Ocean Current

Ocean Current are the horizontal movement of the water over long distances in a fairly defined direction having global circulatory pattern.

Ocean current are surfacial & subsurfacial motion / flow of water induced by the pressure-gradient force in the suboceanic realm. Ocean currents are like the rivers flowing over colder & much denser thermocline layer, with global circulatory pattern, corresponding to the planetary wind system.

Pressure gradient force = $Z \cdot d \cdot g$ | PGF more Velo. more

Z = The depth of water

d = Density - » - »

g = gravitation, (high at pole)

Ocean current influences the physical properties of water, dynamic motions & distribution of marine life. It also helps maintaining the latitudinal heat balance. They influence the coastal climate & human life at large; because 2/3rd population of the world distas live within a distance of 250 km from the coast line.

Types of Current

i) Based on temp → Cold & warm

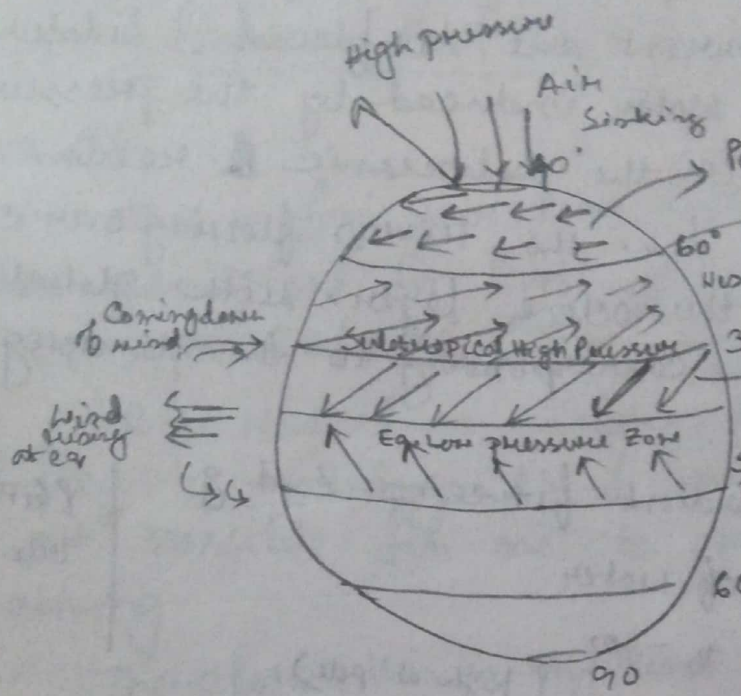
ii) Based on Velocity

	Velocity	Volume
Stream	very high	high
Drift	less	very high
Current	high	high
Channel	very high	very low

