Hydrosphere

Wednesday, April 11 2012, 9:12 PM

Ocean Floor

Continental shelf: Angle is 1º, depth is 120-150 m and it extends generally 70 km into the sea. But this varies a lot - in west coast of S America the continental shelf is virtually absent while in east coast of N America it is 120 km wide. In Bay of Bengal, it is very wide as well.

Continental slope: @ the end of continental shelf, slope steepens to 5º. Its end marks the end of continental blocks.

Continental rise: @ the end of continental slope, slope becomes gentle again to 0.5º to 1º. Its end marks the end of continental margin.

Abyssal plains: Slope is 1:1000. They occupy ~40% of the ocean floor. They are more common where land derived sediments are in great supply. The irregular topography gets buried.

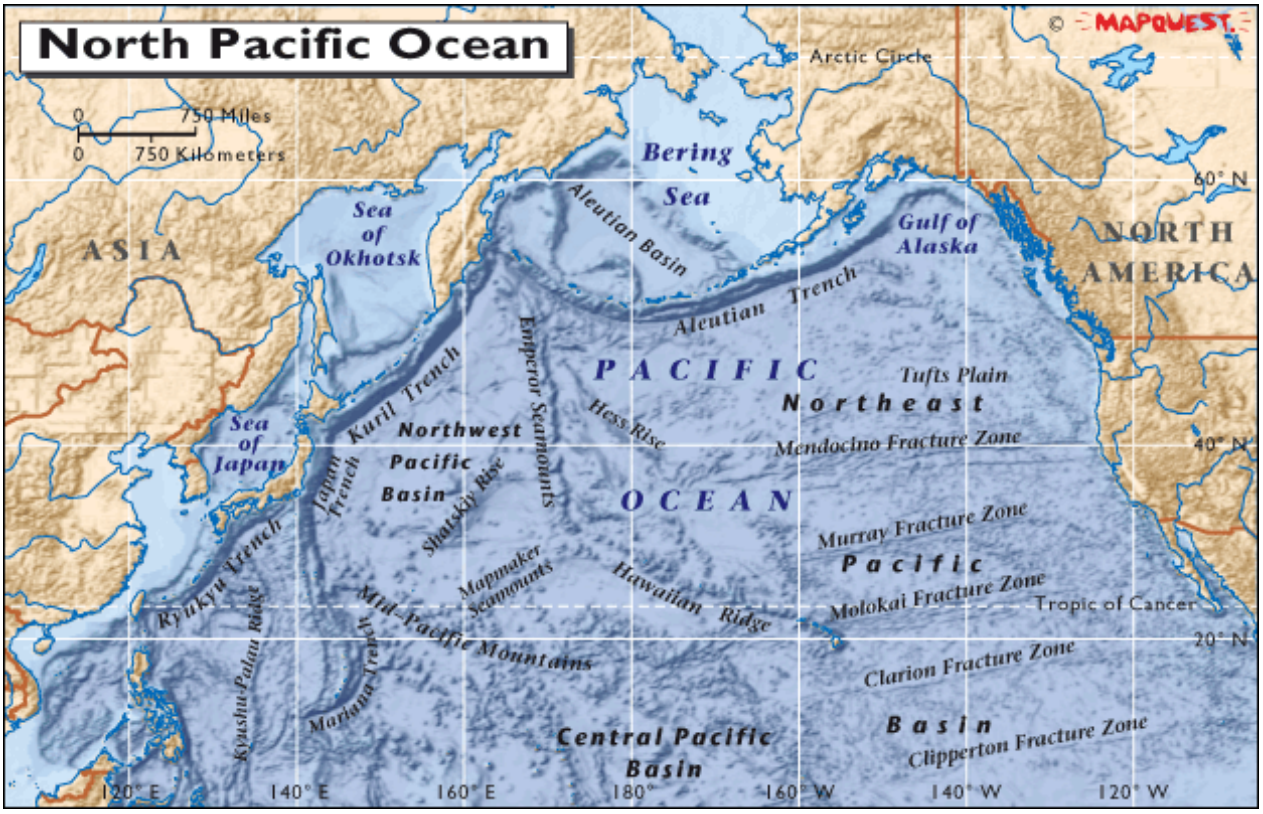
Abyssal hills, sea mounts & guyots: Sea hills on abyssal plains rising ≤ 1000 meters from the floor are called Abyssal hills. Sea hills on abyssal plains rising > 1000 meters from the floor are called sea mounts. Guyots are seamounts which have flat tops. All of them are generally of volcanic origin.

