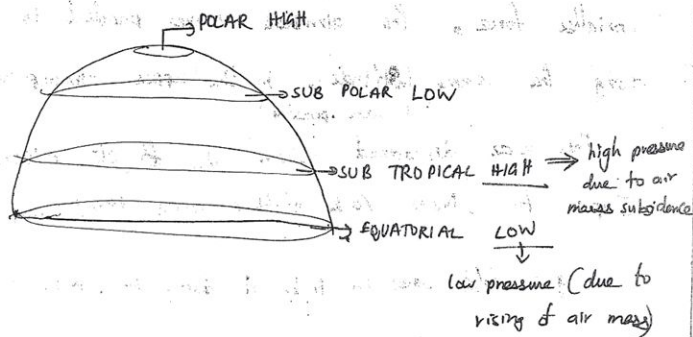


22/07/2

CLIMATOLOGY

V.P. GAUTHAM, AS

1



Isobar → Places having equal pressure.

- Winds (air mass) moves from HIGH PRESSURE areas to LOW PRESSURE.

- Winds are perpendicular to isobars (cannot move to other side).

→ Cyclone rotates anticlockwise in N hemisphere. Why?

Coriolis force deflects winds to right - But ~~sometimes~~

Pressure gradient acts in the opposite direction. When the pressure gradient is ~~more~~ stronger than Coriolis, it overcomes Coriolis and the winds rotate to the left, in ANTICLOCKWISE DIRECTION. This rotation of winds is CYCLONE. CAN ⇒ Cyclone in Anticlockwise in North.

Jetstream (ROSBY WAVES OR UPPER ATMOSPHERIC OR GEOSTROPHIC WIND)

When the pressure gradient is equal to the coriolis force, the air mass moves parallel to the isobars, along the same latitude, in the upper atmosphere \Rightarrow JETSTREAM
 \downarrow (same pressure)

This was discovered when US jets returned from Japan to New York after WWII Atomic bombing

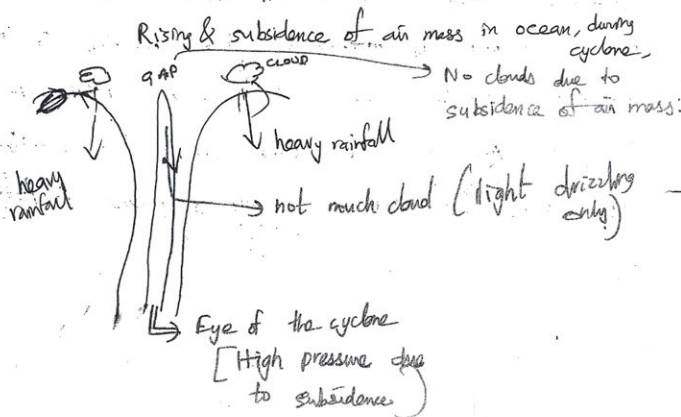
eg:- Cold waves in N. Delhi during winter \rightarrow due to jetstreams

\Rightarrow Higher the temperature, lower the pressure.

In India, Why cyclones form during winter?

Cyclones are formed due to Low Pressure areas ^{in SEAS}. But only during winter (Oct-Nov), the sea (Bay of Bengal) has a higher temp than land. Because ~~land~~ sea is cooled slower than land.

This higher temp. in sea causes air mass to rise.



⇒ Frontal & Back portions of the cyclone ^{causes} very HIGH RAINFALL.

→ The eye of the cyclone (centre portion) produces very little rainfall.

N.E. trade does not bring rainfall to certain EAST PARTS of continent due to presence of ~~rainfall~~ land in the N.E. side.
(eg: - West Bengal (India) due to China, Somalia, Ethiopia (Africa) due to west Africa.)

ENERGY ~~THE~~ SOURCE OF CYCLONE

Latent heat of evaporation provides the energy for rotation of cyclone. The cyclone never itself moves, it just rotates at the same position.

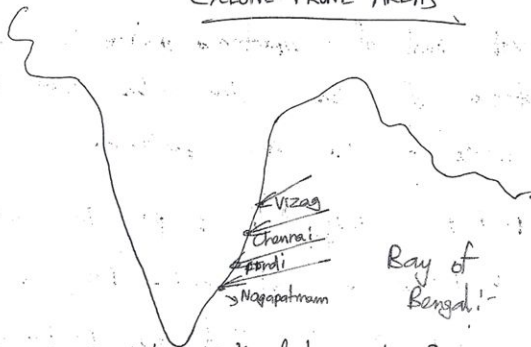
N.E. trade winds tend to push the cyclone in Bay of Bengal towards the east coast. But, the high pressure in land (due to cooled land) provides some resistance to the entry of cyclone. Anyhow, N.E. trade brings the cyclone to the coast. Once the cyclone reaches the coast, it loses its source of energy (latent heat of evaporation) as there is no moisture over land. It brings rainfall only by its frontal portion, since it breaks down ^{after} entering land. Sometimes, when the entire portion of ^{broken} cyclone manages to enter, we can experience absence of rain (for ^{frontal} ^{portion} ^{of} ^{the} ^{cyclone}) as b/w heavy & continuous showers.

Cyclones $\left\{ \begin{array}{l} \text{Tropical cyclones} \Rightarrow \text{carried by Trade winds} \\ \text{Temperate cyclones} \Rightarrow \text{Carried by } 45^\circ - 60^\circ \text{ Westerlies} \end{array} \right.$

\Rightarrow In tropical areas, ~~and~~ only EAST COAST gets rainfall. Why?

Tropical areas are influenced by TRADE WINDS. So, they cross the sea at the ~~are~~ ~~carried~~ towards EAST COAST.

CYCLONE PRONE AREAS



Why Chennai is hit by the first cyclone?

Chennai is the most urbanized area on the east coast. So, it has highest temp. (due to anthropogenic heating) and hence has lowest pressure on east coast. So, the first cyclone attacks CHENNAI first.

Orissa (1999 floods)

Orissa is on the east coast. But it is NOT usually affected by cyclone because NE trades

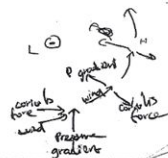
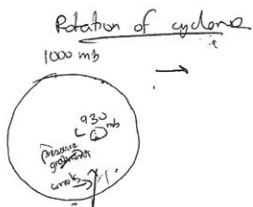
reaching Orissa are from land (NE India, China) ~~and~~ ⁵
~~NOT from~~ But in 1999, two to three cyclones had
 already brought rainfall to most of the east
 coast (Chennai, Vizag, Pondicherry, Nagapattinam) & hence most
 of the east coast was cool & hence high
 pressure. So, the cyclones, unable to reach
 these places took a trajectory towards
 Orissa. As it progressed, it gained high
 energy (due to vapourisation) and high speed and it
 produced DEVASTATING FLOODS IN ORISSA.

Tropical cyclones \Rightarrow heavy & continuous rainfall
 for 2-3 days, with a slight clear sky for
 2-3 hrs \Rightarrow due to EYE.

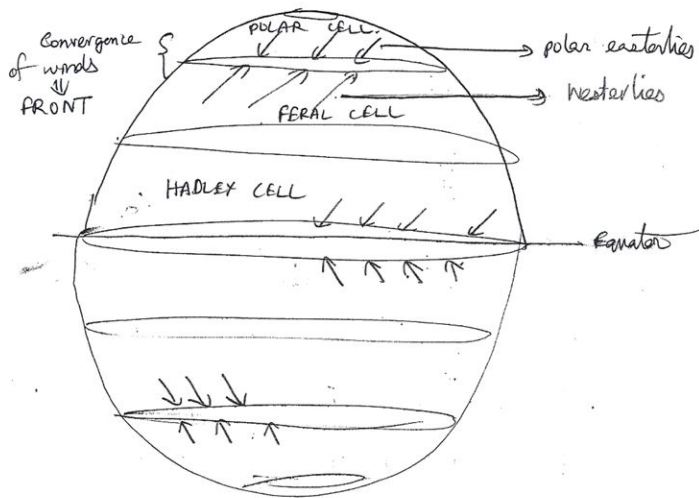
ROTATION OF CYCLONE \Rightarrow due to Coriolis & pressure gradient.
 \downarrow
 anticlockwise in N.Hem. - (source of energy: latent heat of evaporation).

MOVEMENT OF CYCLONE \Rightarrow due to Trade winds.

Low atmospheric pressure
 area in sea \Rightarrow Storm \Rightarrow Cyclone \Rightarrow Cyclone crosses
 coast.



TEMPERATE CYCLONES



Climatological . FRONT :- \Rightarrow Convergence of winds.

Sub-polar & Equator are the two FRONTS

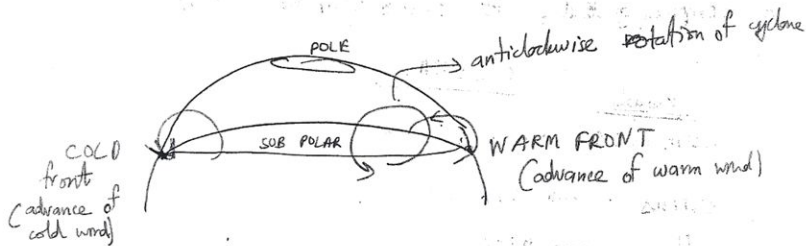
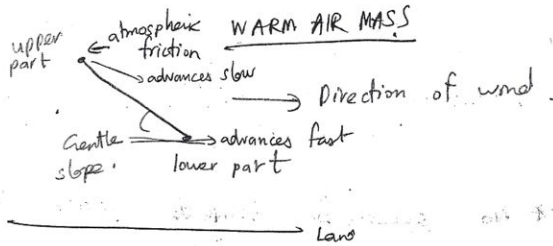
Sub polar FRONT \Rightarrow convergence of WINDS of different nature [cold polar easterlies & warm WESTERLIES]

• Some points of convergence have a higher temperature gradient. (high diff. b/w temp of warm & cold winds) than other places on the same sub-polar latitude.

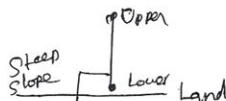
WARM AIR MASS \Rightarrow ~~friction is~~ slightly above the land. (7)

COLD AIR MASS \Rightarrow it is close to land (due to heavier weight)

Warm air mass has a gentle slope. The upper part of warm wind faces friction of atmosphere but the lower part has not atmos. friction. So, the lower part advances slightly faster than the ~~the~~ upper part.



COLD WIND \Rightarrow pretty close to the ground. So it experiences no atmospheric friction. So, both upper & lower parts advance simultaneously.



Advance of warm wind

Warm wind, being gentle, only slightly gentle, raises the air mass as it advances. So, it produces only slight rainfall, without much thunderstorm.

Advance of cold wind

Cold wind, being steep, rapidly rises the air mass as it advances. So, it produces heavy rainfall, with HEAVY TURBULENCE & THUNDERFALL.

Every ~~TEMP~~ TEMPERATE CYCLONE has both WARM & COLD WINDS. So, ~~temp.~~ ^{temp.} cyclone has both light & heavy rainfall.
↳ warm air mass. ↳ cold mass

* No season for temperate cyclones. Wherever there's a temperature gradient; it produces temperate cyclones.

CLOUDS

clouds
cumulus → bulky, dark cloud.
cirrus → high and dry.
alto → middle.
stratus → layered, (at a low height).
nimbus → rainfall.

Clouds \Rightarrow semi-solid.

(9)

Clouds are hanging in the atmosphere by the force of rising air masses. When the cloud becomes too heavy, it pours down as rain.

Cloudbursting

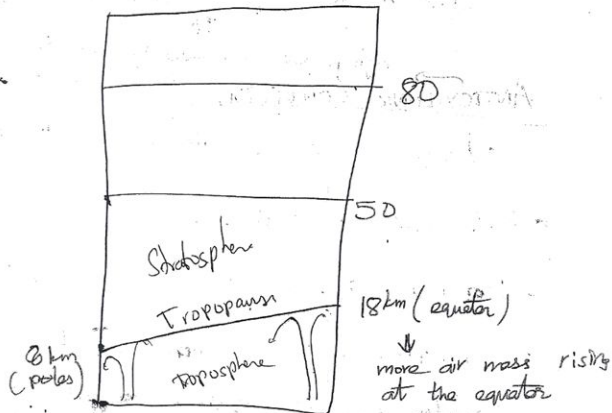
~~Intense~~ eg:- Warband, Hmached

Intense cooling of land \rightarrow no rising air mass to hold the cloud \rightarrow The entire cloud falls & bursts.

Hailstorm (generally come) [in equatorial]

Intense heating of land \Rightarrow bulky heavy cloud \Rightarrow cannot dissolve into droplets due to bulk \Rightarrow falls as hailstorm.

TORNADO \rightarrow a cyclone that originates in land & flows over land. (Texas, Oklahoma, Nebraska, Kansas, Nebraska)



→ In winter & night, ^{temp} more air mass subsidence reduces the thickness of troposphere and stratosphere. ~~and~~ ozone diffuses into troposphere. This causes irritation to nose (during inhaling), beyond a particular limit,

Humidity — { relative
specific
absolute

Relative Humidity

→ 75% rel. humidity implies the air mass holds 75% water vapour & can take in 25% more water vapour.

Absolute humidity:

~~gram~~ weight of ~~air~~ water vapour per volume of air.
→ varies for the same amt. of water vapour for contracted & expanded air.

Specific humidity

weight of water vapour / weight of air.

→ a high pressure, surrounded by several closely spaced low pressure ridges.

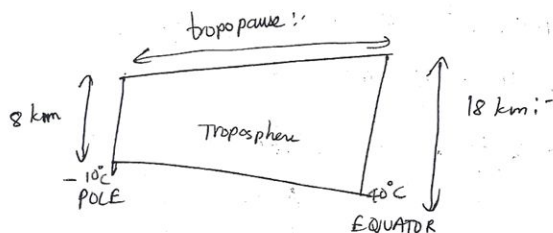
ANTICYCLONIC CONDITION

• Places where the air mass SUBSIDES.

1. East coast of tropical cyclones.
2. Leeward sides of mountains in orographic rainfall.
3. Sub-tropical regions receive rain from

Anticyclone ⇒ rotates clockwise in northern direction.

→ As we move from equator to poles ~~the~~ along (11)
tropopause, temperature increases.



② $6^{\circ}\text{C} / 1\text{km}$ decrease in temp., as we move up the troposphere.

• Thickness of troposphere in pole = 8 km.

$$\begin{aligned}\text{Temp. of tropopause at pole} &= -10^{\circ}\text{C} + (-6^{\circ}\text{C} \times 8) \\ &= -58^{\circ}\text{C}\end{aligned}$$

Thickness of troposphere in equator = 18 km.

$$\begin{aligned}\text{Temp. of tropopause} &= 40^{\circ}\text{C} + (-6^{\circ}\text{C} \times 18) \\ &= 40 + (-108) \\ &= -68^{\circ}\text{C} ; -\end{aligned}$$

Temp of equator is lower than that at poles, in TROPOPAUSE.

⇒ The thin troposphere in poles is the main reason why ozone holes are formed in the poles first.

The CFCs reach the stratosphere in the poles easily.

22/07/12

GEOMORPHOLOGY

Glacial landforms

- Movement of ice along with rocks & stones
- Ice itself is not an eroding agent
- The rocks & stones carried by ice are potential erosion agents.
 - Abrasion \Rightarrow eroding, shearing, scratching rocks
 - Plucking \Rightarrow freezing the cracks, dragging & separating entire blocks
- Glaciers are very powerful erosion agents.

Distribution

eg:- Glacial erosion has created the Great Lakes of USA (Superior to Ontario), Great Bear to Winnipeg (Canada) and several lakes in Finland.

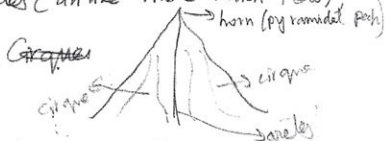
EROSIONAL LANDFORMS

U-shaped valleys

Glacier converts V-shaped valleys to U-shaped valleys for their smooth flow.

Cirque (arm chair like topography):

As the glacier slides (unlike rivers which flow), it creates cirque.



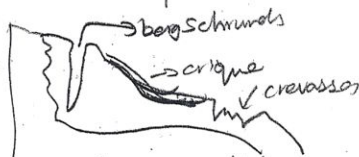
Aretes

Cirques are formed all around the mountain. The gaps b/w cirques \Rightarrow Aretes.

Pyramidal peaks or Horns

(13)

Cirques all around the mt - create peaks called
PYRAMIDAL PEAKS -



Bergschlund

At the head of the glacier, ~~the~~ where it leaves the snowfield, a deep VERTICAL CRACK OPENS UP called BERGSCHLUND. These are major obstacles to climbers → very dangerous.

Hanging waterfalls → After the ice ~~has~~ of a tributary glacier melts, its valley is called hanging valley :-

Waterfalls in summer. Frozen in winter to form a Hanging waterfall → (tributary glacier) :-

Nunatak

A high peak surrounded by snow fields - look like a glacial ISLAND.

Crag & tail topography

Glacier's upslope is steep & ~~the~~ downslope is gentle

paternoster lakes → depressions at the base of cliffs.

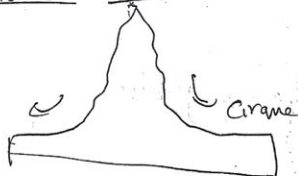
Glacial storage
paternoster lakes :-

Roche mountains :-



Horns

Horn



Depositional Landforms (MORAINES) ⇒ Scratched rock particles that are imbedded in the glacier

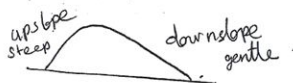
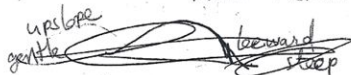
When glaciers melt, the rocks & sediments carried by it are deposited.

These depositional features of glacial till are ridge-like and called moraines:-

Terminal moraines (end moraines) ⇒ end of glacier
Lateral moraines

Medial moraines ⇒ b/w two glaciers

Drum lins. ⇒ similar to (erosional ~~Rock~~); cross & tail)
deposition inverted spoon shape. ⇒ basket of eggs topograph



Glacio-fluvial deposits:-

When glaciers have melted:-
Boulder ⇒ mixture of debris ⇒ rock, angular boulders, pebbles, clay, fine rock flour
Eskers

long, narrow ridge of SAND & GRAVEL
at ground moraines. Roads are laid on eskers

Outwash:-

Water (from melted glaciers) wash the terminal moraines & deposits to form a plain called OUTWASH

Kettles

if the outwash plain has undulations (ridges & depressions), the water stagnates forming a kettle lake
Actions of glacier ⇒ Quarrying, Plugging

Uses of Geomorphology: (as a civil servant). (15)

- Construction of dams (by studying pattern of erosion)
- Town planning (by studying slope patterns & isotasy)
- ~~Path~~ Transport (structure of soil & rocks).
- Managing natural hazards (Predicting & adopting preventive measures of natural hazards)
- Wars (study of terrains & battlefield).
- To determine depth of mining & regions of minerals.

Earthquakes can't be prevented but managed:

Pre-disaster mgmt.

- No dams in earthquake-prone areas.
- Identifying earthquake-prone areas (convergent zones)
- Earthquake-wave absorbing buildings.
- No heavy materials for buildings.
- Alternate transport means.

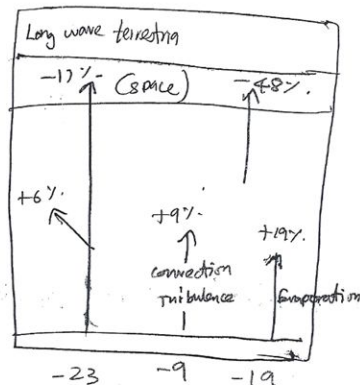
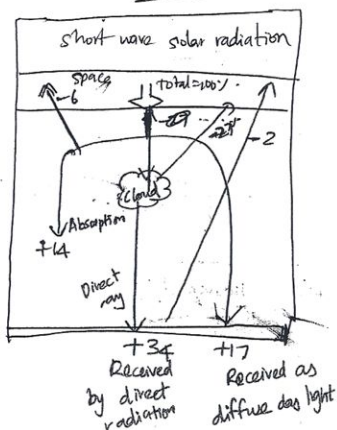
DISASTER MGMT.

- Mock trials for earthquake mgmt.
- Providing adequate training & instructing ppl.
- Stock of food supplies, distribution to ppl. by proper supply lines.
- Resettlement & rehab. areas.
-

28/07/12

Heat Budget of the Earth (15m → open ended) :-

A delicate balance between the incoming short wave solar radiation and outgoing long wave terrestrial radiation - vertical heat budget



vertical heat budget

Operating mechanisms

Scattering, diffusion, direct radiation, absorption, cloud reflection, absorption by earth, absorption by atmosphere.

Horizontal Terrestrial reradiation, evaporation, convection, turbulence.

horizontal heat budget

Tropical & equator receives more insolation than the sub-polar & poles. This difference in heat is redistributed by rising air mass and winds. The winds redistribute heat. horizontal heat budget - convection (horizontal transfer of heat) permanent or planetary winds

Don't mug up minute details (numeric data) reg. the absorption. (17)

SIGNIFICANCE OF HEAT BUDGET

• If there is no delicate ~~horizontal~~ heat budget, the surplus insolation at the tropics & ~~poles~~ ^{equator} result in increased temperature and deficit insolation at poles will continuously decrease the temperature.

It will result in complete ice-covered poles throughout the year & hotter climate in tropics throughout - ~~The temp of~~

• The vertical heat budget of the earth is essential for keeping the overall avg temperature of the earth constant. If it did not exist, the incoming solar radiation will continue to heat up the earth and earth will become progressively warmer, making it unfit for the survival of any organism. All the living organisms owe their survival to the heat budget balance.