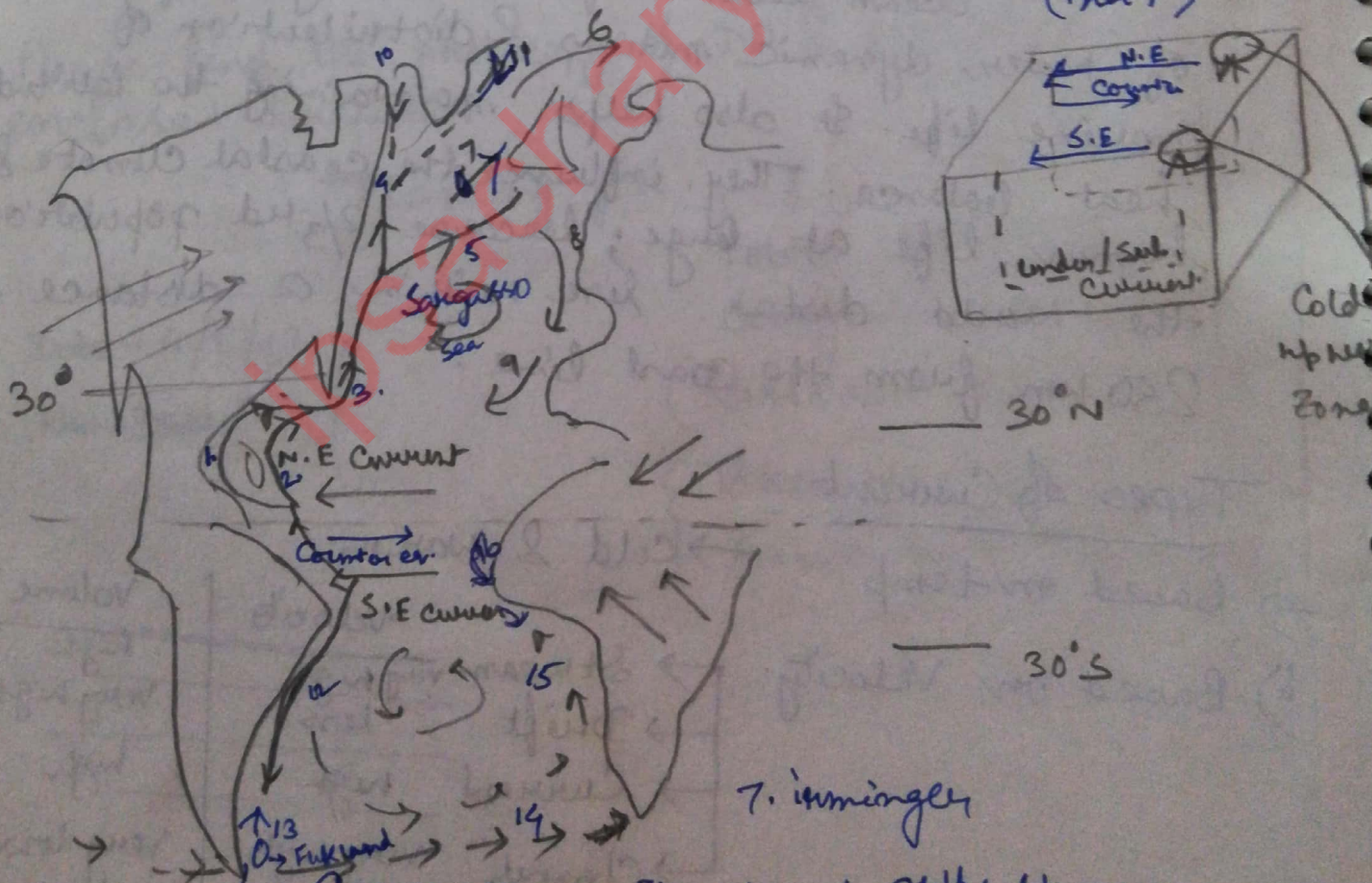
e.g → North atlantic drift

drift will be found in mid ocean

Channel - - - - between two land masses



Co-eriolis is alway greater towards pole. So wind direction is like → (not ↑)



1. Antilles 2. Cayonnes 3. Floreda 4. gulfs Stream
5. North Atlantic drift 6. Norweigian 8. Rennel 9. Canaries
10. Labrador 11. E. Greenland Current

60° → Polar easterly & westerlies are colliding & after collision they rise to form low pressure zone.

Rennel → is a current of France.

12. Brazil current
13 Falkland " by melting ice berg
14. West wind drift
15. Benguela cur
16. Guinea current
Ag current dirⁿ towards pole - warm current
Any . - — — eg → Cold "

Rennel & guinea are exception to the rule
they are warm current

Cold current → dry condⁿ
Warm " → Humid condⁿ
Western coast → drier

Warm currently
↓ Eastern coast is moist
↓ (150-200 cm)
Tropical moist climate

Rain forest (250-300 cm)
Central America → (150-200 cm)
Northern → Fishing zone
Murmas (75°N) Russia,
↓ Port (Never ice frozen) due to warm current.
Sargasso sea → high temp high salinity

[Texamati
↳ Rice grown in Texas]

Along eq. centrifugal force is more
n pole centripetal . - - - more

Q Provide a recent account of currents of Atlantic ocean & discuss their role on coastal climate

Q Discuss the factors originating & modifying ocean current with suitable example.

Q What are Laminar flows. How they are related with ~~Eggman~~ Ekman-Spyral law.

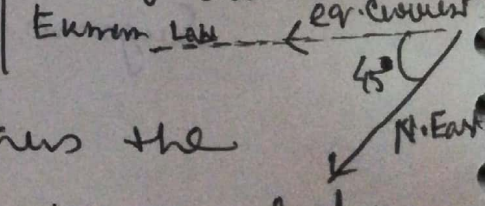
Q What is Ekman pumping & how it is related to cold upwelling zone.

Factor originating ocean current related to Earth

1) Earth Gravity :- maximum at pole, thus there is a general flow pattern from equator to pole (Pull)

2) Coriolis Effect & Ferrel's law :- Due to Earth rotation, the moving objects ~~are~~ are apparently deflected, which called coriolis effect & acc. to Ferrel's law this deflection is right ward in Northern hemi & left ward in Southern hemi.