Submarine trenches, deeps and canyons: Long narrow and steep depression on abyssal plain is called a trench. It is usually found alongside a folded hill and results from fault or down folding. The deeper trenches (> 5500 meters) are called deeps. Canyons are deep concave gorges on continental shelf, slope or rise. They are generally of 3 types - (a) beginning @ the edge of continental shelf and extend down the continental slope to great depths. (b) beginning @ the mouth of the river itself and extending over the continental shelf. (c) those which have a dendritic appearance and cut across the shelf and slope as well. Sometimes they form a fan @ the base.

Banks, shoals and reefs: A bank is generally a flat topped elevation located in the continental margin. The depth of water over a bank is small but enough for navigation. During the pleistocene ice age, the tops of these banks were eroded by glaciers. Banks are host to most productive fisheries grounds in the world. Shoals are detached elevations @ shallow depth. They are dangerous for navigation. Reefs are organic deposits forming a ridge.

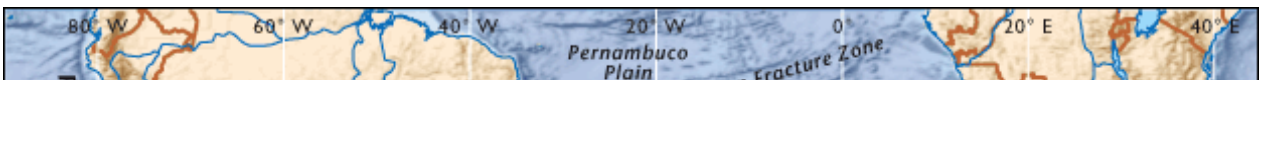
Strait, sound / channel: Both straits and channels are narrow pieces of water connecting two larger bodies of water. Straits is narrower than a channel or sound.