• The horizontal heat budget is one of the important causes for the change in seasons.

The horizontal redistribution of heat is one of the main causes for change in seasons.

• There would be NO winds if a horizontal heat budget did not exist. Rising, subsiding, convergence & divergence of air mass is attributed

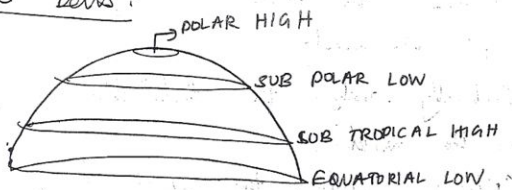
to Nature's redistribution mechanism & it tends to restore it to equilibrium. This ~~winds~~ movement of air mass horizontally along the land is ~~essential~~ the main ^{source} ~~cause~~ of rainfall in several regions of the world.

- Ocean current movement is due to heat budget. The ocean currents move from warm areas to cold areas to maintain equilibrium of pressure.
- UV rays may enter the earth if there was no prevailing heat budget mechanism.
- Heat budget is the main cause for air mass rising, condensation and cloud formation. It is the cause of rainfall.

But, this delicate balance of the earth is disturbed by anthropological activities such as green house ^{gas} emission (which ~~causes~~ ~~ozone~~ depletion and deforestation. If this harmful trend is not arrested at the earliest, it will result in destruction of

→ Pressure belts:-

(19)



Equatorial low

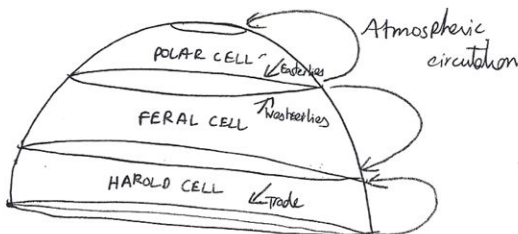
- $5^{\circ}N$ to $5^{\circ}S$
- Doldrums - \rightarrow unstable
- ~~Start~~ ^{Source} of all rising air mass
- Low pressure
- Rising air mass \rightarrow condenses \rightarrow cloud formation
- Dense cloud, high temp, heavy rainfall.

- Discuss the basis for origin of pressure belts of the world.
- Critically analyse the distribution of pressure belts in the world.
- Critically evaluate the impact of pressure belts of the world.

* STABLE → ~~rising~~ subsiding air mass (HIGH pressure)

UNSTABLE → rising air mass (LOW.)

- Discuss the origin of planetary winds / atmospheric circulation
or
significance
/ stable/unstable regions.



Planetary winds → Trade, westerlies, easterlies.

PRESSURE:

The weight of a column of atmospheric air per unit area. ^{earth's atmos. pressure:-} 1038 mb (milli bars)

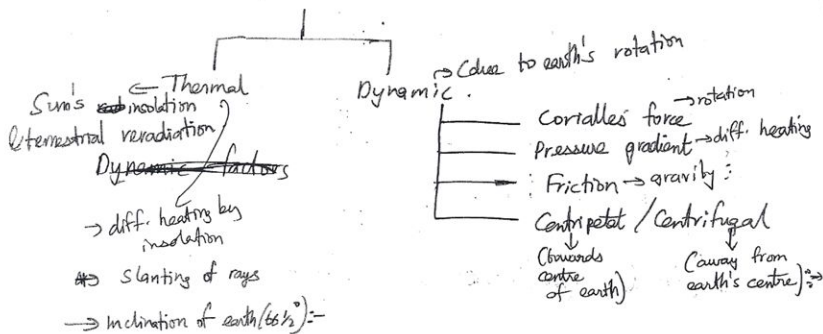
Pressure belt

If the ~~pressure~~ atmospheric pressure is ~~un~~ homogeneous ^{widespread} over a ~~particular~~ area, then it is called a pressure belt.

→ Factors of pressure belt

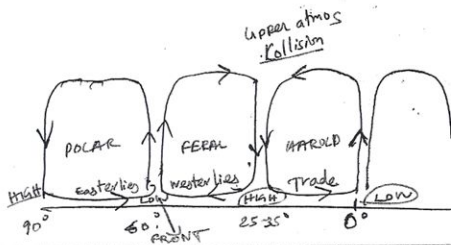
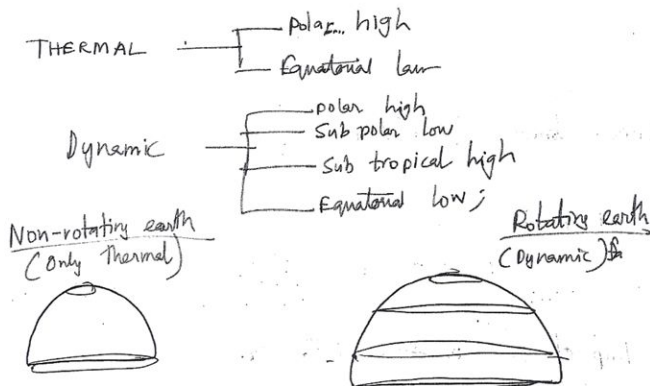
(21)

Factors for pressure belts:-



ORIGIN OF PRESSURE BELTS ⇒ Explain the origin.

For each pressure belt { Mechanism → 90% ; In the mechanism, ^{mention} the attributing factors (men. above)
 { Description of pressure belt → 10% ;



Conclusion

Thus, the simple pressure belt which would have been created by thermal effects alone has been made a bit more sophisticated by the effects & forces caused by rotation of earth.

These varied pressure belts have resulted in various planetary winds.

→ Origin & significance of planetary winds:-

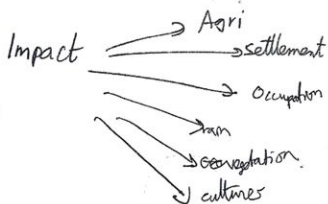
Same as pressure belts -

• Mention more about the ground level winds and the forces acting on them (coriolis, pressure grad, friction) :-

→ Upper atmos. circulation -

• Emphasise more on upper atmos.
(centrifugal/retal, rising, subsidence)

→ Impact of pressure belts -



→ Critically analyse the distribution of pressure belts in the world.

- 7 pressure belts - "
- Due to subsidence, rise & winds -



- Only equatorial pressure belt is contiguous.

SPATIAL VARIATION

- SPATIAL VARIATION
- In the same hemisphere, there is huge difference in pressure due to land & ocean.

HEMISPHERE VARIATION

- HEMISPHERE VARIATION
- Variation of pressure belts in N. & S. hemisphere
- ↓ summer ↓ winter

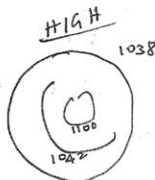
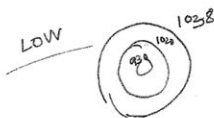
SEASONAL VARIATION

- SHIFTING OF PRESSURE BELTS

SHIFTING OF PRESSURE BELTS

Summer solstice \rightarrow northward shift of pressure belts

winter solstice \rightarrow southward



PLANETARY WINDS

Global horizontal movements of air mass in large scale.

FACTORS

Non-rotating

→ perpendicular to isobars.

→

→ don't write full mech. Start from convergence or divergence on the land.

Origin of Trade winds

Distribution ⇒ map in

Origin of Westerlies

Origin of Easterlies

Significance

Trade wind → rainfall decreases from ~~west~~ east to west.

Western side ⇒ Tropical desert.

- Navigation
- Wind movement → Ocean currents.
- Identifying regions of permanent planetary winds. windmills can be planted.

04/08/12

~~Atmosphere~~

~~Climate~~

(25)

⇒ Atmospheric circulation:-

both land winds & upper atmosphere winds.

TYPES, MODES & DISTRIBUTION OF PRECIPITATION

→ Precipitation:-

Anything which falls either in solid or liquid form after condensation.

Forms of precipitation:- 1) Rainfall, 2) snow, 3) hailstorms 4) Sleet
5) Drizzle

Types of precipitation:- 1) Convective precipitation

2) Orographic ^{ppt.} ~~rainfall~~ 3) Frontal ppt.

Convective ppt. (characteristics)

- 1) In high insolation regions.
- 2) high humidity
- 3) Afternoon rainfall
- 4) Associated with season (increases in summer).
- 5) short duration rainfall, but heavy density.
- 6) heavy turbulence, thunderstorm.
- 7) high cumulo nimbus cloud.

Orographic

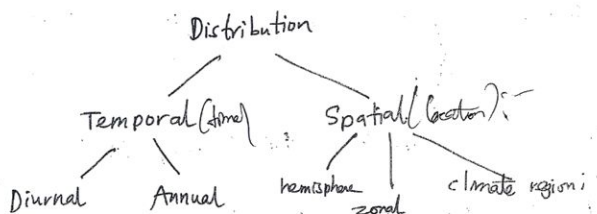
Air mass faces a mountain, ascends, cools adiabatically and condensation (cloud).

- 1) Increases with increasing height, starts decreasing after a certain height.
- 2) Cumulus cloud in windward side, nimbus or stratus cloud in backward side.
- 3) More rainfall in windward side, less or no rainfall in backward side.

4) Not associated with season.

Frontal or Cyclone → Temperate cyclones ⇒ meeting of air mass of opposite physical properties.
 → Tropical ⇒ meeting pt. of air masses of same phy. properties.
 front → meeting pt. of ~~warm & cold~~ ^{two extensive} air masses.

Distribution



Though the world on an avg. receives ~~same~~

Annual

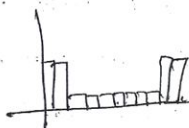
No variation
 (rainfall throughout the year)



summer rainfall
 (monsoon)



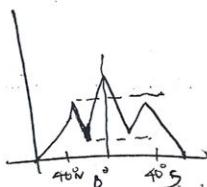
winter rainfall
 (Mediterranean)



Diurnal

Equator → only evening rainfall;

Hemisphere



~~Variation in~~ hemispherical
 Though avg. rainfall in both the hemispheres are same, it shows regional variance.

~~Not~~ Sub-polar ⇒ more rain in Northern than Southern
 Tropical ⇒ less rain in Northern than Southern

In the equator region, northern hemisphere (27) receives more rainfall than the S. hemisphere because the ITCZ (Inter Tropic Convergence zone) is in N. hemisphere for more time in a yr.

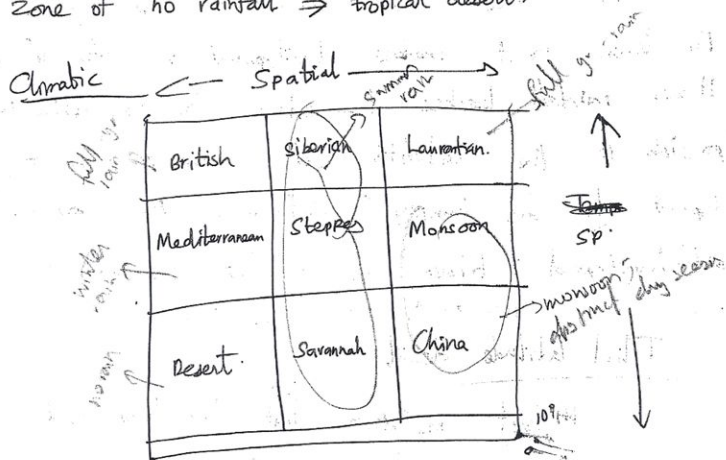
In the mid latitude, the rainfall in N. hemi. is lesser than the S. hemi. ~~because~~ but is compensated by higher sub-tropical polar rainfall in N. hemi.

But, in both hemisphere, rainfall decreases from equator to poles.

Both the hemispheres record almost the same avg. annual rainfall.

Zonal

- 1) Zone of high rainfall \Rightarrow equatorial zone (mechanism).
- 2) Zone of moderate rainfall \Rightarrow ~~tropical~~ temperate
- 3) Zone of no rainfall \Rightarrow tropical desert.



Precipitation \Rightarrow distribution

15 m \Rightarrow draw only chequered board & explain both temporal & spatial with it.

60 m \Rightarrow Write as m note. Dist $\begin{cases} \rightarrow \text{temp} \leftarrow \\ \rightarrow \text{spatial} \leftarrow \end{cases}$

Another way \Rightarrow draw climatological

\rightarrow development of a region & its rainfall distribution goes hand in hand. Discuss.

The rainfall varies to a great extent ~~in~~ from one region to another, depending on its latitude, spatial & temporal distribution:-

Equatorial region:-

High insolation & high humidity causes daily heavy rainfall throughout the yr. ~~As~~ Due to more sunlight & high rainfall, there is heavy dense vegetation with high trees. So, it is mostly dense forests.

The dense forest makes development of infra difficult. Heavy rainfall leeches the soil. So, no agriculture possible in the lateritic soil. The ppl have to depend only on hunting & gathering. They are mostly underdeveloped tribes are in this region. High prevalence of epidemic diseases reduces longevity.

Tropical latitude desert

Highest insolation but dry trade winds

carrying little moisture. So, only dry grid winds ⁽²⁹⁾ & no or little rainfall. Makes vegetation impossible.

Only xerophytic plants. Pl are mostly nomads moving from place to place for water & food, in search of oases. No permanent source of water. The rugged conditions

~~Mediterranean~~

Grasslands (Savannah, steppes)

Savannah grasslands \Rightarrow only summer rainfall.

Some trees due to very little rainfall. Rainfall mostly supports grass. Wildlife sanctuaries of the world.

All cat families. Wildlife inhabitation makes human settlement difficult. During arid times, ppl migrate to other regions.

Steppes \Rightarrow mid latitude (40° - 50°). Moderate rainfall.

Supports only grass — wheat, maize & corn. Large farmlands & ranches. ~~Food factories~~ Bread baskets of the world.

Associated industries like cattle rearing, dairying, meat packing develop. Large farm-sector employment.

~~Sub~~

Monsoon & China

Heavy summer rainfall. Assists Paddy cultivation during rainfall period. Rice producers of the world. Export of rice makes them develop.

Mediterranean & -

^{particular} Only winter rainfall. Dry, warm summers & cool, moist winters. One of the most finest climates in the world. Conducive for long hours of work. Most scientific inventions from this climate, as it allows long hours of toil. Tourism related activities ~~can~~ form a good part of GDP.

Sub-polar regions

Snowfall prevents cultivation. Mostly snow-covered. Ppl have to retire at homes for a major part of the year. So, no major economic activity during this passive period.

British

Rainfall throughout the year allows extensive mechanised cultivation for most part of the year. Most of the ppl are farmers.

Rainfall in depth

- 1) vegetation
- 2) agriculture
- 3) weather & associated diseases
- 4) occupation
- 5) Wildlife
- 6) Tourism

Development & rainfall go hand in hand. Discuss :- (3)

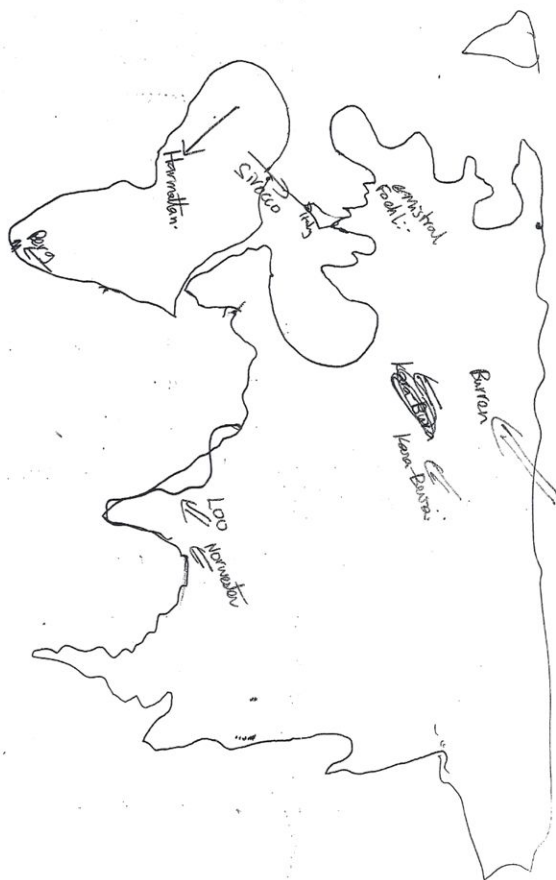
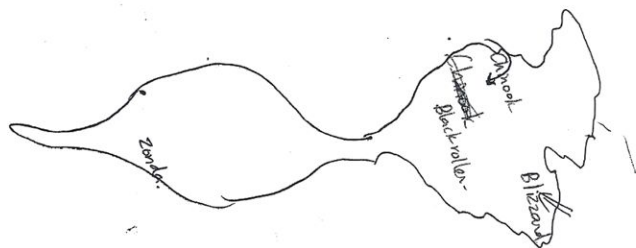
* Not necessarily we have to support, we can also give divergent opinion.

* What is development?

Is the statement a paradox?

| | High rain | Low rain |
|-----------|---------------------------------------|---|
| High dept | China, U.S. Europe... Russia | W. Asia Tamil Nadu |
| Low dept | Equator Asian, Brazil | W. Asia Saharan countries. Ravastan |

Continental Shelf



Cold winds Local winds

(33)

1. Blizzard \Rightarrow snow bringing winds in Canada
 \downarrow (can cause intense cold (Montreal, Quebec, etc. (Hawaii)
cold, polar, snow-bringing.

(\Rightarrow Snow eater)
2. Chinook \Rightarrow ~~the~~ ~~Rockies~~ rises & subsides in the Rockies.

Once chinook subsides ^{on leeward side}, temp. increases and it melts the snow (Snow eater), thus favouring cultivation.

3. Black roller \Rightarrow in the Great plains of N. America
 \downarrow Harmattan \Rightarrow ~~the~~ ~~roller~~

4. Santa Anna \rightarrow dry, warm wind \rightarrow Plains of USA

5. Papa gaya \Rightarrow Mexico...

6. Zonda \rightarrow Argentina: \rightarrow dry, warm wind!

7. Berg (mountain wind) \rightarrow Africa.

8. Harmattan (Doctor) \Rightarrow Ghana, Nigeria.

\downarrow dry wind from desert: ^{strong} warm, dry, dust-laden winds.

It reduces the high humidity in these equatorial regions,

bringing relief to this ppl. So, it is called doctor.

9. Sirocco \Rightarrow from Sahara to Italy:-

~~to~~ Picks up moisture from Mediterranean sea & brings blood red colour rainfall in Italy. ^{damage to fruit crops.}

\rightarrow due to red sandy dust it carries from Sahara.

10. Foehn \Rightarrow Alps to Germany

\rightarrow chinook:-

11. Buran \Rightarrow from Siberia

\downarrow blizzard.

12. Kara - burren ^{→ blown from kara sea.}
↳ Harmattan

13. Loo \Rightarrow dust winds in India
obstructs sight; blocks navigation.
blocks incoming sunlight, reduces temperature.
slight drizzle, all sand settles in the down.
reduces sugar yield of sugarcane...

14. Norwester \Rightarrow Bengal region, New Zealand
↳ Harmattan

15. Brick-fielder \Rightarrow Centre Australia
↳ Harmattan

16. Southerly buster \Rightarrow Australia:-

17. Mistral \Rightarrow severe cold wind
along Rhine & Rhone rivers.

Local winds \Rightarrow Study from 'Savindra'

Significance
Refn:-

- ~~Sea breeze~~
~~Ref~~
- 1) Diff. heat of land & sea
 - 2) Altitude difference:

Economic significance of each local wind:-

Map of distribution

Local winds :- open ended \Rightarrow Mechanism \Rightarrow 50%.
Significance of local \Rightarrow 50%.

Significance of local winds \Rightarrow 10% \rightarrow mechanism
90% \Rightarrow economic significance.

Buys Ballot law (pressure)

(35)

If you stand with your back to the wind, ~~the~~ in northern hemisphere, there is high pressure to ~~the~~ ^{your} right & ~~high~~ ^{low} pressure to your left.

(this causes anti-clockwise (high to low) rotation of cyclones in N. hemi.)

Ferrell's law (direction of coriolis force).

If one stands with your back to the wind, ~~the~~ in Northern hemisphere, the wind is deflected to your right and in Southern hemi, it is deflected to your left.

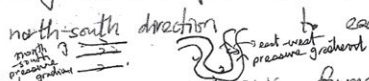
Jetstream

JETSTREAMS

Narrow, meandering, swift-flowing, ^{circumpolar} upper atmospheric geostrophic wind which encircles the entire globe.
↓ parallel to isobars
(balances centrifugal & pressure gradient)

Properties

- 1) Narrow, west to east.
- 2) Thousands of km in length, 600 km width, 4-5 km depth.
- 3) Wavy & meandering path.
- 4) Seasonal change in wind velocity — fast in winter.
- 5) Originates in poles & at 20° lat.
E) Expands at winter till 20°, in summer only at poles.
7) circumpolar → navigates around poles.

→ Stages of jetstream (index cycle)
→ Rosby waves → meandering of jetstream towards equator
→ pressure gradient shifts from north-south direction to east-west direction.

→ Jetstreams are RARELY formed near the equator.

→ Types of jetstreams.

1. Polar front
2. Polar night
3. Subtropical westerly
4. Tropical easterly
- 5) Local ...

→ Significance

→ Winter rainfall in J&K. ⇒ (supports apple & crops):

→ Cold waves in N. India. (very destructive)
in winter

→ In summer, jetstreams move to north of Himalaya.
(withdrawal of westerly jetstream)
Since it leaves the N. India, it leaves a vacuum.