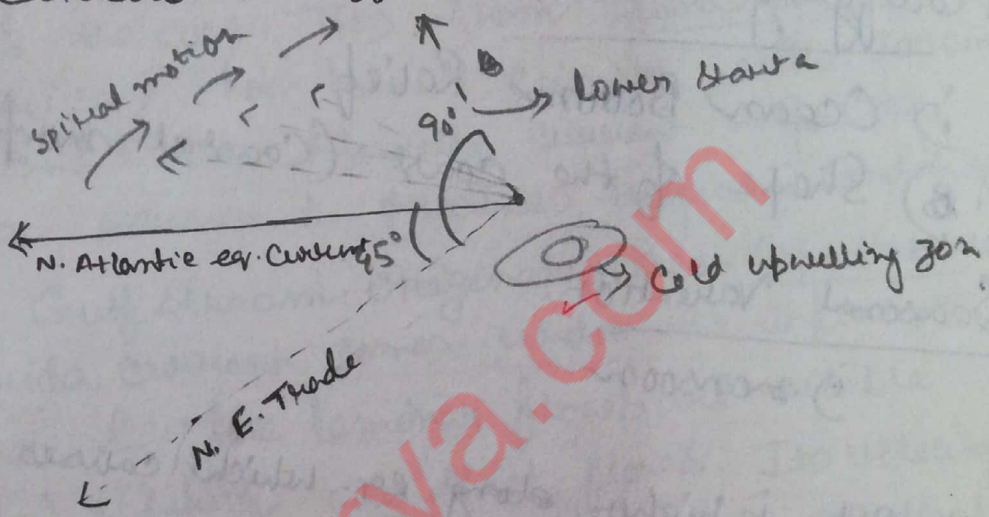
Coriolis eff. in eq. is zero. pole → max^{m}. eq. current are ⊥ to eq due to Ekman law



Ekman's Spyral Law :-

Acc to Ekman ocean currents are deflected at 45° angle from the wind direction & the frictional drag of the wind reduces with depth. Thus the coriolis effect is always @ reducing in the deeper layer, since the velocity also reduces.

The lowermost layer of the current is found at 90° with the wind dirn & from the left of the ocean current cold upwelling takes place, known as Ekman pumping. Thus the ocean current has a spiral flows & sheets of water flow from top to the bottom. This sheet flows are also called laminar flows. For e.g → Gulf Stream, & clockwise circulation is Northern Atlantic.



Related to Atmosphere

1) Atmospheric Pressure System
2) Prevailing Wind
3) Insolation, evaporation, precipitation.

Terrestrial Factor.

1) Ice melt
Otto peterson discovered Greenland current as product of Ice melt.
2) Influx of River water:
Florida current is actually produced by Mississipi

Suboceanic Causes.

1) density difference
2) Salinity "
3) Temp "
4) pressure gradient force & density of waters.

Modifying Factors.

i) Ocean Bottom Relief.
ii) Shape of the coast (Coastal morphology)

Seasonal variation.

i) monsoon

→ ppt. is higher along eq. which causes pilation, & slow current.
→ Ocean bottom relief retard the velo. of current & current can become drift.
→ water will move from low density to high density
→ water " move from ~~low temp to high temp to low~~

Currents of Atlantic Ocean

10°N & 10°S of equator due to frictional drag of the south east trade wind equatorial currents are produced, which are ⊥ to eq., as per Ekman's Spiral law. The water accumulate along Brazilian Bulge, & compensating flow like counter eq. current & under current are produced.

which is know as Lemonos Costk current.

North equtorial current is bifercated by Caucalcan into Cayanes & Atlines which meets in Gulf of mexico & superimpose by the Mississipi water, It flows along the Florida coast upto Cape Hatteras. This currents are harbinger of moisture of the coast. Thus from Guina coast to Central America, hot humid climate with 200cm rainfall is found. The Florida current keeps the coastal area warmer & produces tropical condition.

Gulf stream originates near Cape Hatteras as the Florida current comes under the influence of Westerlies & the laminar flows are visible. (discernible); which are sheet flows. Its velocity is 40 km/hr. & produced by the pressure gradient force formed by the thermal contrast in the ocean layers across latitude. It mixes with the cold coastal water & produces the famous cold-Wall phenomenon, which is hazardous to navigation.

What is cold wall phens?

Gulf stream meet Labrador cold current produced by the ice melt from Davis Strait. This mixing of cold & warm water produce advectional (Horizontal mixing) fog near newfundland & the famous fishing belt.

The gulf Stream along 55°N & 55°W turns toward North-East under the influence of Westerlies & they are called North-Atlantic drift. which is trifurcated by British Islands

→ Rennel Current along ~~Bicay~~ Bay of Biscay (warm current)

→ Irminger " Iceland Coast.

→ Norwegian " Scandenavia & white sea.

Norwegian

this warm current is imp for fishing & keeping murmank ice free, through out (Northern most russian port) the year.