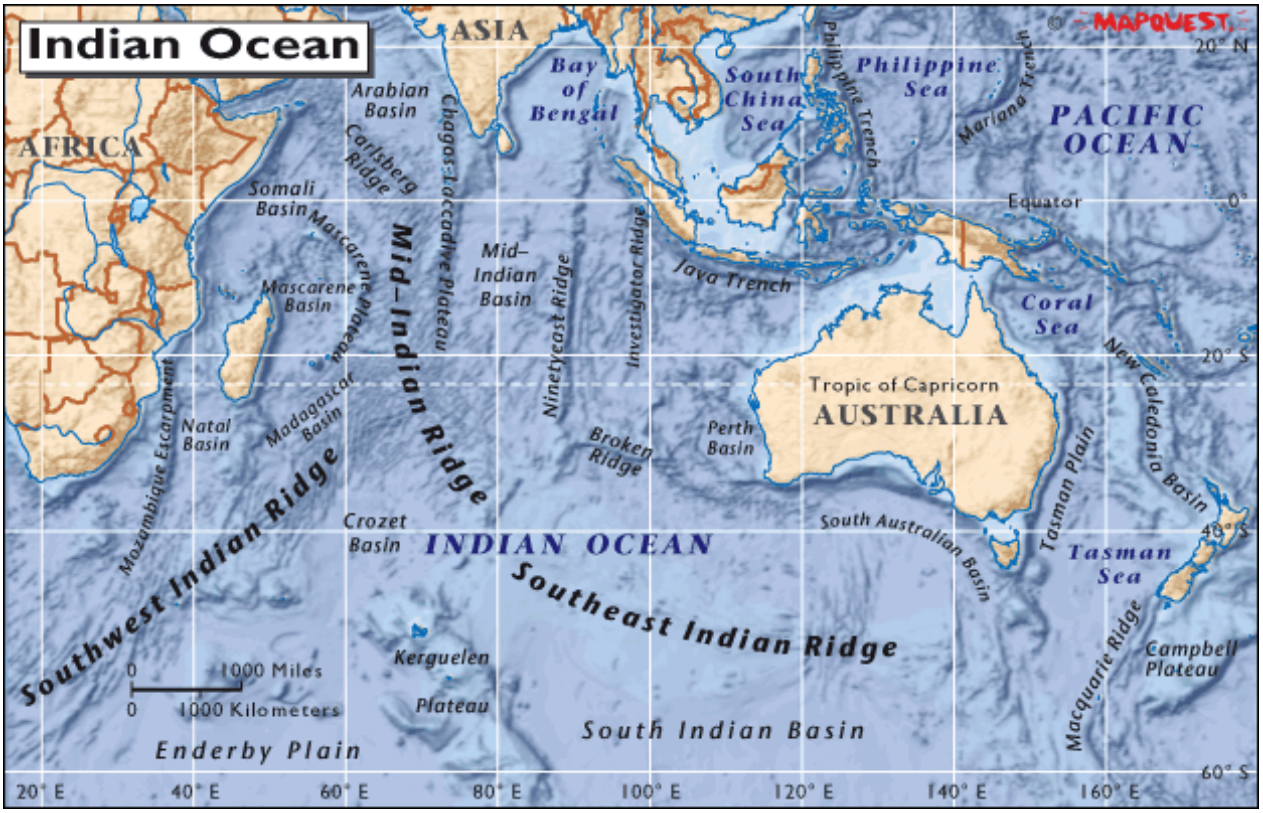
Ocean Floor Maps




South Pacific Ocean
Central Pacific Basin
Northeast Pacific Basin
East Pacific Rise
Peru Basin
Peru–Chile Trench
SOUTH AMERICA
Equator
0°
Coral Sea
20° S
Tropic of Capricorn
New Hebrides Trench
Tonga Trench
AUSTRALIA
New Caledonia Basin
Tasman Plain
Louisville Ridge
Kermadec Trench
Southwest Pacific Basin
PACIFIC OCEAN
Sala y Gomez Ridge
Nazca Ridge
Challenger Fracture Zone
40° S
Tasman Sea
Campbell Plateau
Macquarie Ridge
Southeast Pacific Basin
Humboldt Plain
Eltanin Fracture Zone
Udintsev Fracture Zone
0 750 Miles
0 750 Kilometers
60° S
Pacific–Antarctic Ridge
140° E
160° E
180°
160° W
140° W
120° W
100° W
80° W


North Atlantic Ocean
© MAPQUEST.
Arctic Circle
Norwegian Sea
Hudson Bay
60° N
Northwest Atlantic Mid-Ocean Canyon
Imarssuak Seachannel
Reykjanes Ridge
Maury Seachannel
North Sea
NORTH AMERICA
EUROPE
Biscay Plain
Sohm Plain
ATLANTIC
Mid-Atlantic Ridge
40° N
ASIA
Mediterranean Sea
Hatteras Plain
Bermuda Rise
OCEAN
Gulf of Mexico
Cape Verde Plain
Tropic of Cancer
Puerto Rico Trench
20° N
0 750 Miles
0 750 Kilometers
AFRICA
Caribbean Sea
Middle America Trench
Demerara Plain
Doldrums Fracture Zone
PACIFIC OCEAN
SOUTH AMERICA
100° W
80° W
40° W
20° W
0°
20° E
40° E