So, S.W. monsoon rushes to fill this vacuum.
(withdrawal of westerly jetstream & ITCZ in north India).

→ Temperate cyclones & jetstreams are highly linked.

→ Causes horizontal convergence & horizontal divergence
in the upper troposphere.
forms ^{upper air} ANTICYCLONE forms ^{upper air} CYCLONE

→ Affects the movement of aeroplanes.

→ Transports pollutants throughout the world (by vertical movement b/w tropo & stratosphere)
(distributes pollutants from industrialised areas to all regions of the world).

A more understanding of the jetstream will reveal changes in surface weather phenomena -

→ Easterly jetstream over peninsular India ⇒ (during S.W. monsoon) ⇒ bring rain bearing storms.

→ Westerly jetstreams in N.W. India ⇒ Western disturbances

- winter rainfall → rabi crops
- snowfall in Himalayas → melting in summer is source of perennial rivers.

Air Mass

(37)

Large body of air ~~mass~~ which has uniform temperature & humidity horizontally.

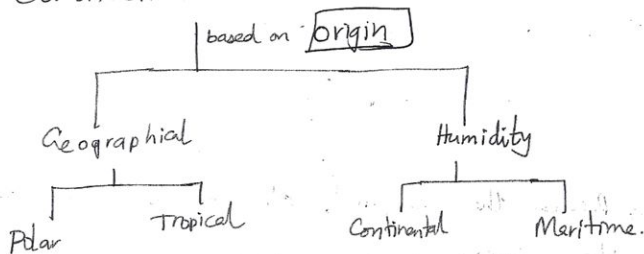
Area of ORIGIN of air mass:- Area of SUBSIDENCE of air mass.

(Pole & Tropic).

Conditions for origin of air mass

1. Extensive & homogeneous earth's surface. (plain relief)
2. No convergence of air ^{in ground floor}; only divergence: in the ground floor.
3. Stable atmospheric conditions.
4. Either only land or only water. No mixture of land & water.

Classification of Air mass based on Origin

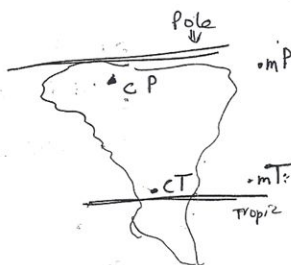


cP → continental Polar

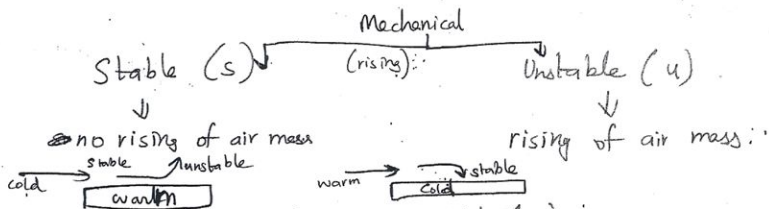
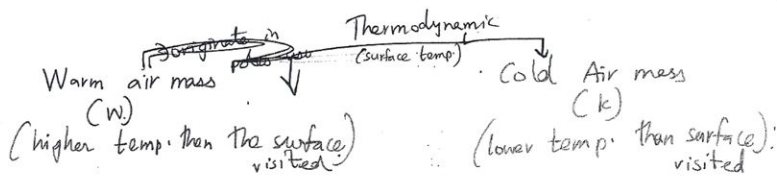
mP → maritime Polar

cT → continental Tropical

mT → maritime Tropical



Thermodynamic classification. (based on place over which it moves.



Initially, when a cold (k) air mass moves over a warm region, the heat of the surface is not sufficient to rise it. So, it is stable: (ks). Once, it over such a warm surface for some distance, it is heated up & rises (ku):

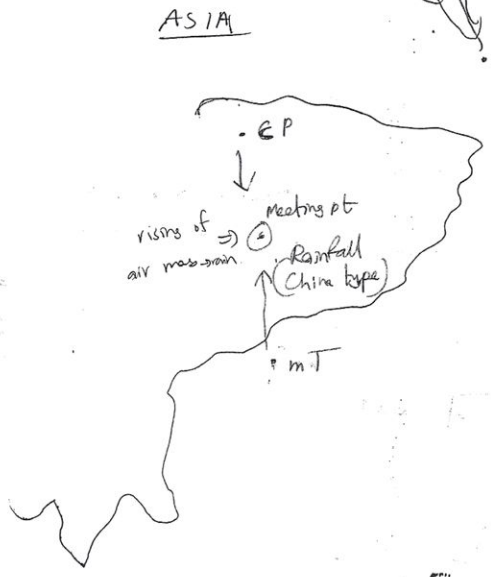
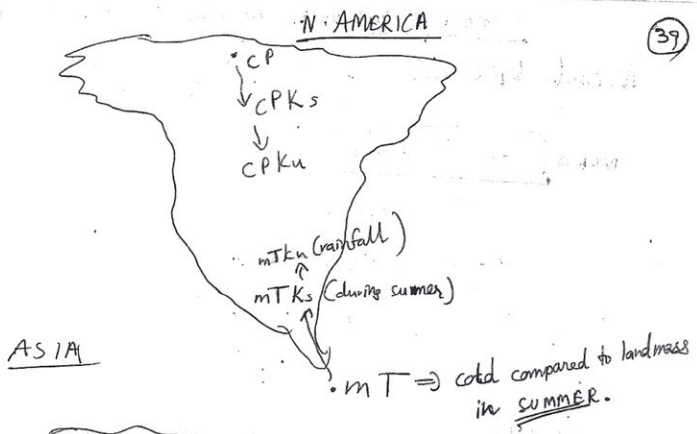
→ Discuss the origin & classification of air masses and its impact on any one region. usually, a specific

→ Defn:-

→ Origin ⇒ conditions for origin

→ Classification [Geographic, humidity
Thermodynamic, mechanical

→ Significance



SIGNIFICANCE OF AIR MASS

- determines the weather of a region.
- stability & instability of air mass plays a major role in rainfall.
- A permanent subsidence of air mass over a region causes aridity & desertification.

Endothermic \Rightarrow absorbs heat

(4)

eg:- evaporation:-

Exothermic \Rightarrow release of heat eg:- condensation

At AC , temp. of air mass = temp. of surr.

\Rightarrow So, no rising of air mass.

But, at this point C , the ~~rising~~ air mass releases energy in the form of condensation & hence it ~~start~~ continues to rise by this energy release. This energy (heat) release reduces the rate of decrease of temp. of air mass, with altitude, after it starts condensation and is called WAR (Net Adiabatic Rate).

~~WAR < NLR~~

$WAR < DAR$

This release of energy causes instability:-

~~NLR~~

$WAR \Rightarrow 5^\circ C/km$

$DAR < NLR \Rightarrow$ UNSTABLE

NLR & WAR are varying phenomena. DAR is constant at all places.

Solar eclipse

S M E
Sun light is blocked by earth -

Lunar eclipse

S E M
The moonlight (which is actually sunlight reflected by moon) is blocked by earth \Rightarrow

The earth can see only ONE side of the moon, because of almost simultaneous & equal rotation & revolution of the earth.

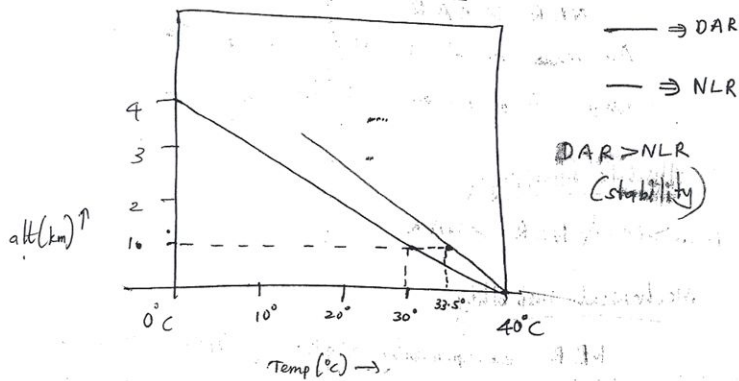
new moon? full moon?

Why is sea water salty?

08/12

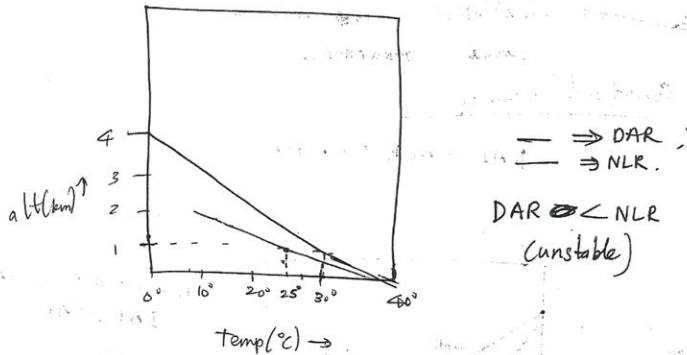
DAR vs. NLR graph (STABLE STATE)

(43)



DAR vs. NLR graph (UNSTABLE)

DAR < NLR



Stable :-

~~At~~ DAR > NLR

Air mass becomes colder than surrounding air at a certain height & starts to descend (as it is heavier) :-

ABSOLUTE STABILITY ⇒ DAR > NLR even at

CONDENSATION POINT. further vertical motion of air is stopped.

Instability

$$NLR > DAR$$

Air mass is at a higher temp. than the surrounding air, becomes lighter and ascends.

Absolute instability:

$$NLR > DAR \& NLR > WAR$$

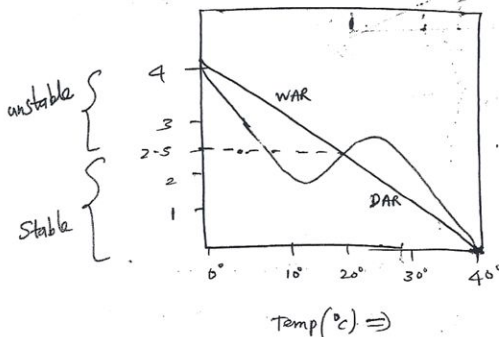
Mechanical instability

NLR exceptionally high. Upper layers of atmosphere become exceptionally cold & denser than underlying layers. Cold & ~~upper~~ dense upper layers descend.

~~⇒ so the underlying air mass rises~~
Causes TORNADOES.

Conditional instability:

$$DAR > NLR > WAR$$



$$h < 2.5 \text{ km} \Rightarrow \text{STABLE}$$

$$DAR > NAR$$

$$h > 2.5 \text{ km} \Rightarrow \text{UNSTABLE}$$

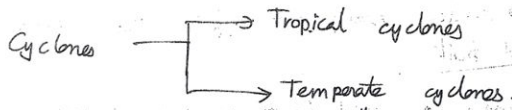
$$NLR > WAR$$

$$\text{---} \Rightarrow NLR$$

CYCLONE :-

(45)

Centres of low pressure surrounded by closed isobars having increased pressure outward and rotates in anticlockwise in northern hemisphere and clockwise in Southern hemisphere.



FRONT

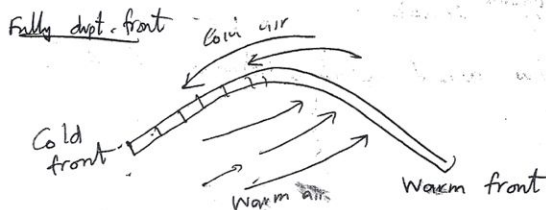
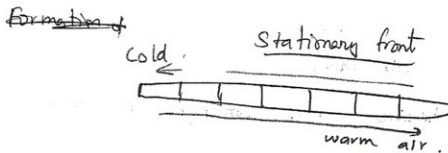
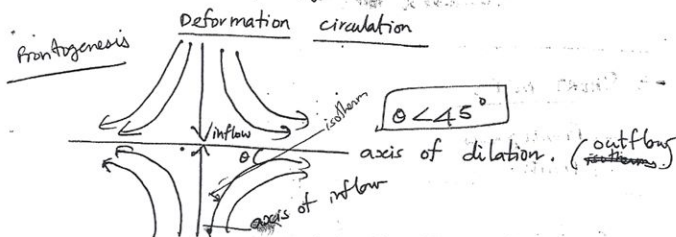
convergence of contrasting air masses

frontal in nature.

FRONT ⇒ A sloping boundary two opposing air masses with different characteristics (temp, humidity, density).

Frontogenesis ⇒ origin & creation of new fronts

↓ deformation circulation is most favourable for frontogenesis



Warm front → high temp., high relative humidity.

→ warm, light air. (low density)

→ gently sloping frontal surface (1:100)

→ ~~dense heavy rain with thunderstorm~~ ⇒ gentle, long duration rain

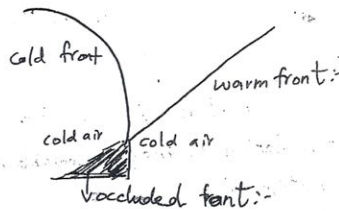
Cold front → low temp., low rel. humidity

→ steep frontal surface (1:50):-

→ dense heavy rain with thunderstorm.

Occluded front

When a cold front overtakes warm front & warm front is ~~dis~~ completely displaced from the ground surface. It denotes a fully formed frontal condition.



⇒ SHORT NOTES

→ Frontogenesis

→ Fronts.

⇒ Conditions for frontogenesis

→ convergence of air mass

→ high temp. difference b/w converging air mass.

→ ~~deformation~~ ^{deformation} circulation.

→ Angle b/w axis of outflow & isotherms $< 45^\circ$.

FRONT \rightarrow short notes

(47)

front \Rightarrow defn.

frontogenesis \Rightarrow defn.

~~deformation~~ circulation \Rightarrow dis.
deformation

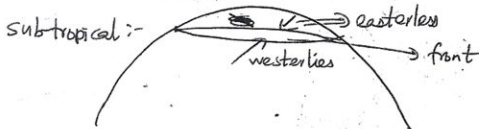
conditions for front creation.

Types of front \rightarrow Warm
Cold
occluded.

Major frontal zones of the world.

Significance \rightarrow temperate cyclones.

Major frontal zones



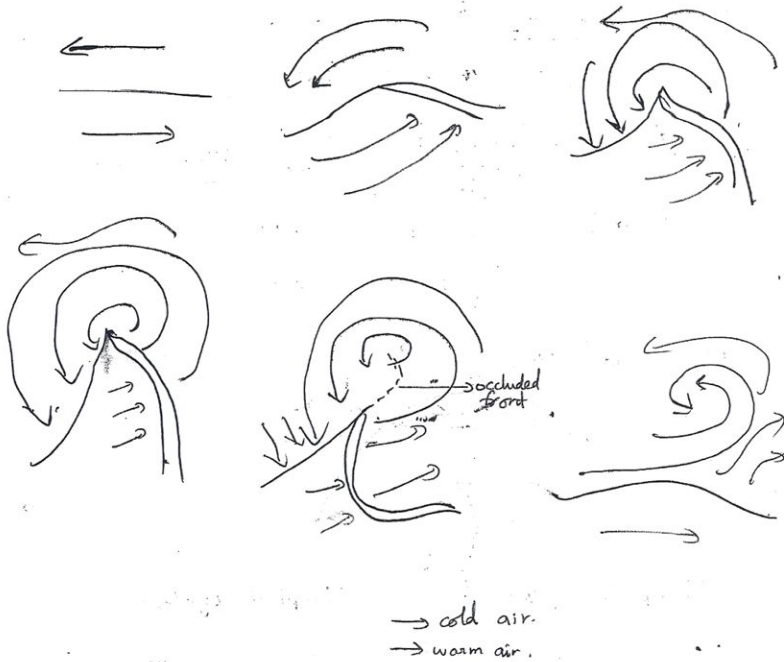
Temperate cyclone

1. \Rightarrow Zone $\Rightarrow 45^\circ$ to 60°
2. Origin \Rightarrow Frontal in nature.
3. Shape: variable (depending on char. of air masses & convergence)
4. ~~Size~~ Size: ^{covers} 1500-3000 km
Large size
5. Speed: ~~100 to 400~~ ³⁰ kmph
(due to ~~small~~ ^{large} size)
6. Two types (warm/cold) of air mass involved.

Tropical cyclone

- " 10° to 25°
- Thermal in origin
(diff. heat of land & sea).
Low depression in sea's.
- Mostly circular in shape.
Only one air mass is involved)
- ^{covers} Size: 150-300 km
Small size
- Speed: 180 to 400 ~~30~~ kmph (due to ~~large~~ ^{small} size)
fence & destructive (cyclones, typhoon, monsoon)
- Only one type of air mass.

Temperate cyclone



Conditions for origin of tropical cyclone

- 1) ~~Low~~ Temp. of oceans $> 27^{\circ}\text{C}$.
- 2) High value of CORIOLIS FORCE $\left(\begin{array}{l} \text{at } 0^{\circ} \Rightarrow \text{Coriolis force} = 0; \\ \therefore \text{No tropical cyclone at equator.} \end{array} \right)$.
- 3) Continuous supply of MOISTURE, since the energy for movement is provided by LATENT HEAT OF EVAPORATION.
- 4) There should be anticyclonic circulation at a height of 9000 m to 15000 m. (upper atmosphere).

Zone of tropical cyclones

(19)

Structure

Temperate

structure



Cold front:- heavy rain

Warm front:- gentle rain.

weather

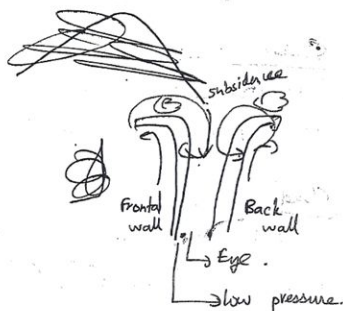
1. Gentle, long duration rain, nimbus cloud.
(warm front)
2. WARM SECTOR \Rightarrow no rain
high temp.
3. COLD FRONT \Rightarrow heavy dense rain
cumulo nimbus cloud.
4. COLD SECTOR \Rightarrow no rain
low temp.

Wind direction

1. Continuous shift of wind direction

~~warm front~~ cold wind
S.E. \rightarrow S. \rightarrow S.W. \rightarrow W \rightarrow N.W. \rightarrow N \rightarrow N.E.
(clockwise) ~~cold front~~
warm wind
(anticlockwise)

Tropical



Frontal & back: Heavy rain.

Eye:- no rain:-

Frontal wall \Rightarrow continuous heavy rain

Eye \Rightarrow No rain, clear sky.

Back wall \Rightarrow continuous heavy rain:-

in case it reaches the land:-

Constant wind direction.

()

Coast affected:-

West coast of continent
(under the influence of WESTERLIES)

Distribution

Draw a world map showing the distribution of
temperate & tropical cyclones.

Origin

Both on land or water,
wherever a front is formed.

Season

Both ~~any~~ seasons (since it does
not depend on diff. heating of ocean)

Cloud

Various types of cloud:-
↳ (due to diff. types of air mass)
Nimbus - cumulonimbus.

Frequency of occurrence

~~Very frequent~~ Less frequent.

Damage caused

Not much damage.

East coast of the continent
(Trade winds):

Originates only in water.

It is a depression in sea.
(const supply of water vapour necessary)

Only in ~~summer~~ ^{summer} (when ocean
is warmer than land) ↓ low pressure.

Only cumulonimbus cloud.

↳ (only 1 type of air mass).

Very frequent. (many
cyclones attack TIV in a single week).

Heavy damage (due to
high velocity & high freq. of occurrence).

Rising of air mass

• Oblique (slanting)

• Does not need
anticyclonic condition.

• Vertical.

Associated with an anticyclonic
condition (subsidence on the eye)

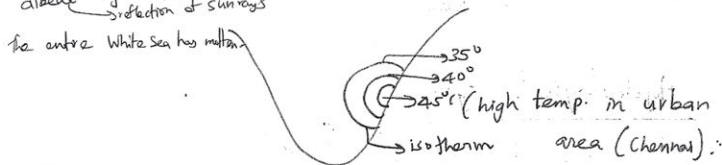
Global Climate change

(51)

Urban heat island. \Rightarrow concrete jungles

\Downarrow
Presence of high temperature in an urban area compared to the surrounding rural areas.

\rightarrow Roads \Rightarrow (black tar) \rightarrow act as black bodies \Rightarrow (absorb a lot of heat).
Heat budget
IPCC report says all ice cover ^{in Arctic} will melt in 2100. This will decrease the albedo by i.e (2%), thus ~~decrease~~ increasing global temperature. Now, almost the entire White Sea has melted.



Temp.

\rightarrow Large emissions of CO_2 by vehicles & factories.

More $\text{CO}_2 \Rightarrow$ greenhouse gas. More trapping of sunlight.

Higher temp.

Rainfall \rightarrow IPCC report \Rightarrow With every 1°C increase in temp., there'll be a 10% heavier rainfall extremes in tropics, causing floods.

\rightarrow Due to the increasing temperature, more air mass rises and these URBAN HEAT islands get HEAVIER rainfall compared to other regions on the same latitude. Moreover, the tropical cyclones attack these heat islands first (due to low pressure).

Wind

\rightarrow Wind will form more eddies (closed whirlpools) & turbulences \Rightarrow cannot flow freely due to obstructing buildings.

Pollution

\rightarrow Since wind cannot move freely out of the city, the pollutants trapped within the city,

Humidity

→ Higher humidity due to high perspiration from densely populated settlements, more water usage by man.

Water runoff

→ HEAVY RUNOFF → since no "free land" to penetrate into the earth. All earth is concreted. ^{underground} So, water table level goes down. Has to be maintained by river water harvesting.