The returning waters along western coast of Africa is called ~~Canay~~ canary current, which converges with equitorial current completing the clockwise circulation.

Southern Hemi

Sao Roque

South eq. current hits Cape ~~Sawock~~ & bifurcated into two branches. Northern branch superimpose the Cannes/Canadian current while Southern branch is called East Brazilian Current which meets Falkland cold current, produced by melting ice berg.

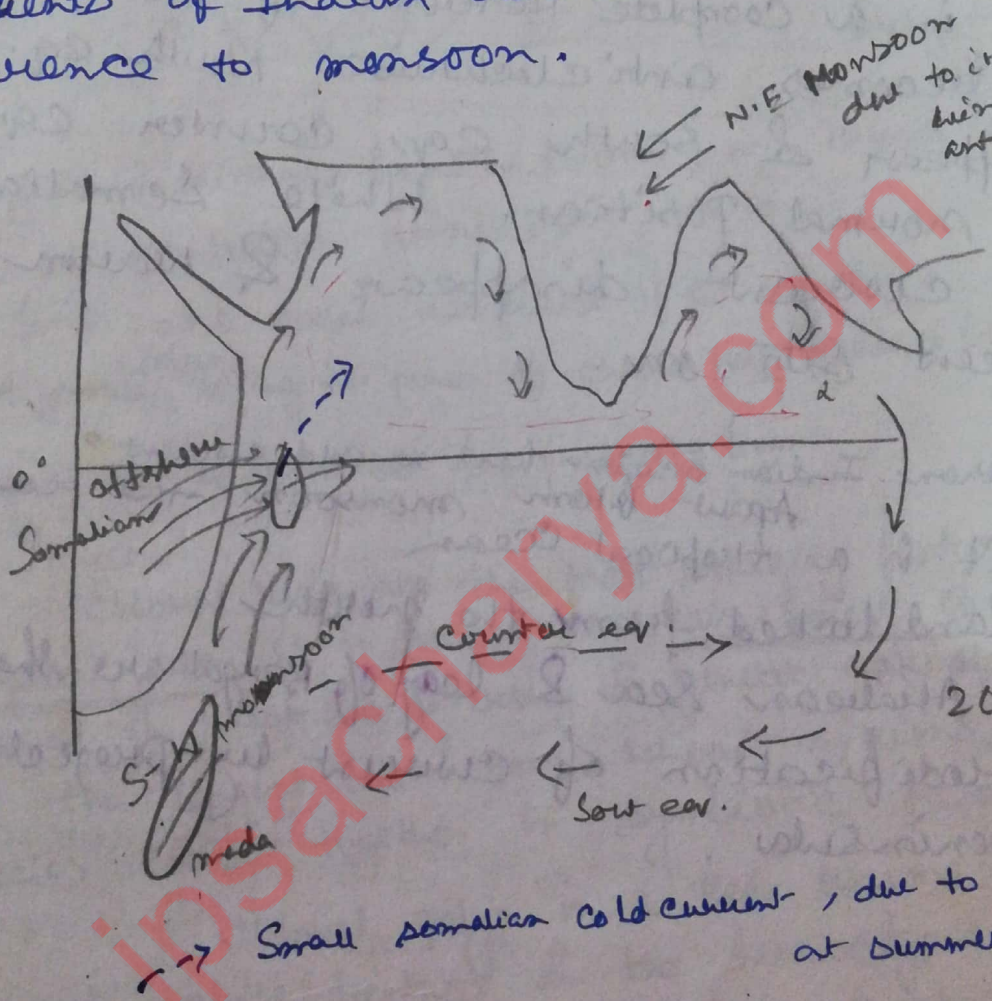
Finally it meets west wind drift or circum atlantic current.

West wind drift is directed by Coriolis & ~~coord~~ cape of good hop, the returning current is called cold Benguila current. It meets South eq. current completely in

anticlockwise gyre (circle/cycle)

The cold current has decipating (drying) effect along western coast & they are one of the factors behind the hot tropical desert.

Q Discuss the factor of modification in the currents of Indian ocean with a special reference to monsoon.



P-94 oxford Atlas

During summer time due to South west monsoon, the north equtorial current are absent because monsoon is a thermodynamic modification of Trades.

Counter equtorial (20°S) & South eqv. are shifted to 10°S, to their normal position. & during the summer season northern indian ocean

will have clockwise circulation known as South-West monsoon drift.

Along Somalian coast wind are offshore which drive coastal water & produce cold upwelling. Due to cold upwelling cold Somalian current is generated, while during winter as North-Eastern monsoon sets on, there is a complete reversal of monsoon drift, it becomes anticlockwise. North eq. current reappear & South eq. counter eq. get to its normal position. While Somalian cold current disappear & warm current sets on.