80° W
60° W
40° W
20° W
0
20° E
40° E
Pernambuco Plain
Fracture Zone



Ocean Waters and Their Circulation

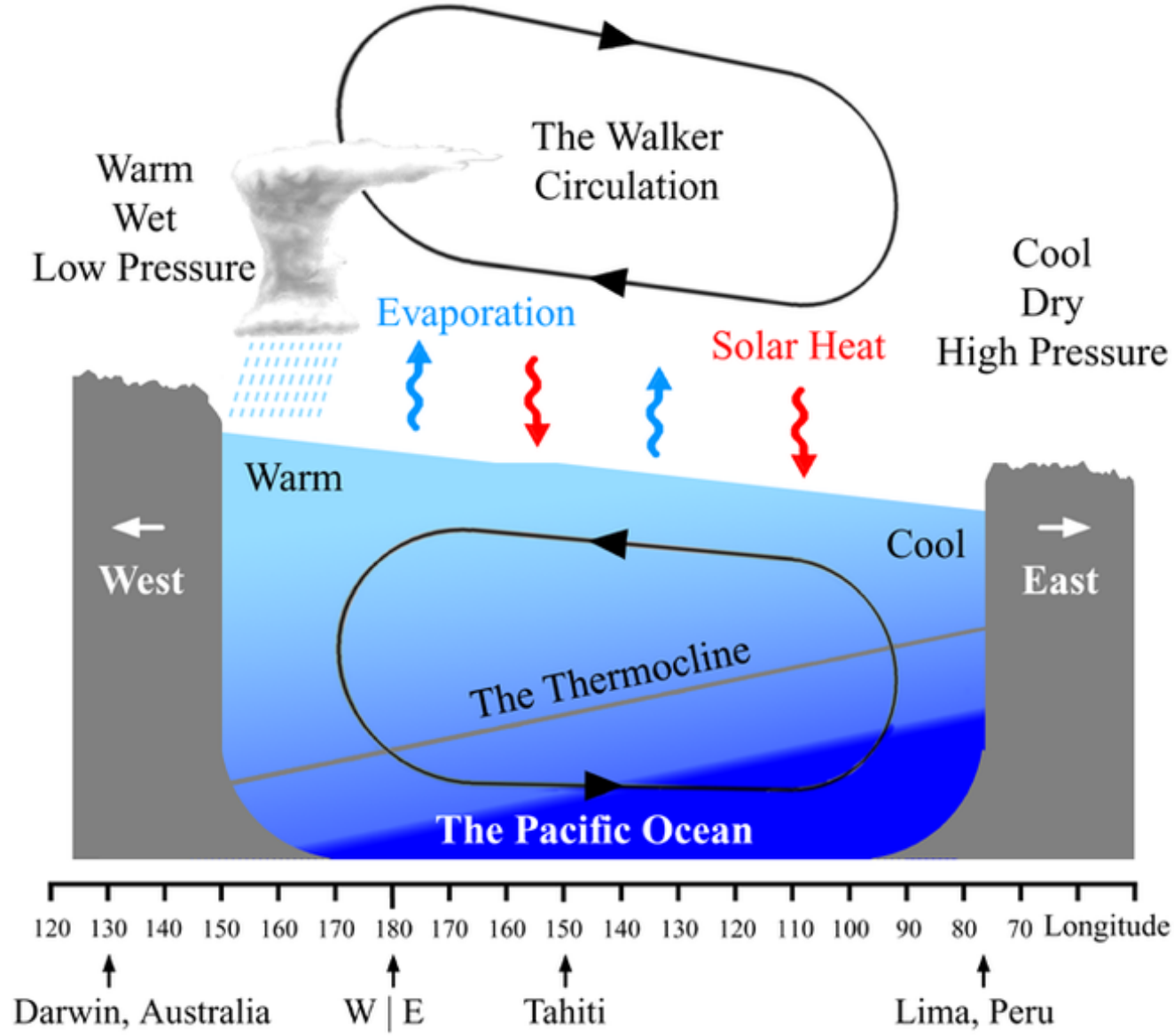
Annual range of temperature is lowest in Pacific due to its larger size. Also the range is greater in N hemisphere than in S hemisphere due to more expanse of water in south.