Health

→ HEAT STRESS & other health hazards are

HIGH.

heat wave

eg:- Delhi:-

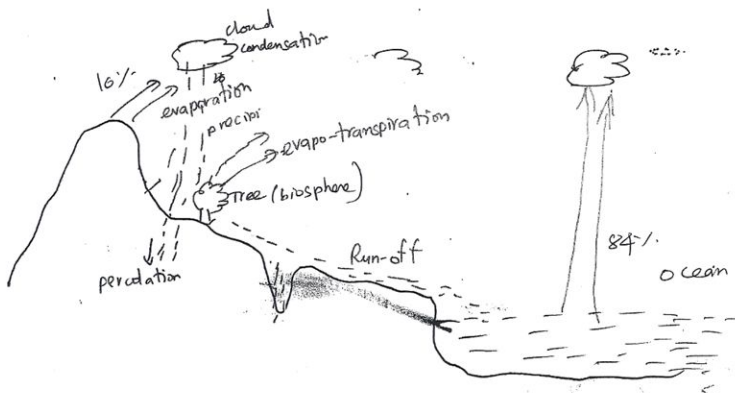
eg:- Madras eye

(Chennai - @ summer)

Hydrological cycle

Change in geographical position and physical state of water between lithosphere, hydrosphere, atmosphere and biosphere.

Hydrological cycle \Rightarrow evaporation \rightarrow condensation \rightarrow precipitation
transpiration



Total evaporation $\left\{ \begin{array}{l} \rightarrow 84\% \text{ from ocean} \\ \rightarrow 16\% \text{ land} \end{array} \right.$

Man's interference in hydrological cycle ...

(53)

Short notes

⇒ Hydrological cycle & man's interference in it.

1. Dams (population) 2. Concrete jungles (trans-evapo) 3. Deforestation 4. ~~Set~~ Encroachment of rivers. (run-off)

APPLIED CLIMATOLOGY

1. Disaster management

Floods, cyclones, drought, hurricanes.

5. Encroachment of lakes
6. Depletion of water table
7. Seeding of clouds
8. Soil management (soil retention) run off reduction

Prediction of time & source of origin, type, velocity of cyclones.

2. Agriculture

- Type of crop (amt. & density of rain in an area)
- Time of sowing (by predicting time of rain)
- Scheduling of irrigation
- Pest mgmt. (type of pest depends on climatic conditions)
- Wind speed & direction.

3. Urban planning

- Drainage (average rainfall, density of rain, percolation of soil).
- Construction of buildings (by a knowledge of wind direction, sunlight)
- Settlements in mountainous landscape (mountain & valley breeze)

4. Navigation.

- Ship movement (wind direction).
 - Flight & train (prediction fog, mist, smog)
- jetstreams

→ Satellite launch.

→ Jet movement in stratosphere (to avoid air packets collision).
(height of clouds → stratus, alto cirrus).

→

Dairy sector

- Milk production fluctuates with seasons (summer → less milk).
- Storage of milk (depends on weather).
- Diseases affecting cattle.

Health mgmt-

→ Occurrence of diseases depends on climate.
(hot-wet equator → malaria; summer - Madras age).

→ Administering of OPV. (in winter).

→ Spread of diseases can be controlled by a good understanding of wind & weather patterns.
rainy season → cholera
↳ in case of air-borne diseases (TB)

Power production

→ Solar power ⇒ amt. of insolation, duration, variation of sunlight, annual & diurnal range.

→ Wind power ⇒ nature & direction of wind, seasonal winds.

Fishing

- ~~Depends~~ Fishing in sea not possible in stormy conditions.
- Wind direction determines current movement & hence fish movement.

Industries

Brick industry \rightarrow operates mainly in summer months & closed down during monsoon

Match box industry.

Salt [high intense insolation reqd.] \rightarrow so,

Film related industries (cinema) \rightarrow requires humid - sea breeze.

Inflation & economy

coastal climate (Chennai, Los Angeles, Mumbai)

Drought \Rightarrow CPI increases, due to food inflation.

Success & failure of monsoon.

Commodity trading.

Indian Budget \Rightarrow Gamble of monsoon.

Culture of ppl.

raw materials for agro-based industries (sugar)

- Food habits.
- Dress worn (cotton \Rightarrow equator; fur \Rightarrow Siberian; wool).
- Type of house (igloo \Rightarrow Polar; flat roof in Rajasthan; sloped roof in Kerala).
- Festival occurrence (harvest fest, sowing festival)

Tourism

- Time of visit of a tourist spot
- Climate (warm & pleasant \Rightarrow Mediterranean climate).
- Types of dress to be worn while visiting a tourist spot.

Reference websites:

• 4 x 4 report \Rightarrow A report by GoI.
 $\downarrow \quad \downarrow$
4 sectors 4 regions.

• UNFCCC \Rightarrow read reports on climatic change (accelerated by human activity)

Rainfall:-

| snow | | |
|------------|-------------------|-------------------------|
| Throughout | Summa | snow throughout |
| winter | summer | pseudo monsoon (summer) |
| No | summer (hot less) | Summer |
| throughout | | |

Natural vegetation

| Lichens | | |
|----------|------------------------|--------------------|
| Poplar | spruce & larch | Maple |
| Olive | | Perbarnet Mulberry |
| Cactus | Acacia, bottle, baobab | |
| Hardwood | | |

Tribes

| Eskimos, Lapps, Inuits | | |
|------------------------------|--------------------------|-------|
| | | |
| | Kyrgyz, Kalmyks, Kazakhs | |
| Aboirigines, Bedouines | Bushman, Masai | Bodas |
| Pygmies, Amazon head-hunters | | |

Occupation

(52)

| Hunting & whaling. | | |
|---|--|---|
| mixed farm, dairy, market gar Saw milling | lumbering | Fishing |
| orchards, vineyard | Extensive & mechanized agriculture - | Rice, fish, sericulture |
| Nomadism | Nomadic & pastoralist | Shifting cultivation, settled agri. |
| Hunting & gathering | | |

Plantation
Rubber, coffee, tea,
cocoa

Crops

| | | |
|--------|----------------------------|--|
| | Oat, barley, potato | |
| Grapes | wheat, corn, soybean | Maize, corn. |
| | | Rice, sugarcane, wheat, groundnut pulses |
| | | |

wildlife (Animals)

| Reindeer, musk ox, polar bear, penguin | | |
|--|---|------------------|
| Domesticated animals cows, pigs | | |
| | | |
| Camel, horse | Giraffe, zebra, ostrich, tiger, lion, cheetah | Elephant, monkey |
| Chimpanzee, Anaconda, Snakes | | |

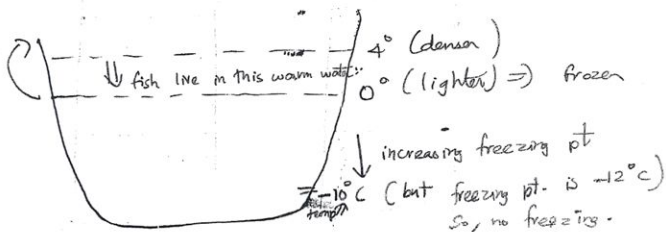
Diseases

| | | |
|------------------------------|--|--|
| | | |
| Mad cow disease (Prions), | | |
| | | |
| Heat stroke. | | |
| | | |
| Malaria, ebola | | |

Sea water is salty. Why?

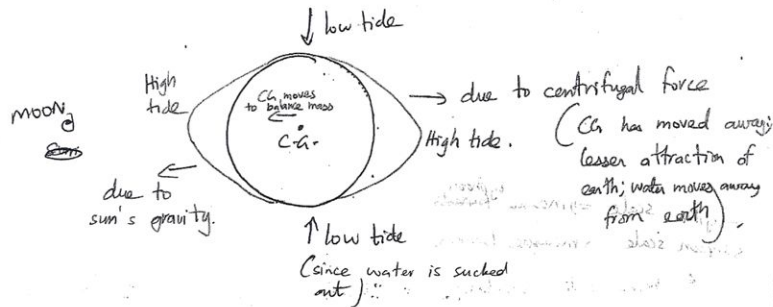
Rivers carry equal amount of sodium & calcium. So, it does not taste salty. But, on reaching the sea, the sea organisms in the shallow seas consume a lot of calcium for shell construction. This leaves only sodium in the sea, making it salty.

Sea water ~~first~~ freezes on the surface. Fish lives in the sea even under frozen conditions.



Tides

(59)



$S \Rightarrow E \Rightarrow M \Rightarrow$ full moon
 same line; diff. angle

$S \Rightarrow E \Rightarrow M$ lunar eclipse
 same line; same angle

$S \Rightarrow M \Rightarrow E$ solar eclipse
 same line; same angle

$S \Rightarrow E \Rightarrow M$ new moon
 same line; diff. angle

full moon
 $S \Rightarrow E \Rightarrow M$

lunar eclipse
 $S \Rightarrow E \Rightarrow M$

solar eclipse
 $S \Rightarrow M \Rightarrow E$

new moon
 $S \Rightarrow E \Rightarrow M$

no light from sun moon

sun's ray blocked

moonlight on this side

→ Large oceans rotate clockwise in north hemisphere,
 anticlockwise in S. hemisphere.

→ Air mass & small water bodies rotate anticlockwise in N. hemisphere & clockwise in S. hemis.

→ TORNADO ⇒ a cyclone on land (no moisture)
 no rain; heavy damage.

→ WATER SPOT ⇒ intense cyclone within ocean (tornado in ocean)
 water stands like a pillar in mid-ocean.

Bathymetry \rightarrow to explore ocean beds

Anemometer \Rightarrow speed of wind

Barometer \rightarrow pressure

Thermometers \rightarrow mercury (in hot conditions)
 \rightarrow alcohol (in polar areas)

Fujita scale \Rightarrow measure ^{typhoon} ~~hurricane~~

Simpson scale \rightarrow measure hurricane

\downarrow it has ^{low} ~~high~~ freezing pt
(sub-zero)

* Work out climatology questions in prelim G.S. (10-15 yrs).

GLOBAL CLIMATE CHANGE — CONTEMPORARY ISSUES

• Doha conference 2012

• World's only binding protocol on climate change \Rightarrow Kyoto protocol ^{first.} \Rightarrow commitment period has ended

• Hot air \Rightarrow The quota of greenhouse gas emissions (as given by Kyoto protocol) NOT used by a country & which can be traded to other countries as Carbon Credit

• Lack of funding (Adaptation fund) due to economic recession
 \downarrow
through tax on CO₂ trade

• No agreement on 2nd commitment period for Kyoto protocol

• Temp to raise by 5°C by 2100, rather than UNFCCC target of 2°C by 2100.

11/08/12

Koepfen's classification

(6)

(units: temp \rightarrow $^{\circ}\text{C}$; rainfall \rightarrow cm)

1. Vegetation
2. temperature
3. Seasonal dist of rainfall
4. Latitude
5. Altitude

Vegetation

Megatherm \rightarrow big leaf, more greenish (tropical rain forest)

Mesotherm \rightarrow medium-sized leaf (mid lat-temp forest)

Microtherm \rightarrow very small leaf (British, Laurentian, Siberian)

Xerophytes \rightarrow no leaf; modified (desertic) \downarrow coniferous forests

Helikistotherm \rightarrow snow-covered areas (polar)

climate classification based on vegetation

megatherm

A

Humid tropical climate

\Rightarrow rainfall throughout the yr, hot & humid, no winters, temp always $> 18^{\circ}\text{C}$.

xerophytic

B

\Rightarrow semi-arid & desertic, evaporation exceeds precipitation

mesotherm

C

Humid mesothermal (WARM TEMPERATE)

\Rightarrow warm temp, no mild winters, avg temp $(-3^{\circ}\text{C}$ to $18^{\circ}\text{C})$ \downarrow winter ~~and~~ summer

Humid microthermal

D

\Rightarrow Humid microtherm \rightarrow cold forest area, -3°C to 10°C

Helikistotherm

E

\Rightarrow ~~frigid~~ Polar climate \rightarrow permanent snow cover, summerless.

Based on seasonal distribution of rainfall.

f → rainfall throughout the yr.

m → monsoon (short dry season)

w → winter 'DRY'; summer rainfall

s → summer 'DRY'; winter rainfall

n → minimum fog; g → hottest season preceding ppt.
 i → diff. of temp b/w warmest & coldest months < 5°C.

Latitudinal variation

h → (hot) avg temp > 18°C [Low latitude]

k → (cold) avg temp < 18°C [high latitude].

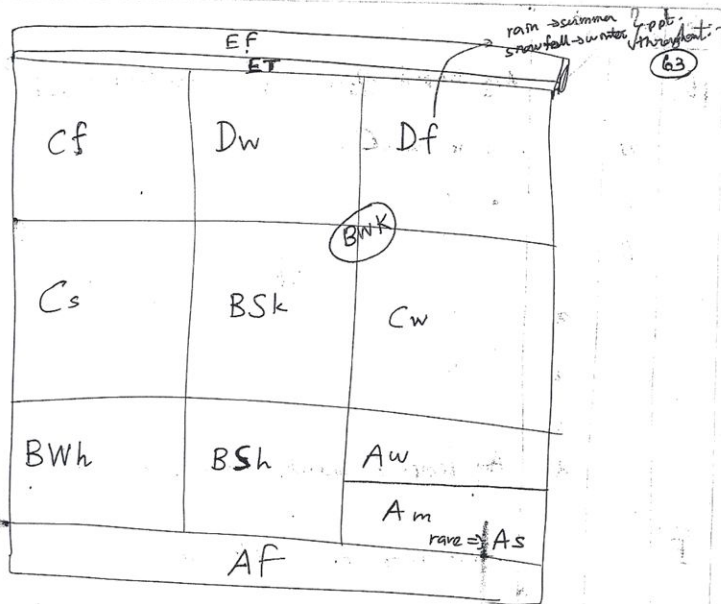
Altitude

H → highland climate (high altitude) with SNOW.

Symbols

Note! - All formulae, measurements are in cm.
 & °C.

| primary | secondary | tertiary | DESCRIPTION. | 1 INCH = 2.54 cm. |
|---------|-----------|----------|--|-------------------|
| A | | | Avg temp. of coldest month > 18°C. (HUMID TROPICAL) | |
| | f | | Every month precipitation ≥ 6 cm. | |
| | m | | Short dry season - At least one dry season < 6cm - ppt. in driest month < 6cm, but > 10-R/25 | |
| | w | | winter dry. ppt. in driest month < 10-R/25. At least one month < 6cm. | |
| | s | | summer dry. Rarest climate in the world. (eg. Mediterranean, Chinese coast). | |
| B | | | evaporation > ppt. $R < (2T + 14)$ → when 70% or more in warm months $R < (2T + 14)$ → when no months > 70% rain $R < 2T$ → 70% or more in cold months | |
| | s | | steppes climate (semi-arid) | |
| | w | | desert climate (arid) | |
| | s | h | savannah | |
| | s | k | Temp grassland (steppes) | |
| | w | h | Hot desert | |
| | w | k | cold desert | |



| 1° | 2° - 3° | Description: |
|----|-------------|---|
| E | W S f | <p>Avg temp of coldest month $< 13^{\circ}\text{C}$, but $> 3^{\circ}\text{C}$.</p> <p>summer ppt. $> 10 \times$ winter ppt.</p> <p>winter ppt. $> 3 \times$ summer ppt.</p> <p>when above both criteria are not fulfilled.</p> <p>no dry season</p> |
| | | <p>temp of coldest month $< 3^{\circ}\text{C}$, min 4 months $> 10^{\circ}\text{C}$.</p> <p>a \rightarrow warm summer. warmest month $> 22^{\circ}\text{C}$, at least 4 months $> 10^{\circ}\text{C}$.</p> <p>b \rightarrow cool summer. No month $> 22^{\circ}\text{C}$, at least 4 months $> 10^{\circ}\text{C}$.</p> <p>c. 1 to 3 months $> 10^{\circ}\text{C}$</p> |

| 1° | 2° | 3° |
|----|----|---|
| D | | Avg temp. of coldest month $< -3^{\circ}\text{C}$; Avg. temp. of warmest month $> 10^{\circ}\text{C}$. |
| | W | same as E. |
| | S | " |
| | f | " |
| | a | " |
| | b | " |
| | c | " |
| E | d | Avg temp. of coldest month $< -38^{\circ}\text{C}$. |
| | | Avg. temp. of warmest month $< 10^{\circ}\text{C}$. |
| | T | (Tundra) ^{no true summer} Avg. temp. of warmest month $0^{\circ}\text{C} < T < 10^{\circ}\text{C}$. |
| F | | (Frost) Avg. temp. of warmest month $< 0^{\circ}\text{C}$. |
| | | Perennial ice cap \rightarrow Perennial ice |
| H | | High altitude. (Highland with snow cover) |

Merits of Köppen's

(65)

- Quantitative in nature → numerical values of temp. & ppt. used to delineate boundaries of diff. climatic conditions.
- He brought out the importance of effective ppt. (amt. of ppt. available to plants, i.e. ppt - evaporation).
- He recognised the association b/w vegetation types & climatic zones.
- His scheme is simple, generalized & descriptive.

CRITICISM

- undue significance to mean values of temp. & ppt.
- neglected other weather elements (ppt. intensity, amount of cloudiness, no. of rainy days, diurnal temp. range, winds).
- ignored the causative factors of climate.
- did NOT include the characteristics of air masses.
- use of alphabets & formulae makes it difficult to memorize.

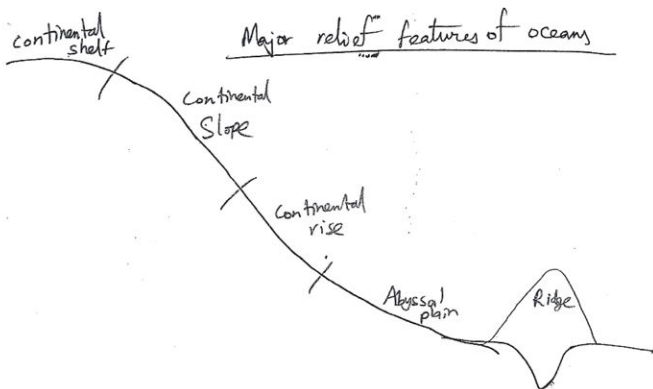
| 1° | 2° | 3° | Description |
|----|----|----|---|
| A | f | | Avg. Temp $> 18^{\circ}\text{C}$. |
| | m | | All months ppt. $> 6\text{cm}$. 6cm $10 - \frac{R}{25} < \text{ppt} < 6\text{cm}$. |
| | w | | Short dry season |
| | s | | winter dry ; driest month rain $< 10 - \frac{R}{25}$ summer dry. Rarest climate. |
| B | | | 70% rain in summer $R < 2T + 28$ |
| | | | No months 70% rain $R < 2T + 4$ |
| | | | 70% rain in winter. $R < 2T$ |
| | s | | steppes climate |
| | w | | desert climate |
| | s | h | Savannah (tropical grassland) |
| | s | k | Steppes (temp. grassland) |
| | w | h | HOT desert |
| C | w | k | cold desert ; |
| | | | |
| | | | |
| | | | |
| D | | | Avg temp. of warmest $< 18^{\circ}\text{C}$; Avg temp of coldest $> -3^{\circ}\text{C}$. |
| | w | | summer rain $> 10 \times$ winter rain |
| | s | | winter rain $> 3 \times$ summer rain ; rare climate. |
| | f | | if neither of the above 2 satisfied. |
| a | | | Warm $> 22^{\circ}\text{C}$; At least 4 cold months $> 10^{\circ}\text{C}$. |
| | | | No month $> 22^{\circ}\text{C}$; At least 4 cold months $> 10^{\circ}\text{C}$. |
| | | | 1-3 months $> 10^{\circ}\text{C}$. |
| b | | | |
| | | | |
| c | | | |
| | | | |
| D | | | Avg. warm $< 10^{\circ}\text{C}$; Avg. cold $> -3^{\circ}\text{C}$. |
| | | | |

| | | |
|---|---|--|
| D | W | same as C |
| | S | " |
| | f | " |
| | a | " |
| | b | " |
| | c | " |
| | d | At least one coldest month $< -38^{\circ}\text{C}$ |
| E | | snow-covered. Warmest month $< 10^{\circ}\text{C}$. |
| | T | Tundra forest (Warmest ; $0^{\circ}\text{C} < T < 10^{\circ}\text{C}$) |
| | F | Frost (Warmest $T < 0^{\circ}\text{C}$) :- |

| EF | | |
|-----|-----|---------------------------------|
| ET | | |
| Cf | Dw | Df |
| Cs | Bsk | Cw |
| Bwh | Bsh | Aw |
| | | Am (Ar) <small>drave</small> |
| Af | | |

17/08/12

OCEANOGRAPHY



Minor relief features of ocean

- Trenches
- Canyons
- Guyots
- Sea mounts
- Reefs

Trench

- Deepest points in oceans.
- Usually parallel to the coast.
- Convergence ^{because} of plates, results in a V-shaped valley → trench.
- Feature of Pacific ocean; absent in Atlantic ocean (convergent zone) (divergent zone).

Canyon

- Perpendicular to coast
↓ because
- erosion by rivers on the continental shelf, after it joins the sea.

~~Seamount~~ Seamount

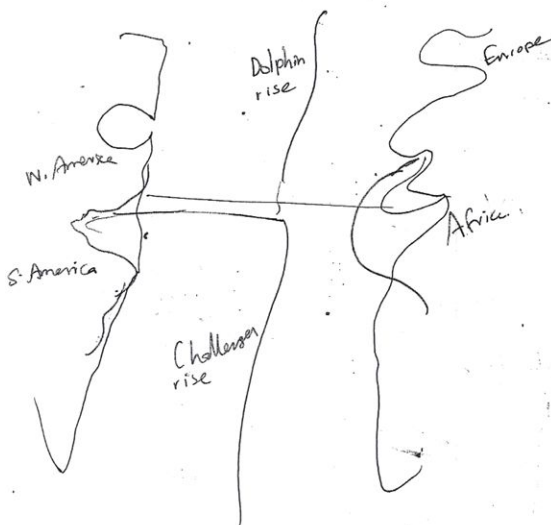
(69)

- Isolated, elevated hills ($> 1000m$) with sharp peak.