Why Northern Indian ocean has no cold current?

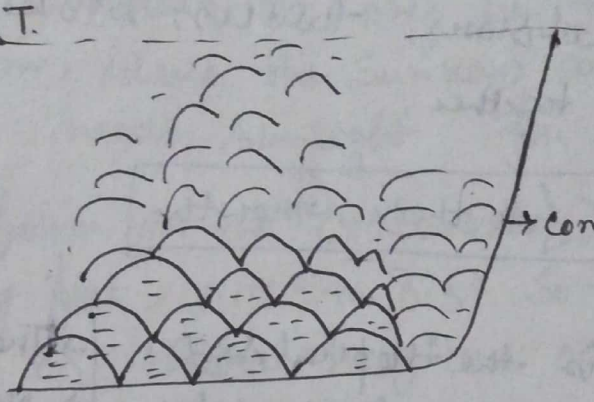
Apart from monsoon the reasons -

→ it is a tropical ocean
→ land locked from the north
→ Arabian Sea & Bay of Bengal are shallow seas
→ Modification of current by projected peninsula.

20/06/13

Chloral Reef

Reef is basically a structure. Accumulation of limestone, sand, conglomerate.



many organism living in symbiosis → ecosystem

Highest biodiversity found in Earth is in chloral ecosystem, not in equitorial rainforest.

It is also called rainforest of the ocean.

Zoo zenthle (algae) living in pores of chloral reef produce it the colour.

Algea are responsible for producing foods.

Chloral reefs are the most striking features of tropical sea. It is known as rain forest of the ocean because of great bio-diversity & genetic variation. They are the largest bio-herms, where millions of species exist together in symbiotic relationship.

Chloral polyp is a sea anime which are immobile benthos & the hermatypic ones are reef building chlorals. Chloral polyps are lime secreting organisms, which develop calcium carbonate shells around their body. Some algae like Xoo-xenthalae & cynobacterium (blue-green algae) and the known algae are found in their pores. They provide (specially xoo-xen) the wonderful colours. They are food makers through photosynthesis. The nutrients so produced are consumed by

the chloral polyps through their tentacles. Other sea Organism like fishes, Gastropods, Stratoporoids, crabs, oysters, lobsters, turtles, snakes & varieties of other co-exist together.

Geographical condn for their Growth

→ They are found in the tropical seas. Specially between 30°S to 40°N.

→ They are nearly (30° absent in Cov. region bec. heavy rain & outpouring of fresh water

→ not found in western margin of continent because cold upwelling zone & cold current

→ 18°C isotherm marks the Poleward limit of chloral reef Temp shall be 18–25°C & the most suitable condn are 22-23°C, however in Red Sea; even at 32°C they continue to survive due to adaptability.

Higher temp. results in higher salinity which can lessen their soft bodies.

→ Salinity must be neither high nor low i.e. 34–35 ‰ is most suitable. However they can survive in 31–36‰. In Red

→ Tropical
→ Never in cold current, pole, equator, fresh water
→ mostly 10°–30-35°. in both hemisphere
→ Not in western coast of continent due to cold current, cold up-welling zone
→ in eastern side of continent
→ flat Slope
→ upto 100m
→ ~~Never~~ Not in river mouth → sediment less temp & salinity

→ It took 10 million year to raise temp of red sea by 2–3°C. So they are now adapt with high temp

Sea they are thriving at 41, due to natural adaptation

→ the live chorals can only be found at the depth of 65-100m, where the sunrays are active, because the algae needs sunlight for photosynthesis.

→ The platform on the continental shelf must be extremely flat, 0.2° to 0.5°. So that the first generation of choral reef are not uprooted by strong waves. → The choral reef ecosys flourishes where sea waves are active but not a strong.

→ The sea wave oxygenate (having oxygen bubbles) the water, specially the breaking waves & also bring the nutrients. The reefers stationary water / stagnant water are not suitable for their growth.

→ Along the river mouth they cannot exist because of sedimentation & lowering of salinity.