In tropical zones, western sections of the oceans are warmer than the eastern sections as currents and winds blow from east to west (they carry with them water vapor hence the latent heat of evaporation is lost by the eastern sections). In temperate zones, westerlies prevail so the eastern sections of oceans are warmer than the western sections of the oceans.

Ice floes vs ice bergs: The extreme north and south oceans have ice fields. During summers they move polewards and during winters they move equator-wards. In summer the marginal ice fields break away and begin to drift towards equator. These are called ice floes. In summers only parts of glaciers also break away from its tongue as it reaches the sea and begin to drift towards equator. They are called ice bergs.

Sub-surface temperature: There is a decrease in temperature with increase in depth. Up to a depth of 100 meters, there is no change in temperature. Below that up to 1800 meters, it falls to 2° C. From 1800 meters to 4000 meters the temperature falls from 2°C to 1.6°C. The rate of decrease is higher @ equator than @ poles (surface temperature is higher @ equator)

@ equator).
Upwelling & downwelling: Upwelling is when the warm surface water is replaced by cooler water from the depth which is rich in nutrients and hence provides good fisheries ground. Upwelling leads to dry coastal areas. In tropical zone it takes place as the trade winds and N & S equatorial currents drag the surface water from east of the ocean to the west. Thus a vacancy is created in the east @ the surface and water from below moves up along the coast of S America. Downwelling is the opposite i.e. surface water sinking to the ground when it becomes more saline and dense. Downwelling causes O_2 to mix in layers below.
Distribution of salinity: Highest salinity is found near tropics and decreases towards equator (heavier rains) and poles (less evaporation). @ poles, the freezing of ice leaves salt in the water which becomes more saline, dense and hence sinks. So most saline areas in poles are deep waters and surfaces have low salinity. In general, salinity decreases with depth. In middle latitudes, it increases up to 35 meters and thereafter decreases. In tropics it decreases with depth.
Al-Nino & La-Nina: La-Nina condition is the strengthening of normal condition in the Pacific. In the normal condition, there is low pressure over west Pacific ocean or Indian ocean (Australia coast) and high pressure over east Pacific ocean (S America coast). The ocean temperature is cooler near S America due to upwelling. In Al-Nino, these conditions are reversed.



The **Walker circulation**is seen at the surface as easterly trade winds which move water and air warmed by the sun towards the west. The western side of the equatorial Pacific is characterized by warm, wet low pressure weather as the collected moisture is dumped in the form of typhoons and thunderstorms. The ocean is some 60 cm higher in the western Pacific as the result of this motion. The water and air are returned to the east. Both are now much cooler, and the air is much drier. An El Nino episode is characterised by a breakdown of this water and air cycle, resulting in relatively warm water and moist air in the eastern Pacific.

Sound speed with depth: It decreases with decreasing temperature, pressure and salinity. Temperature decreases rapidly in the upper kilometer of the ocean and dominates in this region. Thereafter the temperature change with depth is small and speed is determined by the pressure increase with depth. Vertical changes of salinity are too small to have an impact.
Waves: The size and force of the wave depends on - (a) velocity of the wind. (b) duration of the wind. (c) distance over which the wind blows unhindered (the fetch). If the water is deep (so that bottom doesn't interfere with the wave), winds blow over long distances for long waves are bigger.

blow over long distances for long, waves are bigger.

Sea wave, swell wave, surf wave, swash and backwash: Normally several trains of differing wave lengths and directional movements of waves occurs in seas. This overall irregular and chaotic wave pattern is called sea. If the wave moves away from the disturbance zone into a smooth zone, there appears a uniform pattern of equivalent wavelength and amplitude. This is called swell. But as the swell reaches shore, the pattern gets disturbed due to friction from the shallow sea floor and the wave breaks. The lower part of the wave travels more slowly than the upper part so its height increases, they crowd together and eventually break. This breaking is called surf. Once the wave breaks the top fallen over part is carried over to the shore. This is called swash. As the water goes back to the sea it is called backwash.