~~Seamount~~ Guyot

- A ^{sea-mount} ~~guyot~~ with a flat top (instead of sharp peak)

Reef



Mid ~~Atlantic~~ Ridge

- northern portion ⇒ DOLPHIN RISE.
- southern portion ⇒ CHALLENGER rise.

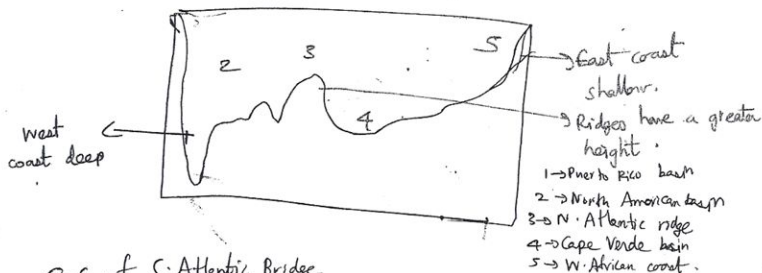
Telegraphic plateau } north
Thompson
Wyville Rise

Walvis ridge ⇒ towards Africa } south

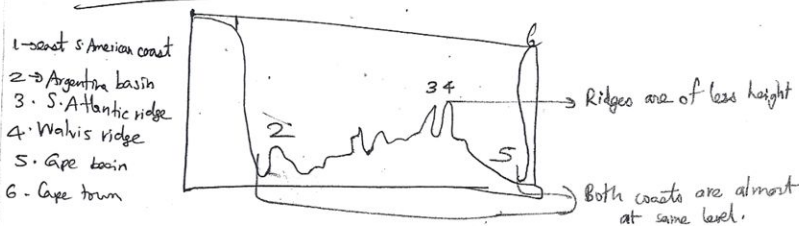
FRACTURES

- Gibbs fracture (40°N)
- Oceanographer fracture (32°N)
- Atlantic fracture (30°N)
- Kame fracture (25°N)
- Wema fracture (10°N)
- Romania fracture (0°) \rightarrow Divides N. & S. Atlantic ridges
 - \downarrow (near equator) \downarrow Dolphin rise \downarrow Challenger.

C-S. of N. Atlantic ridge

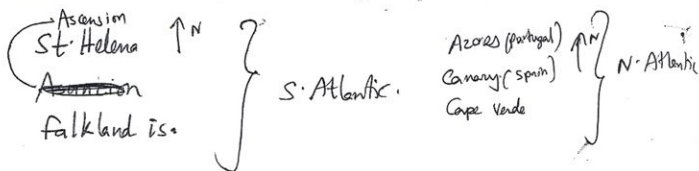


C-S. of S. Atlantic ridge



Bermuda triangle \rightarrow Bermuda, Haiti (Port-au-Prince), Florida (Miami) ..

Almost all island in S. Atlantic ocean belongs to U.K.



Brazil → Continental shelf is narrow (^{narrowest → Cape Sao de Roque}) (71)

It widens from Brazil towards ^{north} & continent ^{South}.
shelf is very wide at Antarctic - (from Bahia Blanca to Antarctic)

It widens from Brazil towards ^{North} ~~South~~ & greatest
at the Caribbean (^{so only} islands due to shallow depth).
(Lesser Antilles).

It again becomes narrower till New York - Again
starts widening towards north. ~~to the~~

Newfoundland ⇒ wide shelf ⇒ Grand Bank ⇒ fishery ground.
↳ fishes found at a shallow depth.

→ Wide continental shelf, in the northernmost
~~part~~ of N-Atlantic ^(Wyville Thompson Ridge) ⇒ that is why Greenland, Iceland.
Wyville Thompson ridge ⇒ b/w Iceland & Scotland; Telegraphic plateau → south of Greenland & Iceland.
Wide continental shelf at Europe & Asia.

↓
Norwegian Sea, North Sea

↓
Herring pond of the world.

Ocean bottom topography (Continental)

→

→ Major relief

→ Minor relief

→ Analysis of continental shelf.

→ Ocean basins

1. Labrador 2. Puerto rico 3. Azores 4. Cape Verde 5. Guinea 6. Angola 7. Argentina

contd ...

Ocean deeps in Atlantic (Trenches)

1. Puerto rico deep 2. Columbia deep 3. Verna deep 4. Romanche deep.

Marginal seas

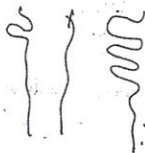
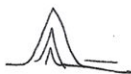
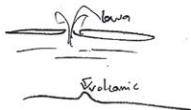
1. Mediterranean sea 2. Caribbean Sea 3. Gulf of Mexico.

~~Mid At~~

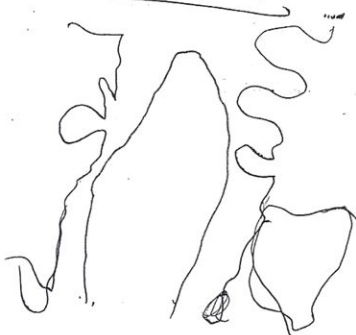
Oceanic ridge (or Mid Atlantic ridge)

→ What is oceanic ridge.

→ origin:-

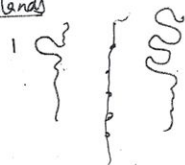


→ Ocean bottom topography



→ Analysis of continental shelf. ⇒ where increases, decreases, why?

→ Islands



Islands ⇒ ~~Azores~~ Azores, Canary, Cape Verde, ⇒ N. Atlantic.
Ascension, St. Helena, ⇒ S. Atlantic.

All islands are located either on the ridge
or continental shelf.

→ Fracture zones:-

(73)

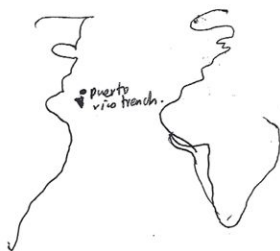


Gao
Oceanographer

→ Trenches.

Not much trenches, because no convergence.

Only one trench:- Puerto Rico Trench.



N. Atlantic ridge:-

→ High height of ridges.

→ West coast is deeper ~~is~~, east coast shallow.

S. Atlantic ridge -

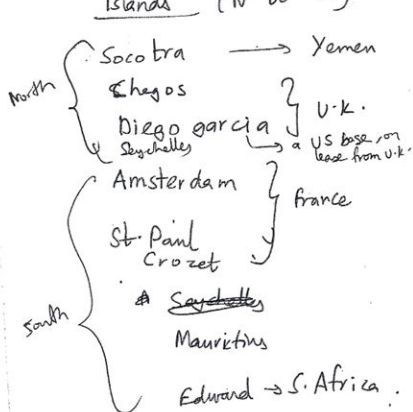
- Avg. height of ridge is lesser than N. Atlantic.

• Both coasts gentle slope

Ocean bottom is a repository of various mineral resources, biodiversity ~~high~~ rich areas & fishing grounds. Understanding is very imp.

INDIAN OCEAN

Islands (N to S)



All islands in Indian ocean are on the mid-ocean ridge.

BIG ISLANDS

Sri Lanka, Madagascar (Mabasy)

Usually, N. Indian ocean → U.K.
 S. Indian ocean → France.

Ridges

Socotra - Chagos ridge.

Chagos ridge → (w India → Lakshadweep).

Seychelles ridge.

Chagos - St. Paul ridge.

NINETY EAST RIDGE → extension of Himalayas in the ocean.

Trench → Java trench (Indonesia).

CONTINENTAL SHELF IN INDIAN OCEAN

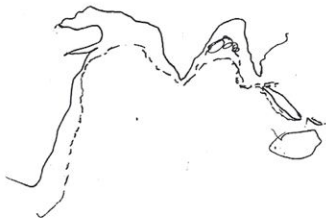
Africa



→ No sea mounts, gorges -

→ Coral reef → Andaman & Nicobar ; Lakshadweep
 rising reefs on east; barrier reefs on west

No Fracture zones, only branches



- East coast shallow ; west coast deep.

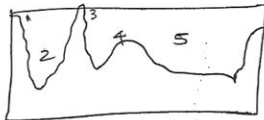
(11)

So, more islands in the east coast.

- No classification of N. & S. Indian Ocean, because

N-Indian ocean is landlocked. Only, consider S-Indian ocean -
 (Gulf of Aden, Gulf of Oman, Arabian Sea, Bay of Bengal)

Draw graph (S-Indian ocean)



- 1 → Madagascar coast
- 2 → Réunion
- 3 → mid-ocean ridge
- 4 → east paul ridge
- 5 → Indian-Aus basin (least known)

Draw diagrams for

Marginal seas

- Less no. of marginal seas compared to Pacific & Atlantic
 1. Red sea 2. Gulf of Oman 3. Bay of Bengal 4. Arabian sea

Ocean basins

- 1. Oman basin 2. Arabian basin 3. Somali basin
- 4. Mauritius basin 5. Mascarene basin 6. Agulhas-Mozambique basin.

11/08/12

MODELS & SYSTEMS

→ Majid Hussain.

Malthusian Theory (1786)

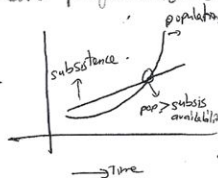
Malthus → British economist → 'POPULATION BOMB.'

① → The power of the earth to produce subsistence is far less than power of the population growth.

② → World population growing in Geometric progression (G.P)
Food Production growing in Arithmetic progression (A.P)

③ → Every 25th yr, population doubles.

Reasons for population growth.



i) Sexual passion.

ii) Availability of subsistence.

↳ resources to sustain the population.

Passion for sex → early marriage → more reproductive period

↓
more children

↓
cycle

Available subsistence → food & resource
↓ (good reproductive health, longevity, more resource to take care of children, less CME, IMR)

sexual relation

↓
more children

↓
population growth overcomes subsistence.

④ If we do NOT apply preventive checks, then the positive checks will start to operate.

Preventive checks \rightarrow moral restraint,

\rightarrow No early ~~late~~ marriage, spaced births, limited no. of children

Positive checks \rightarrow famine, competition for resources

\downarrow \uparrow \downarrow \downarrow
food crisis war. crime

Criticism

- 1) No vision about contraceptive measures, by technological advancement.
- 2) Religious in nature \rightarrow Being a catholic, he does not advocate contraception.
- 3) ~~that~~ That the population doubles in 25 yrs, is arbitrary.
- 4) Sexual ~~desire~~ Desire for sex is a biological phenomenon, whereas desire for children is a social phenomenon. He fails to distinguish these two.
- 5) This theory is NOT universally applicable.
(can't be applied in Arabia, where religion dominates).
- 6) He could not envisage the scientific developments in agri, which ~~would~~ later led to a huge jump in food production.

SIGNIFICANCE

- 1) First to introduce ~~increase~~ the awareness about population explosion & its vagaries.
- 2) Very doomsay in approach. No effective ^{practical} solution suggested.

Marx → German intellectual.

Modes of production → Land
→ Labour
or
FOP (Factors of Production) → Capital
→ Entrepreneurship.

• Marx made a historical interpretation of modes of production. ('historical dialectism')

1. Hunting & gathering → Socialist society; No priv. property
Primitive communism.

2. Settled agriculture → land clearance, domesticated animals
First private property.
Resources were high; so, everybody had
access to resources & private property.

3. INDUSTRIALISED → HAVEs ⇒ Land → Capital → Entrepreneurship
→ HAVE NOTs ⇒ Labour.

HAVEs multiplied their own resources. (increased
their land, capital & entrepreneur skills).

HAVE NOTs multiplied their resources → Labour.

→ population. More children are his only old-age insurance.
More population ⇒ more labour ⇒ less wages on labour ⇒ further increase population ⇒ cycle.

HAVEs reduced their population → less children

→ to prevent DILUTION of their resources.

HAVE NOTs enjoyed their leisure ⇒ no ~~time~~ resources
to conc. on, during leisure ⇒ so, more population.

HAVEs started exploiting \Rightarrow low wages, hire & fire, unsafe working conditions (79)

They established institutions to protect them from the HAVE-NOTS.
 \downarrow
Lawborder, police, state;

Change of population growth with modes of production

Hunting, gathering \Rightarrow have to carry their children on their back, so, no further children until the first child learns to walk. so, automatic control.
LESS population growth.

Settled agriculture \Rightarrow settled home; no need to carry children. ~~Child~~ Cap blw pregnancies DECREASE.
MORE population growth; moreover, settled homes increased the intimacy of relationship \Rightarrow so, more children.

Industrialised \Rightarrow Capitalists BUSY managing their resources. No ^{leisure} time. No population growth.

Mores SOLUTION

Change the capitalist societies to a communist society, to decrease population. HAVE-NOTS will have resources to manage, less leisure, prefer NOT to dilute resources \Rightarrow LESS population growth.

Criticism

- 1) 'Wages' is an economic phenomenon, not a demographic phenomenon (for eg: \Rightarrow In India, though population is growing, wages are increasing yr by yr).
- 2) Distribution of resources equally will severely affect the ability to organise MEGA PROJECTS.
- 3) Distribution of resources will be a disincentive to ppl who work hard & want to earn more.

vs/08/12 Bottom topography of Pacific ocean

⇒ Approach is no mid ridge; so inst. of approaching
as the whole ocean (shelf, islands, ridge), approach as diff.
parts of the sea.

N. ~~WE~~^{NE} Pacific

- Convergence zone → so no continental shelf → no marginal sea
 - ↳ continental - ocean convergence
 - ↳ rocks
- Trenches → Guatemala, California trench
 - ↳ due to convergence
- Continental shelf widens towards Alaska →

N.W. Pacific

- Ridge \rightarrow S. Honshu ridge
- A lot of trenches \rightarrow Kuril trench, Japan trench, Mariana trench, Mindano trench.
- \downarrow
deepest trench:

C-shelf. Though convergence ^{also} place, b/w the island arcs and the mainlands, continental shelf is present \Rightarrow so marginal seas \Rightarrow S. China Sea, Japan Sea, Sea of Okhotsk.
(b/w China & Philippines) (b/w Russia & Japan)

- Deepest part of the ocean.
- Islands \Rightarrow Philippines, a part of Indonesia, some S.E. Asian countries
arcs & festoons \rightarrow Japan arch, Philippines, Kuril, Sakhalin.

S. W-Pacific

contains a lot of islands \rightarrow made of coral reefs
or sea mounts, guyots. (mostly coral reef)
Great Barrier Reef (east coast of Aus.)
scattered islands \rightarrow Micronesia, Polynesia, Melanesia
ridge \rightarrow Lord Howe ridge (b/w N-Z & Aus.)

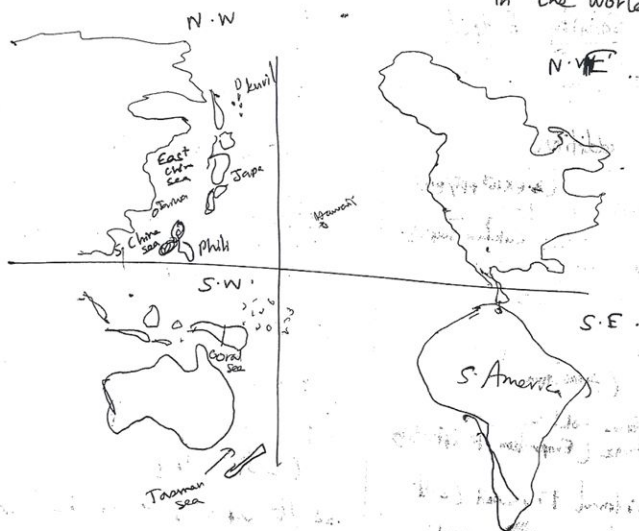
Trench \rightarrow Tonga ^{trench} & Kermadec trench \Rightarrow steepest trench. (81)

Coral reef \rightarrow Great Barrier Reef

marginal seas \rightarrow Tasmanian sea, Java sea, coral sea, Taimor sea.

S.E. Pacific

- Ridge \Rightarrow East Pacific ridge (Albatros ridge)
S.E. Pacific Plateau,
Cocos ridge.
Juan Fernandez ridge (along Chile coast).
Challenger fracture \Rightarrow towards southern tip of S. America.
- less no. of islands.
- No ^{due to convergence (Southwest-Asian \Rightarrow Andes)} continental shelf.
continental seated is. \Rightarrow Juan Fernandez, Ambrosio, Felix
- Trench \Rightarrow ~~Peru~~ Chile-Peruvian trench \Rightarrow longest trench in the world.



- \rightarrow Largest ocean in the world.
- \rightarrow Most variety b/w diff. parts of same ocean.
- \rightarrow Absence of clear-cut ridges.
- \rightarrow Most no. of islands
- \rightarrow Variety of land features \rightarrow coral reef, gayots, sea mounts
- \rightarrow World's deepest & longest trenches.

Salinity of water

Average salinity = 35 ‰

all dissolved salts like
(Cl, Na, SO₄, Mg, Ca, K, HCO₃,
Br, BO₃, St)

Salinity → Amt. of dissolved salt (in gms)
per kg. ~~litre~~ of water - (Measured in parts per thousand
→ ppt or ‰)

∴ Normal salinity of ocean → 35 ‰ salinity

Brackish water ⇒ Salinity < 24.7 ‰

> 24.7 ‰ ⇒ ocean (saline) water

Isolyde → Places receiving the same amt. of rainfall
_{water}

Is haline → Places having the same salinity
_{salt (halide)}

Salinity Budget

Salt ⇒ not only Na, but also Cl, Mg, Ca.

| Salt addition | Salt removal |
|--|---|
| → Addition by ^(2.6 × 10⁶ ppt/yr.) river water. calcium sulphate | → Human consumption (salt extraction) |
| → Dead marine organisms & their excreta | → Reverse osmosis |
| → Wind carries salt from land. (Advection) | → Phyto & Zoo planktons consumption |
| → Surface moisture flux (Evaporation - precipitation) | → Sea breeze carries away salt. |
| → Meridional transport (salt carried by ocean currents) | → Percolation of salt into water table (Sedimentation) |
| | → Salt expulsion during ice formation |

Percolation → vertical movement

Seepage → horizontal movement

Significance

- imp. for marine organisms (eg: Ca is essential for shell forming organisms)
- buoyancy (due to density) → floats → ship navigation.
- salinity affects sp. heat capacity of water → evaporation → ppt. in coastal areas
- salinity → ocean currents; salinity → freezes pt. of water → polar ice sheet

Factors affecting salinity

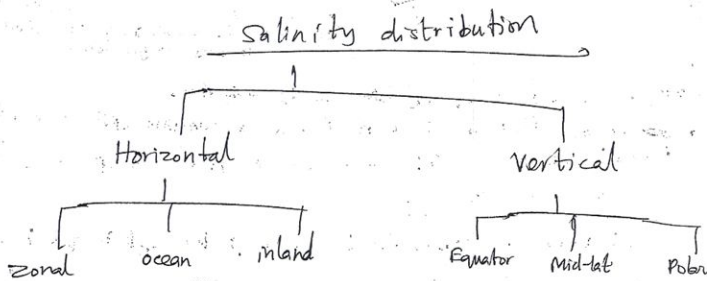
- 1) Influx of fresh water → rivers deglaciation, rainfall. ↓
 eg: Black sea (15%) low salinity → due to Danube, Dnieper, Dniester
 mouth of Ganga, Congo, Amazon; Gulf of Bohman (5%)
- 2) Temperature → evaporation. ↑
 35% at 5°N
 37% at 28°N → subtropic high P, cloudless sky
- 3) Ocean current
 eg: Gulf of Mexico (37%) due to Gulf Stream
 warm current → high evap → high salinity ↑
 N. Atlantic drift increases salinity of N.W. Europe coast
 cold current → low evap → low salinity ↓
 Labrador current → N.W. Atlantic (33%)
 Oyashio current → N.W. Pacific (31%)
- 4) Winds

0° to 30° ⇒ trade winds → flow from east to west
 So, more salinity on the western part of ocean (to the east of the continent).
 low salinity on eastern ocean ⇒ eg: Gulf of California (34%)

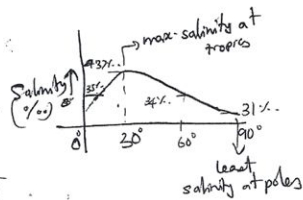
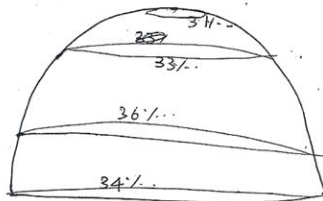
30° to 60° ⇒ Westerlies → west to east
 So, more salinity on eastern part of ocean (west coast of continent)

5) Mid-Atlantic ridge ⇒ prevents mixing of water on two sides of the ocean. But mid-Atlantic Ridge has several holes, through which mixing is possible through seeping.

| Salt | Percentage |
|-----------------------------------|------------|
| 1. NaCl | → 77.8% |
| 2. MgCl | → 10.9% |
| 3. MgSO ₄ | → 4.7% |
| 4. CaSO ₄ | → 3.6% |
| 5. K ₂ SO ₄ | → 2.5% |
| 6. CaCO ₃ | → 0.3% |
| 7. MgSO ₃ | → 0.2% |



Zonal distribution



Equator \Rightarrow low salinity (in spite of high temperature)

Reasons for low salinity

- High rainfall

- Influx of river water from Amazon, Congo, Ganges, Brahmaputra, Irrawaddy.