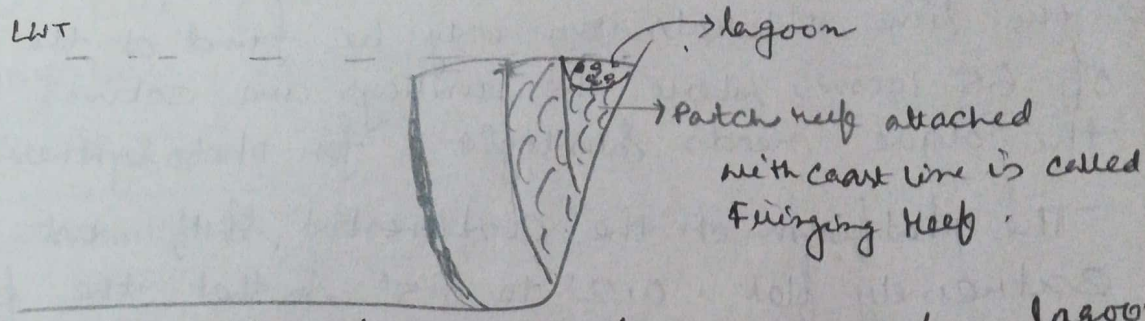
→ They can not survive in fresh water because salts are their food.

→ Along the coastline with cyclone, tsunamis, destructive tides & waves; they can never survive

→ This choral reef hardly (rarely) grows in sheltered water or in lagoons, because of stagnant water

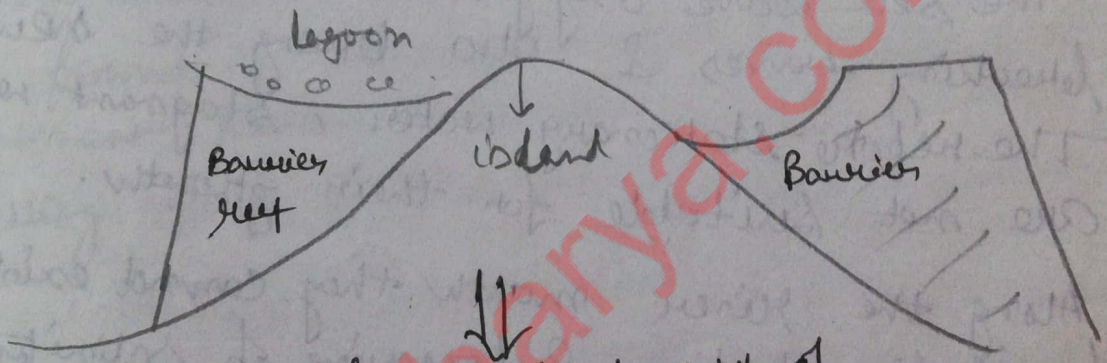
→ They never grow beyond low water tide, because the direct sunrays are dangerous for the algae.

Types & Structure of Chloral Reef



Dissolving action of limestone by sea water to form lagoon. When lagoon formed patch reef are dead. 2 called fringing reef. Reef is growing towards sea.

Note this fringe act as a barrier to sea so called barrier reef



Sink due to huge wt. of barrier reef, so chloral will have upward (vertical) to have the sunlight, & height increases more & entire island will submerged & a ring called ~~atoll~~ Atoll will exist surrounding the submerged island.

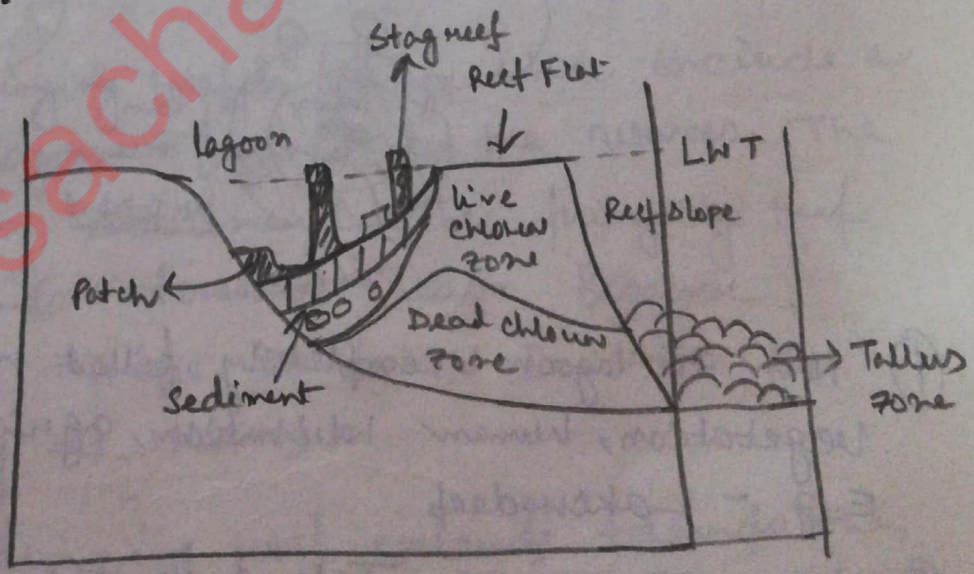
There is a limitation for sea water to dissolve lime stone, so lagoon will have smaller size.