Ocean Currents

In lower altitudes, warm currents flow on the eastern shores while cold currents flow on the western shores of the continents.

In middle latitudes, warm currents flow along the western shores of the continents while cold currents on the eastern shores.

Drift is slower and less clearly defined than a current which is slower and less clearly defined than a stream.

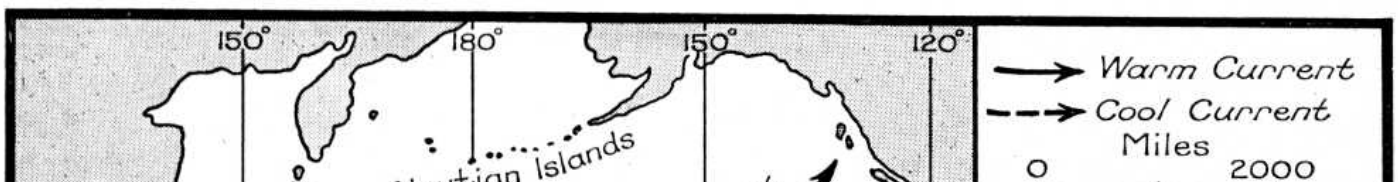
Gyres: They are the loops of the currents formed in the oceans. N Atlantic gyre is also called Sargasso sea (due to presence of seaweed called Saragossa on the surface). S Atlantic gyre is called Navigator gyre (after the Portuguese prince Henry, the navigator), N Pacific gyre is called Turtle gyre, S Pacific gyre is called Hyerdahl gyre, Indian ocean gyre is called Majid gyre.

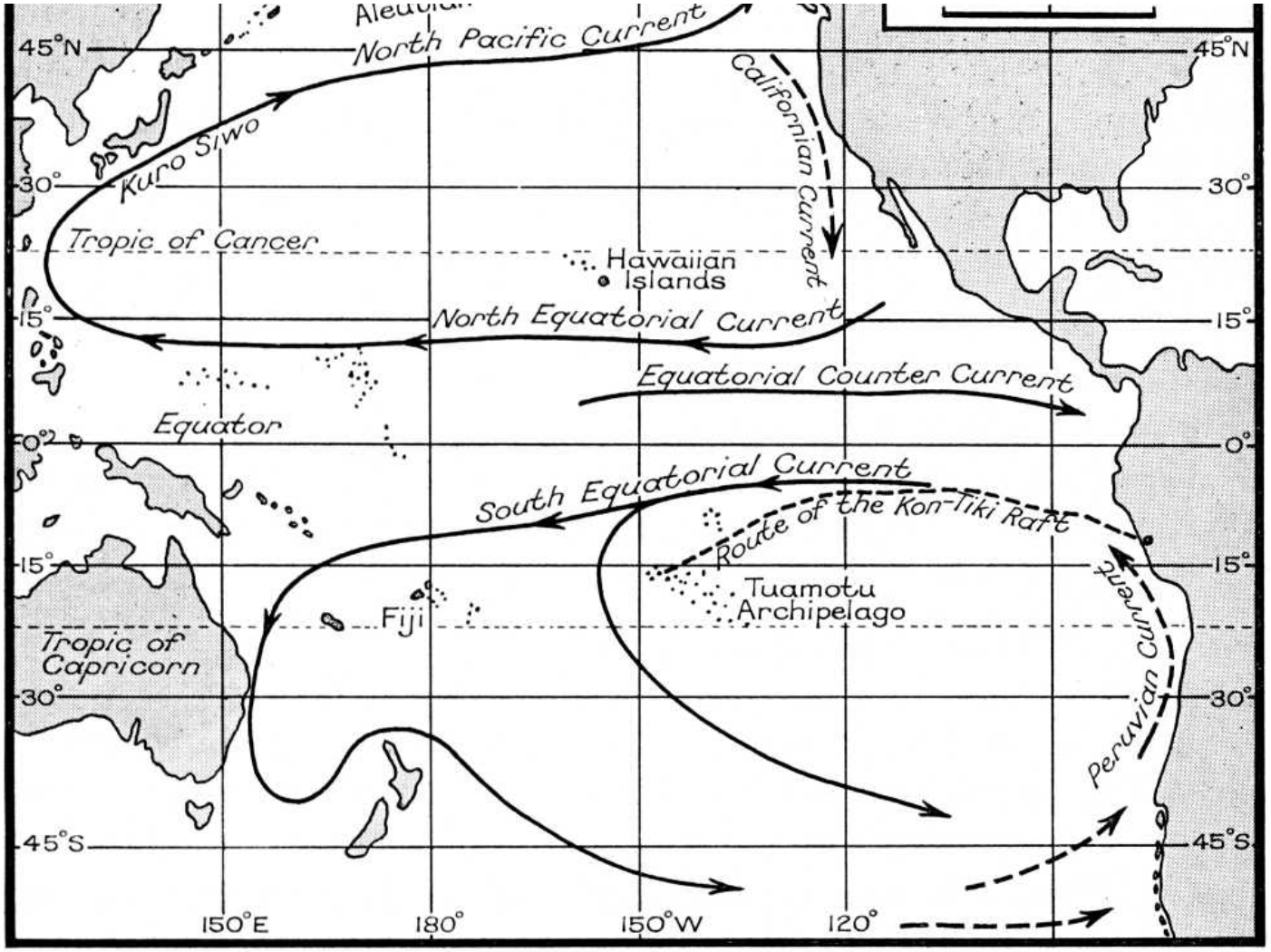
Deep water currents: They are created by density differences which in turn are created by temperature and salinity difference (hence they are also called thermo-haline circulations). They are much slower (10-20 km per year) and bigger in mass than the surface currents.