Mid-latitude

HIGHEST SALINITY

Reasons

- Subsidence of air mass (Anticyclonic condition)
- High insolation, due to clear sky, increases evaporation.
- Not much addition of freshwater by rivers.

Sub-polar

Low SALINITY

Reasons

- Low temp.
- High rainfall (cyclonic)
- Freshwater by ~~Nile~~ Danube, Rhine
- meltwater from polar cold current

POLAR

- Lowest salinity.

(85)

Reasons

- Alternate freezing & ^{melting} thawing expels the salt.
- Large influx of fresh water due to melting of glaciers.

Closely spaced isohalines \Rightarrow high salinity gradient
 \downarrow
fast change in salinity.

SALINITY DISTRIBUTION IN OCEANS

ATLANTIC

HORIZONTAL \Rightarrow 1) westerlies 2) easterlies 3) river inflow

~~ocean~~ ocean

- 4) Latitude \rightarrow evaporation
- 5) Warm/cold current
- 6) Enclosed seas \rightarrow 1) semi (beyond 30°S) \rightarrow regular isohalines

0° to 30° \Rightarrow low salinity in eastern margin \rightarrow African coast

Salinity increases towards western side of ocean \Rightarrow (since trade winds carry ^{highly} saline water from east to west)
 \rightarrow Gulf of Mexico (36‰)
 \rightarrow also due to warm current (Gulf Stream)

30° to 60° \Rightarrow Westerlies (low salinity in

Salinity increases towards eastern side of ocean \Rightarrow North Sea, British coast
high salinity (34‰) despite high latitude (50°N \rightarrow low salinity \Rightarrow 33‰)
due to saline water from N. Atlantic Drift (warm current) & westerlies.
 \rightarrow A big loop is formed in central Atlantic ocean due to gyral formation (rotation of ocean current).

\rightarrow Salinity high in Caribbean \Rightarrow more

- LANDLOCKED SEAS \rightarrow Mediterranean (40‰) \rightarrow high evaporation
- Baltic sea (15‰) \rightarrow high inflow of freshwater.

\rightarrow Mouth of Amazon (15‰) \Rightarrow N.W. South American coast

mouth of Amazon \rightarrow 31‰

Rhine \rightarrow 32‰

Gulf of Bohemia \rightarrow 5‰

\downarrow
~~less~~ less salinity.

\rightarrow Isohalines in S. American coast never touch Africa due to the effect of cold current in Africa.
 \downarrow
low salinity.

\rightarrow Beyond 40°S, there is regular horizontal isohalines,

due to the absence of land.

\rightarrow Though ridges are present, NO salinity divide as there are openings in the ridges which allow inter-mixing of water.

Indian ocean

- Salinity divide \Rightarrow A vertical isohaline \Rightarrow due to the effect of a mid-ridge.
prevents inter-mixing of water on two sides, creating a salinity divide.
- High salinity in ~~Bay of Bengal~~ Red Sea & Persian Gulf (41%) (40%) due to land locked nature & dry weather (middle east \rightarrow desert).
- But, salinity of Arabian sea $>$ Bay of Bengal (35%) (30%).
 ↓
 (less influx of freshwater than Bay of Bengal; more arid climate (blowing winds) from Arabia; high salinity from Red sea)
 ↓
 and influx of Ganges, Brahmaputra, Irrawaddy
- Loop formation \Rightarrow S. Indian ocean (near Aust. coast) due to change in direction of ocean current in Indian Ocean, (S.W. monsoon / N.E. monsoon) absence of loops in N. Indian ocean.

Pacific ocean

- High irregularities in salinity due to presence of several islands.
 • Huge variation due to big area.
- Loop formation both in N. Pacific & S. Pacific.
- 0° to $30^\circ \Rightarrow$ salinity increases forwardly (due to trade winds) western part of ocean (Gulf of Mexico low salinity, Caribbean sea, eastern part of ocean)
- 30° to $60^\circ \Rightarrow$ " " " eastern part of ocean (due to westerlies)
- No ridge \rightarrow no salinity divide.
- Low salinity in river mouths \Rightarrow Yangtze river mouth (33%) (30%)
 Yellow river (Hwang Ho) mouth (30%).
- Salinity low in N.W. Pacific (Okhotsk sea \rightarrow 31%; Manchuria \rightarrow 34%) due to influx of melt water & Oyashio cold current from poles.

Inland seas

(87)

• Salinity also depends on presence or absence of outlets with ocean.

• Presence of outlet \Rightarrow Mediterranean sea \rightarrow high salinity due to evaporation.
 \downarrow
 exchange of water salinity b/w inland sea & ocean.

\downarrow
 so, comparatively less salinity.

Inland seas with no outlet

Absence of outlet

\downarrow
 no salinity exchange

\downarrow
 so, all salt conc. within the inland sea

\downarrow
 more salinity. (in low latitude \rightarrow due to higher evaporation)

Isr-Jordan

\Rightarrow Dead sea

238‰

Turkey

lake Van

330‰

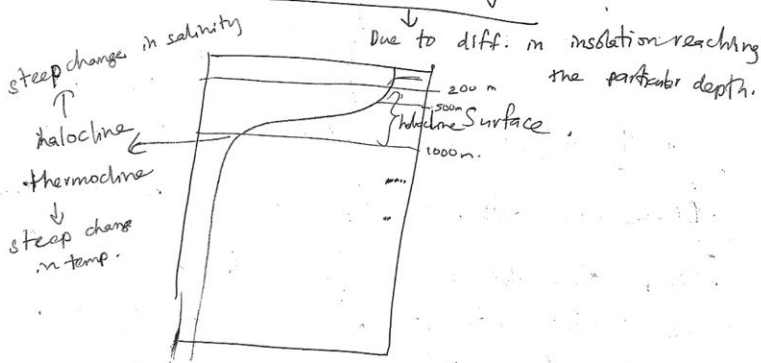
220‰

Great salt lake

highest salinity in the world

However, Black sea has low salinity due to influx of Danube (freshwater)

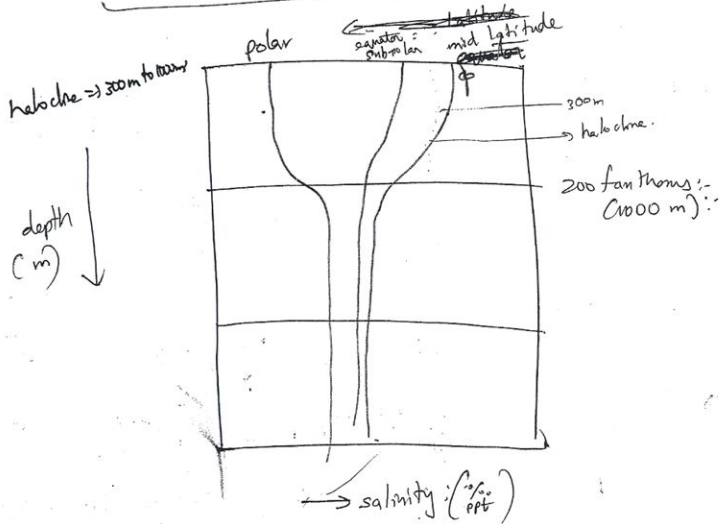
Vertical distribution of salinity:-



surface \Rightarrow more sunlight penetration \Rightarrow more evaporation
 \downarrow
 more salinity

Subsurface \Rightarrow not much penetration of sunlight

Salinity of mid-lat > Salinity of equ, sub-polar > Salinity of polar.



- In polar regions, the surface is less saline due to deglaciation & ~~but~~ salt expulsion from the surface. also due to glacial meltwater.
- After a certain depth salt content increases.

Critically analyse the salinity distribution in the world. (15m or 30m)

- Discuss how salt budget is maintained in the ocean. (12m)
 - Temp. alone does not increase salinity of the ocean.
- with ref. to this statement, explain the factors influencing the dist. of salinity. (15m)

If, 15m Critically analyse salinity dis.

→ Land locked ⇒ salinity high

→ Mid-oceanic ridges ⇒ salinity divide

→ Loop (ocean current)

→ wind influence

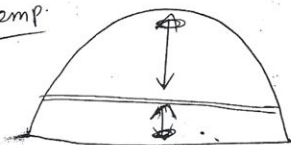
→ vertical dist.

DO NOT go deep into the various oceans

Temp. alone does not increase salinity!

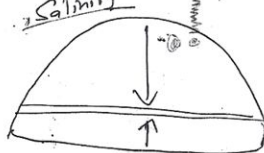
In case of a statement-type ques. first explain the statement - support or negate it & then go with the flow.

Temp.



⇒

Salinity



There is a correlation.

But, it is not the only deciding factor.

for ex:-

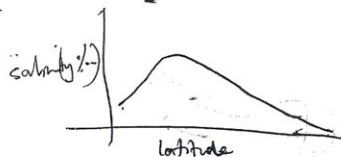
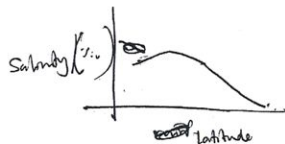
Equator does not have as much salinity as dictated by the temp.

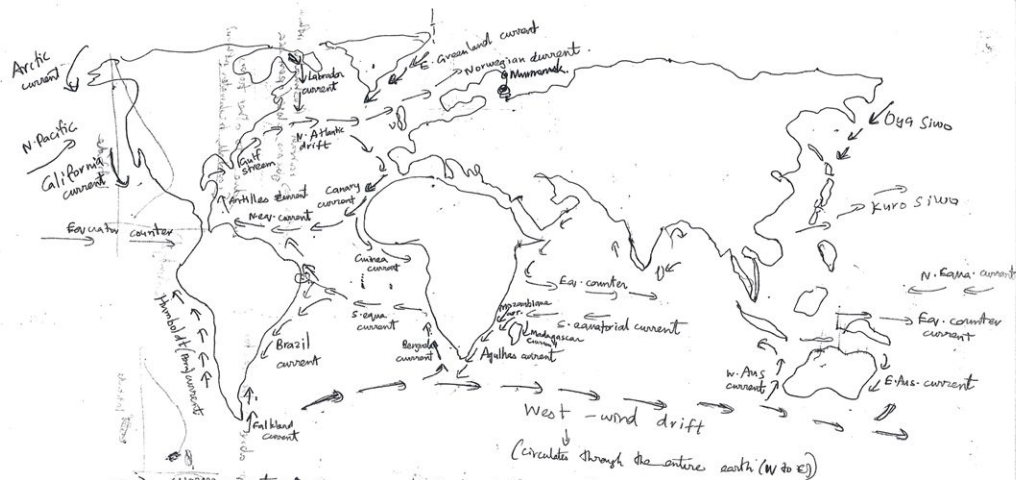
other

factors ⇒ rainfall - freshwater inflows
glaciers, close/open sea
ocean currents, ridge

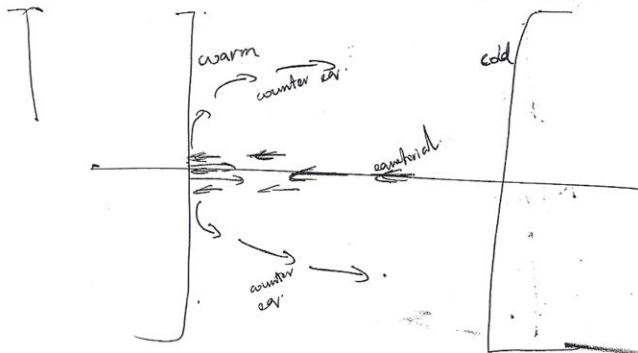
if temp alone is the factor

but, due to other factors
(rainfall, freshwater inflows)





N. hemisphere → cold current on eastern coast of continent.
 S. hemisphere → cold current on western coast of continent.
 cold current → always directed from higher latitude (poles) to lower latitude (equator)



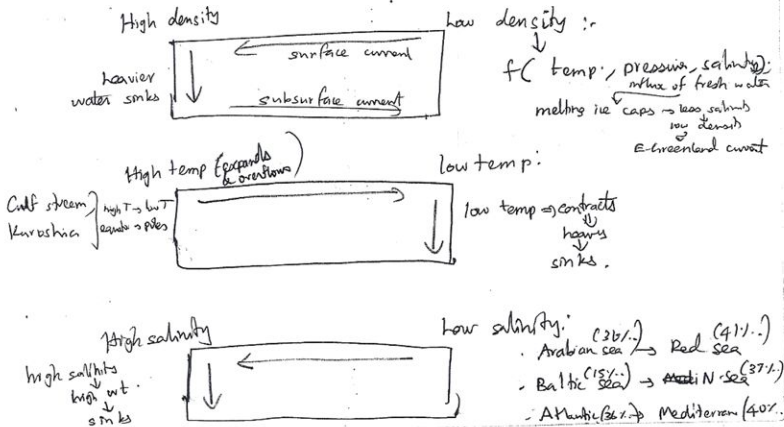
Earth rotates from west to east \Rightarrow due to inertia, the ocean current moves from east to west.
 Equatorial cur. \Rightarrow due to earth's rotation & influence of trade winds
 east to west

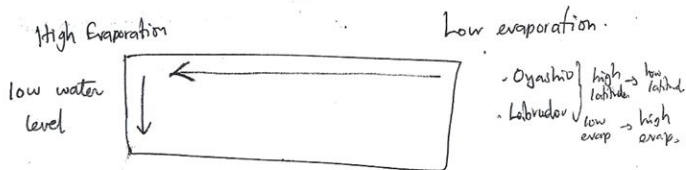
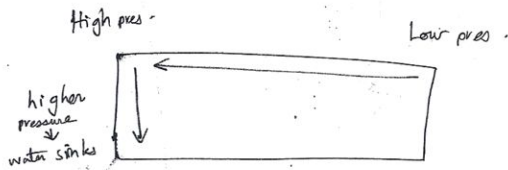
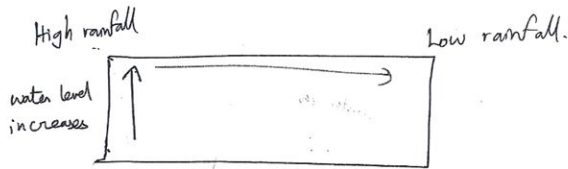
Counter equatorial current \Rightarrow on hitting the continent moves in the oppo. west to east.

Equatorial current on hitting continents splits in N. & S.
 clockwise. anticlockwise.

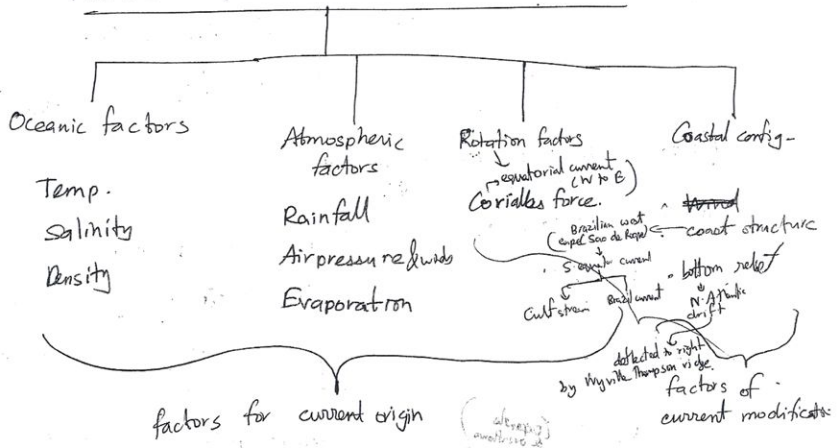
Factors affecting ocean current

Oceanic factors \rightarrow Density, temperature, salinity.





Factors responsible for ocean currents



- Current \rightarrow has a definite direction & greater velocity. (93)
- Stream \rightarrow Speed is increased (more than a current)
- Drift \rightarrow Does not have definite direction; dictated by wind.

Speed

Stream $>$ Current $>$ drift

- Meeting pt. of cold & warm currents \Rightarrow large amt. of phytoplankton & zooplankton available \Rightarrow food material for fishes \rightarrow fishing industry.

Cold current \rightarrow food material available for fish.

Warm current \rightarrow not enough food for fish

EL Nino & Southern Oscillation

* important mechanism & effects

EL Nino, Modoki;
dipoles in Indian ocean

- In some extraordinary yrs., the Humboldt current (a cold current) on the Peruvian coast is replaced by EL Nino (warm current).

- This reduces the available food for fish \Rightarrow

Anchovies fishes on Peruvian coast die without food

\rightarrow Guano bird dependent on Anchovies fish dies \rightarrow Guano

\rightarrow from its droppings (excreta)

fertilizers production decreases \rightarrow economy suffers

- The EL Nino (warm current)'s effect is carried throughout the world by the West-wind drift. This is called southern oscillation.

EL Nino has a detrimental drought effect in India (sw. monsoon \Rightarrow no rain) & floods in China.

Impacts of ocean current

1. Fishing ground \rightarrow meeting pt. of warm & cold current

USA Canada \Rightarrow Grand Bank

Meeting of \downarrow Gulf stream & Labrador current.
 \downarrow warm \downarrow cold

Japan \Rightarrow meeting pt. of Kuro Siwo & Oya Siwo.
 \downarrow warm \downarrow cold

2. Climatic alterations.

• warm current \rightarrow brings more rainfall to the coast.

• N-Atlantic drift keeps Britain warmer than other

~~places at the same latitude (Canada)~~
~~(warm current) in the north~~

~~also known as the Norwegian current~~
• Norwegian current keeps the Russian port

\downarrow warm
Murmansk on the Arctic coast is free throughout the year.

3. Navigation

• Direction of ocean current \rightarrow fuel efficiency.

• Meeting pt. of warm & cold current \Rightarrow ~~meeting~~ ^{seabergs} of warm & cold ~~air~~ ^{winds, waves} \Rightarrow ~~cold~~ ^(mixing) warm air mass rises, cold air ~~settles~~ ^{settles} at the bottom \rightarrow mist formation
(Inversion)

\downarrow
T. I. TANK (Grand bank)
 \downarrow meeting of cold Labrador current & warm Gulf stream.

④ Salinity distribution.

Fish movement

Desertification

(95)

cold current \Rightarrow subsidence of air mass \Rightarrow no rainfall.

All deserts are backed by cold current.

Atacama \Rightarrow Humboldt current

Patagonia \Rightarrow Falkland current.

W. Australia \Rightarrow W. Aus current

Sonoran, Mojave \Rightarrow California current.

~~Car~~ Sahara \Rightarrow Canary current.

Cyclones

cyclone \rightarrow low pressure warm current \rightarrow rainy climate.

cold current \Rightarrow high pressure \rightarrow no cyclone.

Delta formation

Amazon, Parana-Paraguay \Rightarrow no delta formation \Rightarrow only estuaries.

\downarrow
deposited silt is carried away by the warm current.

Heat budget

.. west wind oscillation ...
.. equatorial current ...

Pollution spreading

Oil spills in an ocean are carried throughout the world.

Sea weeds

Cirral formation (loop) \rightarrow all dust acc. in the centre

\rightarrow Sea-weeds (Sargassum) grow well.
eg: Sargasso sea.

Coral reef

\rightarrow Found on the eastern coast of the continent.

\rightarrow Coral reef \rightarrow need warm temperature \rightarrow so warm current reqd.

Energy production

- Non-conventional renewable new energy from rotation of turbines by ocean currents.
- OTEC \rightarrow Ocean Thermal Energy Conversion;

El Niño

- Impact on monsoon.
- Causes coral bleaching.

Malthus theory

1. Poverty & misery \Rightarrow natural inevitabilities.
2. Solution \rightarrow preventive & positive checks.
3. Economically driven theory.
4. Formal in approach.
(Arithmetic \propto pop. G.D.,)
mathematical calc.
5. Dedicated population theory.
6. Factors for population growth
 - 1) Desire for sex
 - 2) Avail. of subsistence
7. Period of doubling
— 25 yrs.
8. Population leads to poverty.
9. Wider applicability.
10. Supported capitalism.

Mars theory

(97)

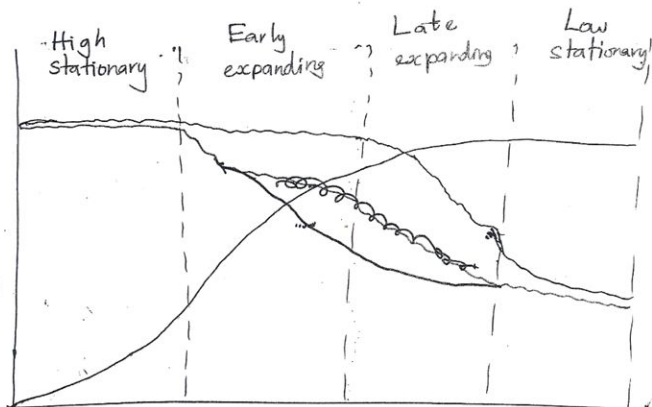
- Poverty & misery \Rightarrow gifts of capitalism.
- Solution \Rightarrow distribution of resources. (change in mode of production).
- Politically driven theory.
- Based on observations (reform).
- By-product of his economic & political theory.
- Factors of population growth
 - Need to produce surplus labour.
- Period of doubling
 - \downarrow varying with various societies (depend on occupancy pattern).
- Poverty leads to population growth.
- Constraint only to certain sections of society.
- Supported communism.