1) The Patch Reef :- They are the initial reef formation. They develope along stable coast line with, gentle waves.
e.g- Gulf of mannar.

2) Fringing Reef :- They include the coastline & sometime shallow lagoon can be found, which are very narrow, thus known as boat channel. This lagoons are formed by dissolution of CaCO3 by the sea wave of the dead chorals.
e.g → Florida, Rameshwaram.

3) Barrier Reef :- The most massive chorial structure on the continental shelf, wide & large lagoon separating the reef flat from the coast line.
e.g → Great Barrier Reef, of Australia, on the coast of queensland.

Structure



Stag reefs are structure like formation above LWT, representing the remnant of previous chorial structure in lagoons. Chorals are dead. It grows above LWT due to deposition of sediment by wave.

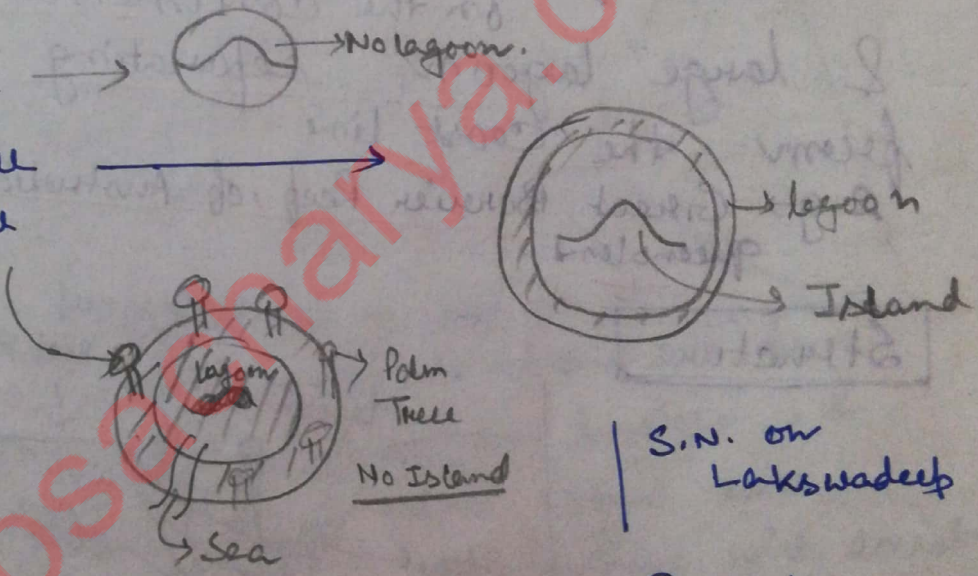
A series of stags are called Chloral Pinnacales.

Tallus Zone

Tallus is the fragments derived from the chloral reef which create the new platforms for the sea-ward growth of chloral. ~~Tallus~~ Tallus is dolomite & $CaCO_3$. ($MgCO_3$)

Atoll :- Atolls are circular or annular, ring like formation of chlorals having a large but shallow central lagoon. There types of Atoll :-

i) Atoll Island :-
ii) Island Atoll
iii) True Atoll



S.N. on Lakshwadeep

(1) When the lagoon is completely filled up & soil, vegetation, human habitation, agriculture developed. E.g - Lakshwadeep.

(2) When there is a Island in the shallow lagoon e.g → An island of Mauritius, Fizzi,

(3) When the shallow lagoon has no island, all the chlorals are dead & the vegetation grow over the atoll structure. E.g → Central pacific.

Subsidence theory by Darwin :-

Q:- Critically examine subsidence theory of Darwin

Darwin presented his theory in 1842 during his Begal voyage. While passing through the central pacific Islands he received the theory of ~~Coo~~ cajssimo. The basic postulates :-

→ In favourable geographical condⁿ, the patch reef grows into fringing reef. Thus the growth of Chloral reef system begins along a island.

→ The different types of reefs are various stages, & represent the growth stages.

→ The Island begin to subside due to tectovolcanic processes.

→ The formation of lagoon is by dissolving action of seawaves on the caco3.

→ The lagoon remain shallow because the rate of sedimentation is equal to the rate of subsidence of the basin.

Stages :-

Stage 1 :- The fringing reef is form which include a narrow lagoon formed by the waves. The island remain stationary. The fringing reef gradually expands towards seas. Because nutrients are more available & water is oxygenated by the waves.

Stage 2 :- The fringing reef extends towards the sea & the lagoon is enlarged. There is both vertical & horizon growth of chloral because island has began to sink (subside)

This barrier reefs are formed.