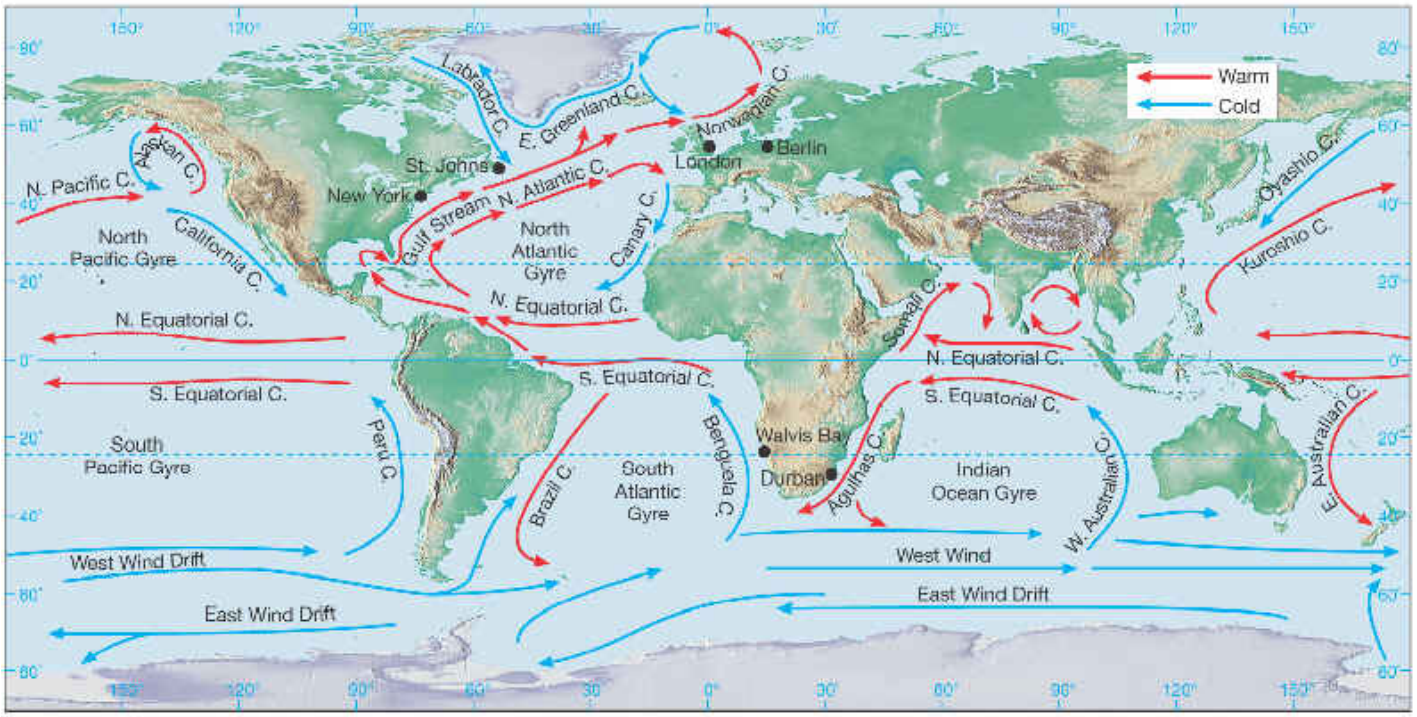
Ekman spiral and transport: When the wind pushes the water in its direction, the surface layer begins to move but gets deflected towards the right (in N hemisphere) due to Coriolis force. This surface layer pulls along the layer immediately below with it. But as that layer moves it gets deflected further to right. Successive layers move progressively right until a layer moves 90º to the direction of the wind. This is called Ekman spiral. Ekman transport is the movement of the 90º layer.

