

What drives the bottom currents?

1. upwelling and downwelling water
2. thermohaline circulation

Upwelling

- surface currents move away from each other
- surface currents move away from a landmass
- water rises up
- surface divergence

Downwelling

- surface currents collide or
- are forced against land masses
- water sinks
- surface convergence

Both upwelling and downwelling are nearly permanent.

Permanent zones (Fig. 9.24)

- tropical convergence
- Northern and Southern convergence
- Arctic and Antarctic convergence
- Northern and Southern divergence
- Antarctic divergence

Seasonal zones (Fig. 9.15)

- of the coast of North America
- result of change in wind direction and Ekman transport
- summer upwelling produces the band of COLD coastal water at San Francisco (formation of the frequent summer fog little above headlight high)

Upwelling and downwelling are crucial for the ocean productivity.

- deep ocean water loaded with nutrients rises up and stimulates algal growth → plankton growth → anchovies growth ⇒ **ocean productivity**
- in downwelling areas → lack of nutrients ⇒ **ocean starvation**

Wind driven surface currents are coupled with Thermohaline circulation ⇒ *complex system of the ocean water flow*

Temperature & salinity
control
the **density of water**

More dense water will sink

Less dense water will rise

Above 4°C Temperature ↑ Density ↓

Below 4°C Temperature ↓ Density ↓

Salt ↑ Density ↑

Differences in density are incredibly settled

The structure of an ocean is defined by layers of water with characteristic salinity – temperature combinations that produce the same DENSITY.

See Figure 6.11

Put the following waters on diagram in Fig. 6.11

	Salinity	Temp
	%	° C
1. North Atlantic Deep Water	34.9	3
2. Antarctic Intermediate Water	34.4	5
3. Antarctic Bottom Water	34.8	-0.5
4. South Atlantic surface Water	36.5	25
5. Mediterranean Water	36.0	10

How deep will water sink from the surface depends on its **density!**

Sinking-dense-water causes convective water movement or vertical circulation.

Because the density is controlled by salinity and temperature, this circulation is known as thermohaline circulation.

The thickness and horizontal extent of each layer depend on

- a) the rate of water formation
- b) the size of the surface region from which the water came

All the factors controlling the density of the ocean are AT THE SURFACE.

1. Evaporation vs. Precipitation
2. Freeze water → salty water remains
Melting → water less salty
(Ping-Pong of North and South Pole with salinities)
3. Rivers (Amazon, Mississippi, Congo...)
Less salty ocean off the mouths of the really large rivers (Amazon 200 miles offshore)

Vertical layering of the ocean is density driven.

Thus, dependent on their density, waters originating at the surface will either stay at the surface (less dense) or will sink to certain depth related to their density.

See Fig. 9.23.