Stage 3: The subsidence continues & island sinks below the sea level, stimulating faster vertical growth. Thus near the LWT a ring like formation remains, known as Atoll

Criticism

→ The causes of subsidence are known.

⇒ In central pacific thousands of Atoll are found, what led to the subsidence of so many island? while Spacific is stable plate.

→ If barrier reef & fringing reefs are two stages while certain island has these two types on two sides.

→ Murray wrote a letter to Darwin explaining submarine volcanic crater can also develope Atoll which Darwin readily agree.

→ certain coral reef which develop along the shelf area are no older than Pliestocene. The Darwin theory does not take into account the sea level changes during the ice age.

B Glacial Control Theory By Daly:

→ It belongs to the stands still hypothesis, developed by Murray in his plateform theory.

→ This theory is based on the pliestocene fluctuation on sea level. It suggested during ice age sea level fell by 33 to 38 fathoms.

most of the chloral reef must exposed to death by subaerial processes.

→ The sea leaves through the abrasive action created various structural platform, where developed the rocks were softer, larger platforms & rock were harder - narrow platform. Along wider platform developed barrier reef & along narrow fringing reef & Atoll developed as the peak of the island, where eroded by the wave & toppled in ocean. Thus they are three diff. types & not diff. stages.

Atoll Formation in Darwin:

→ Subsidence of island
→ vertical growth of chloral

Cliff → hard steep rock wall along sea coast. No beach form.

Murray
Submarine volcanic crater - P-404

Daly
Toppled peak of Island. - ~~P-4~~

Davis Theory

Davis - father of Geomorphology. He applied the physiographic evidences to find out the truth.

Physiographic evidences:

i) He found granitic structure in lagoon suggesting the presence of an island.

ii) Rocks were not only granitic but has angular arrangement suggesting the peak.

iii) Shallow lagoon remain shallow only because of subsidence otherwise they will be easily filled up.

iv) Subsidence is possible because of the increasing weight on the crust & isotatic adjustment.

v) He also found a co-relation between the existance of cliff symbolizing a stable coast line & the absence of chonal reef. Because chonal reefs can only developed where there is subsidence.

vi) But Darwin was an agreement with Daly that Pliestocene upheavals (fluctuation) in the sealevels will definitely influence the chonal reef formation. Both theory complement each other. Two third of chonal reef formation can be explained by Darwin & 1/3rd by Daly.

Chonal Bleaching :-

It refers to whitening or decolonation of the chonals, which is caused by the death of Zoo-xanthies, which provides the luxurious & relevant colour to chonals. Since they are primary producer, the long term effect is death of chonals.

Chonal bleaching 1st noticed by John Mayor in 1912. But in 1997 during the period of hottest year of the century (Global warming) Wilkinson noticed the large scale chonal bleaching & classify them into

Extremely affected or Catastrophic :- where 75% or more chorals are death. e.g- central pacific

Severely Effected or disastrous :- where 50-75% chorals are dead. e.g- Red Sea, Caribbean Sea.

Moderately :- 25-50% chorals are dead. e.g→ Lakshadeep, Andaman, Cessels.

No effected :- less than 25%, which are supposed to be natural death.

1997 were also declared as the year of Choral reef. Humans are dredging sand to build their own houses at a devastating destruction of the choral reef system.

Causes of Choral Bleaching :

i) Global warming - Rise in temp of sea by 1°C it can dissolve $CaCO_3$

ii) Increase in the acidity of sea water.

iii) El-NINO event, which is warming of the eastern pacific ocean.

iv) Sedimentation :- by rivers or ocean dredging

v) Marine Pollution

vi) Ocean Dumping

vii) Epizootic :- Proliferation (growth) of microbes which causes several deseases. For eg- Black Band / White Band desease, Choral plague.

This is a man made (Anthropogenic) problem. Because it is a product of pollution.

iii) Xeno Biotic :- It refers to the addition of chemicals by various herbicides, pesticides, chemical contaminants such as Cupper. Such chloral bleaching is highly localised.

21/6/13

Tides

Tides refers to natural oceanic phenomenon, which occur at regular interval with defining periodicity, reflected in the rise & fall of the sea level induced by the celestial motion of Earth & moon; as if they have tied up in optical knot forever.

Tides are the longest oscillation effecting the deepest water & on the longest wave produced in the ocean by the differential gravitational force of the moon on rotating Earth.

Tides are significant with respect to the coastal modifications & marine ecosystems.

Types of Tides

i) Diurnal Tides:-
ii) Semidiurnal Tides:-

→ P-122 NCERT

(i) Due to differential gravitational pool of the moon