Similarities

- \rightarrow Failed to realize religious factors of pop. growth. (Appl of many religions consider children the gifts of God & hence use of contraceptives).
- \rightarrow Failed to envisage the tech. dpt. & contraceptive methods.
- \rightarrow Failed to take in local factors
(In India, population growth was mostly due to the desire for a male child.

Demographic transition theory

Thompson & Notestein



~~~~~ ⇒ birth rate  
 ————— ⇒ death rate

|               |                                          |        |                         |                               |
|---------------|------------------------------------------|--------|-------------------------|-------------------------------|
| I<br>Agrarian | ⇒ High stationary                        | ⇒ High | High epidemics          | <del>stable</del> slow growth |
| II            | ⇒ Early expanding<br>(mortality induced) | ⇒ High | ↓                       | Increases at a high rate      |
| III           | ⇒ Late expanding<br>(fertility induced)  | ⇒ ↓    | low                     | Increases at a lower rate     |
| IV            | ⇒ Low stationary                         | ⇒ Low  | Low                     | slow growth                   |
| V             |                                          |        | Birth rate = Death rate | zero growth                   |

When a country or a region develops from an agrarian society to an industrialised modern society, a particular direction of demographic transition occurs — from high fertility, high mortality to low fertility, low mortality.



I stage

- Pre-modern, pre-indus.  $\Rightarrow$  no tech. innovation.
- Agrarian societies
- No rudimentary instruments used -  
wasteful production; less life expectancy.
- Long period of breast-feed & nomadism will put preventive checks on pop. growth.
- High death rate due to epidemics.
- Large family considered an asset

II stage

- $\rightarrow$  eg:- India, Kenya, Indonesia, Pak., B'desh.
- Introduction of medical facilities.
- Industrialisation.
- New societies (from feudal to ~~the~~ organised form of govt.).
- Death rate reduced drastically
- In the late second stage  $\Rightarrow$  slow decline in birth rate,  
steep decline in death rate.
- No longer, large families are assets?

III stage

- entrepreneurship.
- Luxurious goods consumption.
- more conc. on consumer goods.
- Birth rate reduced  $\Rightarrow$  drastically increased awareness of  
contraceptives.  $\rightarrow$  eg:- China, Brazil.

IV stage

- Highly specialised society.
- Consumerism : demand-driven
- Boom in tertiary sector.
- Birth rate & death rate match each other.
- Population will become stabilised.
- Abundance of tech. know-how; labour specialization.

eg:- Anglo-America.



→ Population is a self-adjusting phenomenon, as the society gradually matures.

→ Economic & social dept and class mobility is

|       | I                         | II                                                      | III               | IV                      |
|-------|---------------------------|---------------------------------------------------------|-------------------|-------------------------|
| World | Certain African countries | India, Pak., B'desh                                     | China, Brazil     | Scandinavia, U.S., U.K. |
| India | Tribal communities        | BIMARU<br>Bihar, M.P., Rajasthan, U.P.<br>(CEAG states) | Karnataka, Andhra | TN, Kerala              |

### Significance

- A proper understanding & analysis of the stage of population growth of a particular region will help in deciding on the type of policy measures in that region. For eg.: for a region in stage I, it is essential to introduce medical facilities to choke the high mortality rate. For a region in stage II, it will be suitable to spread education about contraception.

## Merits

(10)

- First theory to relate dpt. & population.
- Supported by statistics (birth rate & death rate figures).

## Criticism:-

- West Asia → Economic dpt. <sup>has</sup> ~~did~~ not <sup>brought</sup> ~~bring~~ down the population growth. Religious ~~po~~ factor not considered.
  - China → has jumped the II stage in a short time by autocratic & suppressive measures → One Child policy
  - ~~The~~ An important factor → Migration — is not included.
  - France, Germany ⇒ gone beyond stage IV  
    ↓  
    now in demographic trap.
  - What after stage III? Is it a cycle? No mention.
  - France, Aus ⇒ still an agrarian country but population growth has stabilised. So, stages of pop. does not entirely depend on the type of occupation.
  - U.S.A. ⇒ born in the II stage.
- So, all stages not applicable to the entire globe.
- sequential dpt. of stages may be disturbed by a sudden war or a natural calamity.

Though, ~~this~~ this theory is widely applicable.

- Mainly based on empirical observations ~~of~~ ~~the~~ in the West. Does not take into acc. the socio-economic factors of east.

19/08/12

## Thornthwaite's classification

1931 classification (all formulae use temp. in °F & rain in inches)

→ He accepted vegetation as a basis, but not directly.

→ He took temperature as a factor, but not abs. values.

He introduced

→ Precipitation efficiency → Amt. of ppt. that is available for the growth of vegetation.  
~~percentage through the soil~~

→ Thermal efficiency → positive deviation of mean temp from freezing pt.

To calculate these, he used <sup>Ppt. eff. index (P/E)</sup> ~~Humidity~~ <sup>Province</sup>  
and Thermal efficiency index (T/E).

$$P/E \text{ ratio} = \frac{\text{Total rainfall (monthly)}}{\text{Total evaporation (monthly)}}$$

$$P/E \text{ monthly ratio} = 11.5 (r t - 10)^{10/9} \quad P/E \text{ (annual)} = \sum P/E \text{ (monthly)}$$

$r \rightarrow$  rainfall (monthly) (in inches).  
 $t \rightarrow$  temp. in fahrenheit. (monthly)

Based on P/E ~~indices~~ indices, he classified HUMIDITY

PROVINCES.

### Humidity provinces (5)

| Humidity province | Vegetation          | P/E index - (annual) |
|-------------------|---------------------|----------------------|
| A → wet           | Tropical rainforest | 128+                 |
| B → humid         | Sub-tropical        | 64-127               |
| C → semi-humid    | Tropical grassland  | 32-63                |
| D → semi-arid     | steppe              | 16-31                |
| E → arid.         | Desert vegetation   | < 16                 |

## Thermal provinces (6)

Based on T/E (index), he classified thermal provinces:

$$T/E \text{ (monthly)} = (t - 32) / 4 \quad (t \rightarrow \text{monthly temp (fahrenheit)})$$

$$\text{Freezing at } 32^\circ \text{F} \quad T/E \text{ (annual)} = \sum T/E \text{ (monthly)}$$

|                                       |        |                                        |
|---------------------------------------|--------|----------------------------------------|
| A' $\rightarrow$ Tropical (Megatherm) | 128+   | $0^\circ \text{C} = 32^\circ \text{F}$ |
| B' $\rightarrow$ Mesothermal          | 64-127 |                                        |
| C' $\rightarrow$ Microthermal         | 32-63  |                                        |
| D' $\rightarrow$ Taiga                | 16-31  |                                        |
| E' $\rightarrow$ Tundra               | 0-15   |                                        |
| F' $\rightarrow$ Frost                | < 0    |                                        |

## Seasonal distribution of rainfall. (4 categories).

r  $\rightarrow$  rainfall in all season

S  $\rightarrow$  summer dry

w  $\rightarrow$  winter dry

d  $\rightarrow$  dry in all seasons.

Combining humidity, thermal provinces & seasonal dist. of rainfall, he made  $5 \times 6 \times 4 = 120$  classifications theoretically, but only 32 are practically applied.

## Criticism

- large data reqd. for calc. P/E & T/E.
- very diff. to memorise, due to a lot of symbols
- this classification needs a lot of calculation & skilled persons.
- large no. of climate types.
- failed to give relation of temp. & ppt. with wind, ocean current, etc.

1948 classification (all formulae use temp. in  $^{\circ}\text{C}$  & rain in cm)

Introduced 2 more variables

- i) Potential <sup>index of thermal eff. & water loss</sup> evapotranspiration (PET) (loss of water from plants & soil)
- ii) Soil moisture index (ability of soil to retain water)

$$PET_{(\text{in cm})} = 1.6 (10t/i)^a \rightarrow \text{monthly}$$

$t \rightarrow$  monthly temp. ( $^{\circ}\text{C}$ )

$i \rightarrow$  ~~sum of~~  $(\sum t) \left( \frac{1.54}{5} \right)$

$a \rightarrow$  complex fn. of  $i$

Soil moisture index

$$I_m = (100S - 60D)/PET \rightarrow \text{monthly}$$

$S \rightarrow$  monthly water surplus

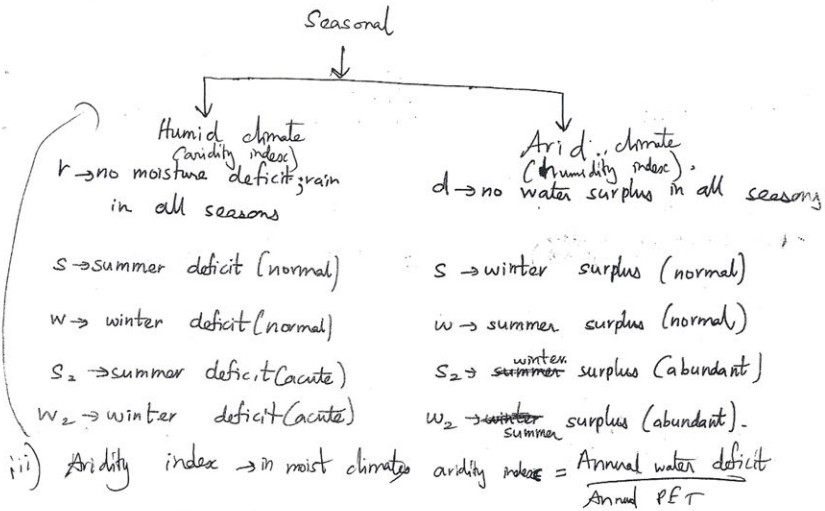
$D \rightarrow$  monthly water deficit

New humidity & thermal provinces:-

| Moisture index | Humidity province | Thermal province |
|----------------|-------------------|------------------|
| $\geq 100$     | Per humid         | Megatherm        |
| 20-100         | Humid             | Mesotherm        |
| 0-20           | Moist subhumid    | Microtherm       |
| -33-0          | Dry subhumid      | Tundra           |
| -67 to (-34)   | Semi arid         | Frost            |
| -100 to (-68)  | Arid              | —                |

## Seasonal variation of Effective moisture

(105)



In dry climates, Humidity index  $= \frac{\text{Annual water surplus}}{\text{Annual PET}}$

iv) Thermal efficiency index :- PET expressed in cm.

$\rightarrow$  Critical appraisal of Thornthwaite (30m)

$\rightarrow$  Comparative analysis of Thornthwaite's 1931 & 1948 classification.

$\rightarrow$  Koepfen's has more applicability than Thornthwaite's.

$\rightarrow$  For climate change, read 4<sup>th</sup> report of GoI, 6 and UNFCC report & Science exp. website



## Koeppen

- Directly considered veg. as a basis.
- Abs. values of temp. & rainfall.
- Evaporation not given weightage (except in 'B')
- No mention of transpiration.
- Globally & general applicable. (popular among climatologists, meteorologists, geographers, botanists).
- Spl. weightage to altitude & latitude.
- Climatic zones perfectly coincide with veg. zones.
- Relatively less no. of zones.
- Simple & less no. of formulae. Computation & data collection easy.
- Considered rainfall as such.
- B  $\Rightarrow$  semi-arid, arid.

## Thornthwaite

- Only considered as a veg. indirectly, through evapo-transpiration.
- Values sub. to give certain indices, which are used for classification.
- Evaporation considered a major factor.
- Transpiration is included in 1948 class.

Can be used only at research level. (popular only among botanists & geographers).

No mention of altitude & latitude initially, but only later included.

No coincidence except in N. America.

3 times more climatic zones.

Complicated formulae.

Calc. effective rainfall through P/E, PET, soil moisture index.

B  $\Rightarrow$  Mesotherm.

## Similarities.

1. Both used symbols & formulae.
2. Both recognised the role of vegetation.
3. Rainfall & temp. are major factors, in both classification.
4. Both used quantitative values for delineation of climates.

## Comparison of 1931 & 1948 Thornthwaite

(107)

### Similarities.

- 1) Both recognised vegetation, only indirectly -
- 2) Both appreciated evaporation as a major factor -
- 3) Both classified humidity & thermal provinces -
- 4) Both did NOT take into account causative factors
- 5) Both are very complex & exhausting.

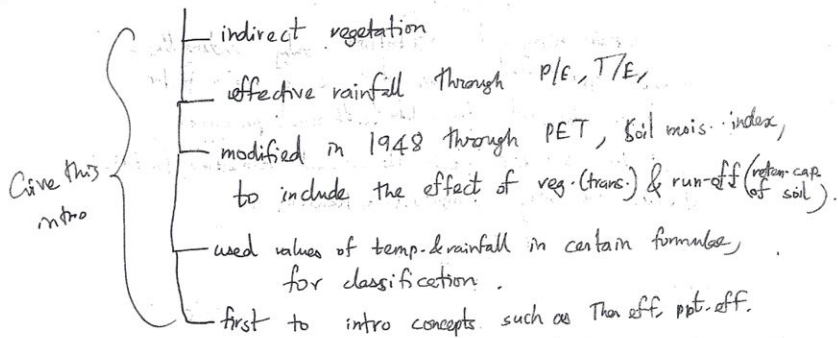
### Difference

1931

1948.

- |                                     |                                                                                                            |
|-------------------------------------|------------------------------------------------------------------------------------------------------------|
| 1. Variables :- H/E, T/E            | PET, Im                                                                                                    |
| 2. Only evaporation                 | Evaporation, transpiration, soil retention                                                                 |
| 3.                                  | Can be used by agri. scientists for irrigation scheduling                                                  |
| 4. 5 humidity, 6 thermal provinces. | 6 humidity, 5 thermal provinces.                                                                           |
| 5) Only one semi-humid.             | <del>Atmos</del> Semi humid $\begin{cases} \rightarrow \text{Moist} \\ \rightarrow \text{dry} \end{cases}$ |
| 6) Both tundra & taiga included.    | No mention of taiga.                                                                                       |
| 7) Considered only N. America.      | Considered the entire world.                                                                               |

→ Critical appraisal of Thornthwaite's.



→ Now elaborate on the <sup>adv.</sup> +ve's of Thornthwaite, comparing its advan. over Köppen's shortcomings.

→ Comparative analysis of Köppen's & Thornthwaite's

→ Both similarities & diff.

→ Use the pts. in the table.

Elaborate by explaining what are thermal, humidity provinces.

• Explain Thermal eff., ~~moist.~~ ppt. eff., soil retention.

• Give formulae for  $T/E$ ,  $P/E$ , PET,  $I_m$  & elaborate on the data reqd. the range of these indices.

• Give the applicability of.

→ Köppen's more applicable than Thornthwaite -

⇒ 5 lines; esp. abt Köppen & Thornthwaite. Matching of climatic zones with veg. makes for

easy class.

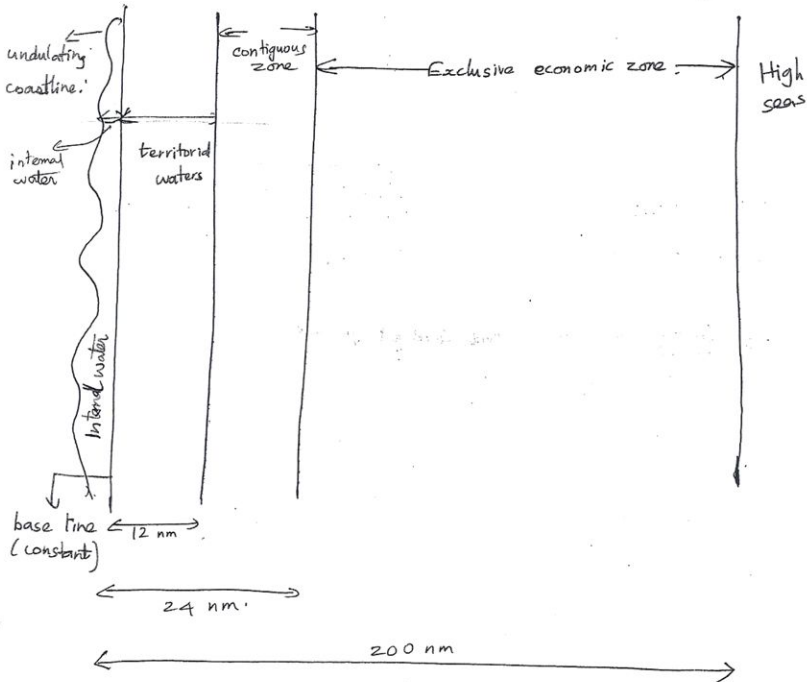
• Use of abs. values make even ar common.

Law of Seas.

→ U.S. has NOT ratified. India is a party.

UNCLOS → UN Convention on Law of Seas.

ISBA → Intl. Sea Bed Authority.



Horizontal distance → measured in Nautical miles (1 nautical mile = 1.85 km)

Vertical distance → measured in fathoms (1 fathom = 6 ft.)

Blue water policy → <sup>acraft carriers, submarines;</sup> expedition in <sup>high seas adjacent</sup> another country's territorial waters

Green water policy → expedition in ~~another country's~~ our EEZ

Brown water policy → expedition in ~~another country's~~ rivers, our territorial waters, <sup>mainly rivers & inland seas</sup>

→ Territorial water  $\Rightarrow$  complete security <sup>similar to one country's land mass itself; state govt. has jurisdiction</sup>

National constitution applies.

• Also called 'marginal sea' or 'marine belt'.

- 0-12 nm from base line.
- No other country can enter the territorial waters of a country without its permission.
- However, there is a narrow HIGH SEA PASSAGE even in territorial waters for: port accessibility & free trade & transit.
- Coastal nation has COMPLETE SOVEREIGNTY over its territorial waters.

→ Contiguous zone  $\Rightarrow$  under central govt's jurisdiction

- 12 nm to 24 nm from base line.
- Concerned nation has rights of custom duties, fiscal, strategic, defence, immigration & sanitary (marine pollution) regulations in the territorial & CONTIGUOUS ZONES, and it also has the right to PUNISH concerned parties for infringement of these regulations.

→ ~~Econom~~ Exclusive Economic Zones (EEZ).

- 24 nm to 200 nm from BASE LINE.  
India has an EEZ of 2M sq km.
- Concerned coastal state has exclusive rights over ~~sub-sea deposits~~ exploitation, conservation & mgmt. of mineral resources, of ~~ocean deposits~~ ocean floor (crust), marine water energies, WATER & MARINE ORGANISMS within this EEZ. (MINING, FISHING).
- But, in the EEZ outside territorial waters is open for laying cables, navigation of ships, flying of aeroplanes of OTHER STATES.

Disputes in maritime  $\Rightarrow$  due to overlap of maritime boundaries  
(in closely located coastal countries).

• Kuril islands  $\rightarrow$  Russia & Japan. (III)

• Paracel is. & Spratly is. (South China Sea)  $\rightarrow$  China, Taiwan, Philippines  
Vietnam, Indonesia, Malaysia.

• S. India  $\rightarrow$  Katchikattur; fishermen's rights.

• Falkland is.  $\rightarrow$  Argentina & Britain.

• Diaoyu (Senkaku is.)  $\rightarrow$  China & Japan.

Disad. for land-locked countries.

• But, the coastal countries near land-locked countries ~~to~~ are supposed to charge low transit fee for them (eg. India gives free port areas to Nepal).

• Nowadays, land-locked countries are also demanding for drilling rights in oceans.

Mgmt. of High Seas

• Disputes over law governing high seas.

Sea bed  $\Rightarrow$  upto 200 n.m. or edge of continental margin, with a limit of 350 n.m. from baseline or 100 n.m. from 2000m isobath.

• Sometimes, continental shelf of a coastal nation extends far beyond their EEZ. So, they are demanding ISBA for rights over these maritime regions.

$\rightarrow$  Russia's continental shelf extending in the Siberian part of Arctic ocean.

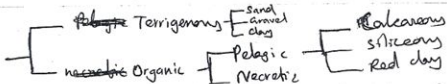
$\rightarrow$  Malaysia's continental shelf extending into S. China Sea.

