.g. Mid-Atlantic Ridge





Ocean Floor Sediments

Four main classes:

1. **Oozes**
2. **Muds and Clays**
3. **Turbidites**
4. **Authigenic Sediments**

1. Oozes:
   - sediments made from microscopic shells
   - Calcareous ooze: contain calcium carbonate
   - Siliceous oozes: contain silicon dioxide
2. Muds and Clays:
   - mixtures of fine particles that settle on the ocean floor
   - May come from land, ash/dust from volcanoes, icebergs

3. Turbidites:

- deposits made by turbidity currents (these are currents that sweep material down the submarine canyons and out over the abyssal plains)
- Form graded beds

4. Authigenic Sediments:

- Authigenic (means formed in place) so these sediments don't settle on the bottom but form directly on the seafloor (eg. Manganese nodules)