(A) There r 2 types of ocean circulations- Wind induced and Thermohaline. Thermohaline circulations are due to changes in density (which in turn is caused due to changes in temperature and salinity...hence the name). Thermohaline circulations can be both - Vertical(i.e upwelling or downwelling eg: when Gulf stream meets East n West greenland currents) or Horizontal(eg: Density differences btw Mediterranean Sea and Atlantic Ocean cause a surface current flowing into Mediterranean and sub-surface current flowing out of it).

(B) Ekman Transport is a result of friction and coriolis force on all moving objects i.e winds and ocean currents. Coriolis force is a fn. of velocity and velocity of winds increases as we go higher up due to reduced friction. hence more coriolis force which implies more rightward movement in the Northern Hemisphere. Thus a schematic of the wind velocity as a fn. of its height would be a spiral called Ekman Spiral.

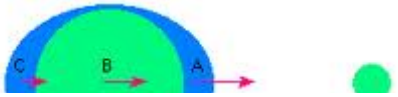




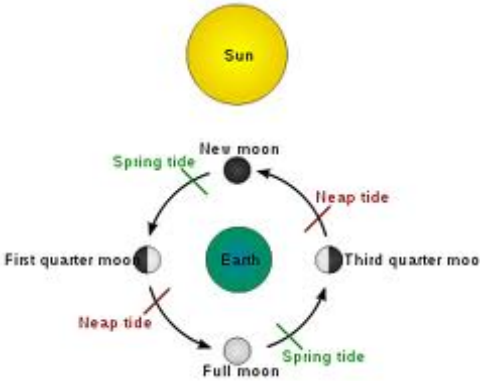


Tides

Tidal bulges: Tidal bulge appears not only @ A but also @ C. This is because @ C, the centrifugal force is the highest.



Spring tides & neap tides: Spring tides are maximum tides which occur when moon, earth and sun are in one line (either in same direction or opposite). Neap tides are minimum tides which occur when moon, earth and sun are @ 90º.



Tidal bore: When a tide enters a narrow and shallow estuary of a river, the front of the tide appears to be vertical (due to piling up of water because of bottom friction). This is called tidal bore.
Tidal current: When a gulf is connected with a sea through a narrow channel, during tides water flows in and out. This is called tidal current.
Kallakkadal: These are ocean swells which occur in Indian ocean during April-May. They originate in S Indian ocean due to storms and propagate northward with ocean currents. They get amplified as they reach shores. The flooding is most severe on spring tides.