Marine Pollution

Oil spills  $\rightarrow$  all strategic minerals even in one's own territorial waters, spreads to the entire HIGH SEAS. Who's responsible for the cost of cleaning this?  
 $\rightarrow$  Cu, Co, Mn, Ni; Co, Ni not found on Indian land.

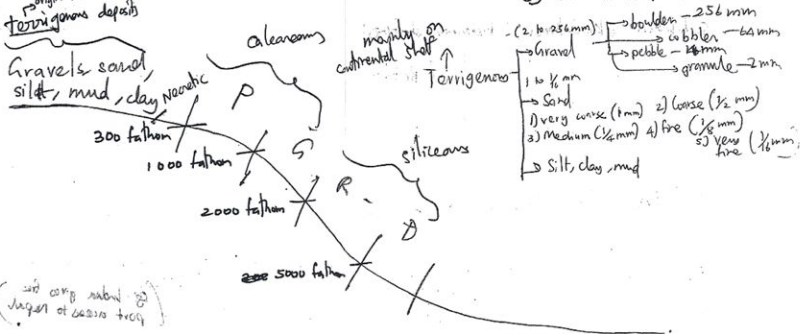
PMN  $\rightarrow$  Poly Metallic Nodules  $\rightarrow$  minerals in ocean deposits that take the form of nodules (rounded deposits). INDIA is the first country to obtain rights for drilling exploiting PMN. (pioneer investor)  
by UNCTAD.

# Ocean Deposits



Thin blanket like deposits that are found on the ocean floor. Source of marine deposits → 1) continental rocky-sediments; 2) marine organisms → decomposition; 3) volcanic erupting

origins from land  
Terrigenous deposits



Blue mud, Green mud, red mud,

Pelagic deposits, → derived from algae and in the form of liquid ooze.

Pteropod, globigerina, diatom, radiolarian, red clay.

## Terrigenous

Blue mud → iron sulphide.  
35%  $CaCO_3$

Green mud → potassium silicate, glauconite, cal. carbonate.  
56%  $CaCO_3$

Red mud → iron oxide.  
32%  $CaCO_3$

MUD ⇒ finer than clay.

→ non continental exp.  
Organic → Neobiotic (skeletons shells of marine organisms)

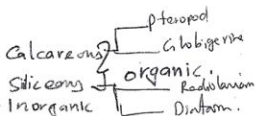
→ Pelagic deposits

oozes (liquid form)

Calcareous ooze → calcium

pteropod

globigerina.



diatom holes



Pteropod  $\Rightarrow$  mainly Atlantic;

(113)

• Formed of molluscs

• Mollusc  $\Rightarrow$  soft-bodied, shelled animals.

$\downarrow$   
intake Ca from sea water for shell formation.

• high Ca content  $\rightarrow$  so, not found deep  $\rightarrow$  since Ca is soluble/cannot exist at a depth

• When they die, they deposit

3000-1000 fathoms

on Mid Atlantic ridge  $\rightarrow$  Canaries, Azores

• Pacific, Mediterranean, Indian ocean, Azores, Gona

Globigerina

Antilles, Shallow

• shells of foraminifera.

• Formed of germs  $\Rightarrow$  so globigerina.

• found in abundance in all oceans;

2000-4000 fathoms.

Silica

radiolarian

$\downarrow$   
mainly SPONGES  $\rightarrow$  diatom

Radiolarian  $\rightarrow$  mainly Pacific

• formed by shells of radiolaria & foraminifera.

• dirty grey powder.

• More silica; small  $\text{CaCO}_3$ .

$\rightarrow$  Not soluble.

• Lime content decreases with increasing depth.

• 2000-5000 fathoms.

• Pacific ocean.

Diatom  $\Rightarrow$  HIGH LATITUDES.

• microscopic plants.

• Phytoplankton  $\Rightarrow$  food for fish (this is why cold currents from poles are very good for fish).

• Occur mainly in high latitudes.

• N. Pacific, Alaska to Japan belt, Antarctica.

(Jaccard)

Inorganic materials  $\Rightarrow$  dolomite, iron,  $\text{MnO}_2$ , barite, amorphous Silica.

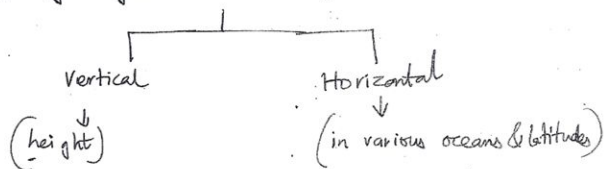
mainly cosmic origin

RED CLAY:  $\Rightarrow$  abundant in all oceans.

$\rightarrow$  imp. inorganic  $\rightarrow$  silicate of aluminium; iron oxide.

$\rightarrow$  radioactive materials;  $40^\circ \text{N}$  to  $40^\circ \text{S}$  in Atlantic

⇒ Critically analyse distribution of ocean deposits.



## OCEAN RESOURCES

- Fisheries. ↗ nutrition support
  - Polagic (surface; school-forming)
  - Demersal (deep sea)
- Oil offshore oil fields
- Minerals
- Poly Metallic Nodules ↗ now endangered species.
  - sea cucumber, sea horse, pipe fishes
  - spirulina
  - Agar-agar
  - Nastix
- Medicines ↗ 1/3 of CO<sub>2</sub> is absorbed by oceans
- Carbon sequestration
- Pearls ↔ from oysters...
- Salt
- Water (by reverse osmosis).
- Tidal & wave energy ↗ 32 phyla, 10 m species.
- Biodiversity - more than
- Over-fishing (esp. in deep sea)
  - Deep sea fishes (at depth > 400m) are usually slow-growing & late breeding, that makes them vulnerable to overfishing.
  - EU has recently halved the quota allowed for deep-sea fishing.
  - Intl. Council for Exploration of sea.

→ Ocean resource is the last resort to human. Discuss  
Pearl cultivation  
Fishing. (15)

Overfishing may lead to the depletion & even extinction of certain species of fish. The govt. is taking measures to prevent fishing, esp during breeding seasons. Extinction of fish may lead to a complete breakdown in the <sup>cer. kind</sup> aquatic food chain.

#### Mining

With only minimum exploration of oceans so far, we are unaware of the quantity of both abiotic & biotic resources available in ocean floor. Without this proper knowledge, human exploitations in oceans may lead to denudation of whatever resources are in oceans, if they are present in minimal quantities. Mining wastes may disturb the delicate ecosystem & biosphere in oceans.

#### Whaling

Though various steps have been taken to prevent whaling, it is very difficult to contain <sup>such</sup> marine exploitation. Though whaling is banned, it is still allowed for scientific research purposes. Many ~~Res.~~ countries like Japan exploit these provisions for ~~whale for food~~.

#### Mariculture

Introduction & rearing of new types of ~~food~~ fishes may adversely affect the delicate ecosystem of ~~sea~~ seas. Moreover, fishes like to travel freely (both horizontally & vertically) and do not like man-made boundaries.

# Ocean ranching

Ocean power (tidal/buoy)

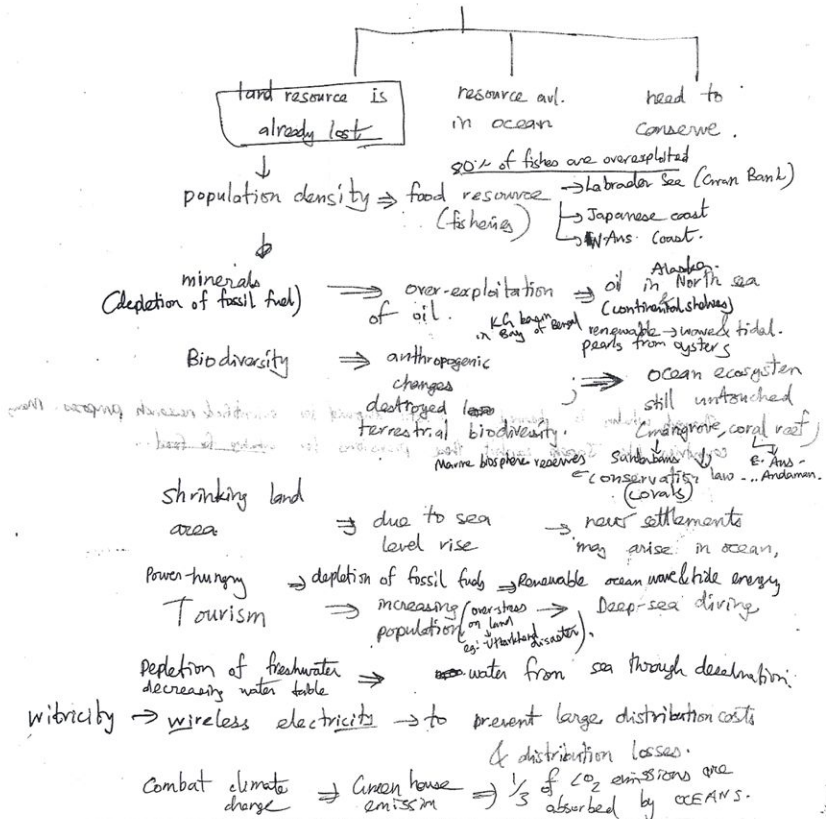
Ocean water (desalination)

## Deep sea diving

A recently introduced tourist activity. An increase in this hobby may introduce a never-before human artificial interference to the deep sea organisms.

Theme of 11<sup>th</sup> COP to G80 (Hyderabad) :- Conserving marine & coastal ecosystems

→ Ocean resources is the last resource to human. Disuses.



~~South~~ Africa

S-Africa

Orange river → Aghrakas falls.

Grasslands → 'Velds' → High Veld.

Mountains  $\Rightarrow$  Berg  $\Rightarrow$  Drakensberg, Swartberg; -

R. Limpopo → Mozambique, S.A, Zimbabwe

Kalahari Desert { Okavanga Swamps  $\Rightarrow$  largest inland swamp in the world.  
Swamps usually occur in coasts.  
Makgadikgadi Salt pan  $\Rightarrow$  high evaporation  
 $\downarrow$   
Salt acc. on the surface.

Zambezi river  $\rightarrow$  Victoria falls

↓  
Kariba lake → Kariba dam.  
→ Kobora Bassa dam.

Black mountains  $\rightarrow$  Mithumba mt.  
Machunga mountains

Mt. Kilimanjaro → Kenya →  
↳ highest peak in Africa

Great African rift valley. — Kiou  
Edward  
Albert  
Turkana  
Tana

Great lake region -

Niger river  $\rightarrow$  tributary Benue  
 $\downarrow$   
 $\rightarrow$  Drains in Gulf of Guinea.

Jos Plateau  $\rightarrow$  Nigeria  
 $\downarrow$   
Rich in tin.

Atlas mountains  $\Rightarrow$  N.W. Africa  
 $\downarrow$   
Highest pk  $\Rightarrow$  Mt. Toubkal.

### Laws on Marine Pollution

1973  $\rightarrow$  <sup>Marine Pollution</sup> MARPOL Convention  $\rightarrow$  most imp. convention on pollution by ships. It is called 'Intl. Convention for Prevention of Pollution by ships'.

1978  $\rightarrow$  The 1973 convention was amended. So, it is called MARPOL (73/78).

- Indian Merchant shipping Act, 1958 gives effect to the Intl-Convention for Prevention of pollution of Sea by oil (1954).
- MARPOL 73/78 <sup>one of</sup> is the most imp. intl. marine environ. convention. It concerns with prevention of pollution by oil, bulk chemicals, dangerous goods, sewage, garbage, atmos. pollution of ships.

# India

(118)

## Largest states

Rajasthan

Madhya Pradesh

Maharashtra

Andhra Pradesh.

Land of Gods  $\rightarrow$  Uttarakhand (more pilgrimages' -  
Haridwar, Rishikesh, Gangotri;

God's own country  $\rightarrow$  Kerala

$\downarrow$   
all beastes of

## Tourism

Incredible India  $\rightarrow$  Tagline  
Aditi, Dev Bhav.

Tropic of Cancer  $\Rightarrow$  8 states.

$\downarrow$   
Gujarat, M.P.

Closest capitals to Tropic of Cancer

Ranchi

Bhopal

Gandhi Nagar

Aizawl

States sharing boundary with only

1 other Indian state  $\rightarrow$  Sikkim (WB) & Meghalaya (Assam)

State with the longest coastline

Gujarat.

The country with which India shares max. bandary

$\downarrow$   
B'desh -



States with no intl. boundary (neither maritime or land).



M.P., Chhattisgarh, Jharkhand, Haryana.

State which shares max. no. of boundaries with other states



U.P. (8 states)

Smallest state → Goa

↑ Smallest population → Sikkim

~~New~~ Youngest state → Jharkhand? (check)

Jurisdiction of Lakshadweep → Cochin high court

" " Andaman, Nicobar → Calcutta high court

⑥ Territory of Ind. with 4 dist. but which do not share boundary with each other ⇒ Pondicherry

Pondy, Mahe, Karaikal, Karaikal.

Chicken neck of India → Siliguri corridor  
(Sikkim - WB - B. dash border)

## Kerala

(121)

Coastal

Kasaragod

Kannur

Kozhikode

Kollam

Kovalam

↑ N  
⇒ rainfall

high; leaching of soil; lateritic soil

↓ red soil  
silica washed  
only Mg & Fe

↓  
not suitable for cultivation  
↓  
only cashew cultivation

Vembanadan lake ⇒ lagoon

Ernakulam (Cochin)

Alappuzha → Venice of the East

Kottayam

Kuttanad ⇒ low (below mean sea level) ⇒ Paddy cultivation.

Kumarakom

Thiruvananthapuram → cultural capital of Kerala.

Dalalgaudi → TN border.

Vegetation.

WYNAD ⇒ mountainous region (W. ghats)

↳ ~~cross~~ junction of Kerala, Karnataka, TN

Kasaragod, Kannur, Kozhikode ⇒ lateritic soil (rich in iron)

↓  
tiles (♀ ♂) (base of iron content hard)

→ famous lagoon.  
Vembanadan

⇒ Tourism

(Kottayam, Alappuzha, Ernakulam).

Kochi (Ernakulam) → NH 47(A) → smallest NH of India

Trivandrum  $\rightarrow$  capital of Kerala.

↓  
VSSC (Vikram Sarabhai Space Centre), Thumba equatorial  
rocket launch station.

Kollam, Kovilam  $\rightarrow$  monazite sand (Thorium ore)

Coir industry  $\Rightarrow$  coconuts  $\Rightarrow$  from Kottayam to Trivandrum.

Kerala → one side W. Ghats; one side lowland;

heavy rain  $\Rightarrow$  water logging.

→ So, pop. settlement linearly on highlands.

↳ so high population density.

→ Mountainous area → rubber plantation.

→ paddy cultivation → paddy that survives in water.

→ land of spices → pepper, cardamom

↓                  ↓  
Cardamom hills.      100% KI spice market  
                                      (Spices Board of India)

→ TOURISM.

→ Rob model for health system.

→ Universal PDS.

→ Highest literacy rate.

→ Highest HDI

→ Highest sex ratio (more than 1000 females per male)

- Matriarchial society (mother based)
- Linear settlement (along the roads.)
  - ↳ Hig
- First Communist (non-Congress) govt. in India → EMS Namboodiripad (1952)
- Gulf syndrome (almost all families will have persons in Gulf countries. esp. in Malabar regions).
- Malabar → Muslims. (Moplah Muslims).
- Beautiful houses (even in villages).
- Ayurvedic medicine (Kottakkal Ayurvedic Vaidhya Shala)
- High unemployment -
- Highest consumption of alcohol.
- 1'
- Ecological areas → Periyar, reserve, Anamalai, Wynad, Mambanad.
- Dance → Kathakali, Mohiniyaattam.
- Martial art → Kalari.
- S.W. Monsoon → onset in Indian mainland (June 1<sup>st</sup> week)
  - ↓
  - Kerala.
  - Heavy rainfall.
  - Tropical forests → -

Religion → Majority Hindus, lot of Muslims & Christians.

Muslims → N. Kerala (Malabar)

Christian → South of Calicut.

Jews → Mattancheri.

• Highest pk. → Anaimudi (in Anaimalai, W. Ghats)

↓  
(on Kerala-TN border) :-

• Palaghat pass → wide gap in W Ghats.

• No major river → many small rivers.

• Kerala has a tradition of tolerance and a harmonious existence of Hindus, Muslims & Christians

• Famous Personalities

Atul Gopala Krishna → director, film-maker.

Lifetime Achievement award.

M. N. Nambiyar

M. G. R

} Kerala origin.

Festival → Onam → marks the visit of mythical king

↓  
"Pookdam"  
MATTABALI from the "netherworld".

Kerala has produced several top notch bureaucrats.

Krishna Menon → first foreign secretary

Shiv Sankar Menon → National Security Advisor.

## Heat budget

1. vertical budget
2. horizontal bud.
3. Diffusion mechanisms, radiation
4. Significance.

(H)

## PRESSURE BELT

1. Defn: Atmos. press.
2. Rotating; non-rotating
3. Diff. pressure belts
4. Vam/intra-belt variation
5. Temporal (seasonal) var.  
→ Continental, mar. time.
6. Significance.

chequered board

## Atmos. circulation

1. Non rotating - only 2
2. Other forces rotating
3. 3 cells → Polar, Equatorial, polar.

chess board

## Planetary wind

- 1) Non rotating; rotating
- 2) 3 winds
- 3) .

chess board

## Jetstreams

- 1) Defn.
  - 2) Condition for formation
  - 3) Index cycle
  - 4) Significance
- Robby waves

## Local winds

- 1) Mt. & valley breeze
- 2) Sea & land breeze
- 3) Local winds
- 4) Sig.

## Stability

1. NLR, DAR, WAR
2. Abs & relative stability & instability
3. Impact.
4. Stable & unstable  
= one

## Cyclones

1. ~~low~~ Front, warm, cold air mass
2. Tropical & temp. cyclones
3. Condition for frontogenesis
4. Deformatory waves
5. Places
6. Diff. b/w trop & temp. cyclone

## Airmass

1. Defn.
2. Conditions for formation

## Koeppen

- vegetation
- abs. temp. & ppt.
- $10 - R/25$
- $R < 2T + 28$   
10  
0
- A, B, C, D, E.
- f, m, sw, S, W, h, k, H
- 3 → a, b, c, d, e.

## Climatic class

## Thornthwaite

1931

$$I/E = 11.5 (14 - 10)^{1/4}$$

$$T/E = (1 - 32) 4$$

1948

$$PET = 1.6 \left( \frac{1}{101} \right)^a$$

$$b = \pm 1.514$$

25/09/12

# OCEANOGRAPHY

## Tides & waves

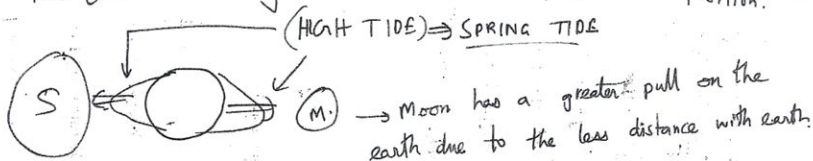
### Tides

1. Vertical movement of sea water
2. Due to gravitational pull of sun & moon & earth.
3. Tides are periodic
4. Not frequent: Occur with intervals.

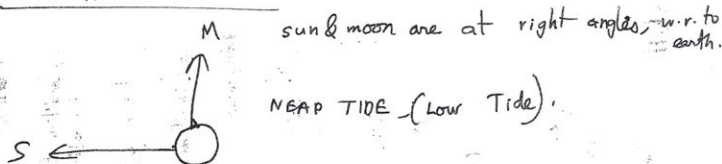
### Tide

Due to gravitational interaction of sun, earth & moon.

Szyay  $\Rightarrow$  When sun, earth & moon are in the same line (NOT necessarily in the same angle). (SEM or SME position).



### QUADRATURE POSITION



### Wave

- 1) Circulatory
- 2) Translatory
- 3) Breakers  $\rightarrow$  plunge, spill, surge.



5. Tides  $\rightarrow$  common in coastal area.

6. Tide  $\Rightarrow$  a weak erosional agent.

7. Tide  $\Rightarrow$  high potential ~~before~~ for power.

8. Tide  $\Rightarrow$  also caused due to COASTAL CONFIG.

Waves occur in inland and coastal oceans.

Wave is a strong erosional agent due to its frequency.

COASTAL CONFIG. does not dictate the waves. It is vice versa.

### Significance of tides

- Useful in navigation (eg: Kolkata port, Shanghai port).
- Intrusion of water into land at the time of tide results in salination of groundwater & surface water and also causes damage to livelihood & properties.
- A High tide affects the formation of deltas.

Bay of Fundy  $\rightarrow$  highest tide in the world.  
 $\hookrightarrow$  (north of New York).

Southampton (London)  $\rightarrow$  4 tides per day. (due to coastal config.)  
 $\downarrow$   
usually, 2 tides/day.

## Tidal theories

- 1) Progressive wave theory
- 2) Equilibrium wave theory
- 3) Stationary wave theory

## Coral Reefs & Atolls

→ 1% of earth's surface.

Coral reefs & Atolls: Formed due to deposition & acc. of skeletons of lime secreting organisms called coral polyps.  
↓  
(Calcareous shells)

Dist.  $\Rightarrow 25^{\circ} \text{N}$  to  $25^{\circ} \text{S}$  latitudes.

Symbiotic relationship b/w coral polyps & Zoo Xanthellae.

Coral Reefs  $\Rightarrow$  highly sensitive & significant ecosystems  
↓  
called 'RAIN FOREST of oceans.'

Coral reefs <sup>bioz</sup> provide a habitat to a diverse variety of organisms. (About 1,00,000 species reside in coral reefs).

$\Rightarrow$  Conditions for growth of coral polyps

1) Corals are very temp. sensitive. Need mean temp. of  $27^{\circ}\text{C}$  (tropical oceans).

This is why corals are found only in the eastern side of continent (Great Barrier Reef (Aus.)).  
Western side of continent experiences cold currents, so temp. is very less.

2) Corals live only in SHALLOW WATERS (up to 200-250 ft.).  
Bioz, sunlight &  $\text{O}_2$  is important for its growth.

3) Clean sediment-free water is reqd. for its growth. <sup>(129)</sup>

If sediments are there, then the sediment may plug the narrow mouth and cause its death.

This is why corals do not occur <sup>very near to</sup> ~~along~~ coasts, because run-off from land ~~is~~ brings sediments.

4) Freshwater is injurious to corals.

This is also why corals do NOT grow along coast since rivers may bring freshwater to sea.

Bioz:- freshwater does NOT bring food for coral growth.

∴ There is a discontinuity of corals at places where rivers join the sea.

5) Very saline water is also injurious.

Salinity of 27‰ to 30‰ is ideal.

Because highly saline water contains less  $\text{CaCO}_3$ , which the corals need for their growth.

6) Extensive submarine platforms are reqd. ~~below~~

The corals use these platforms as a base to grow.

The corals, therefore, act as barriers to ships entering the coast.

In Sydney, Brisbane ports, ships can ONLY enter the coast at places where the rivers join the sea. (since corals do not grow here).

#### SIGNIFICANCE OF CORALS

- 1) Shield humans from Tsunamis & ~~seagames~~ hurricanes.   
 (30% of ocean biodiversity & 70% of fish catch)
- 2) shelter more than 1 million fishes & marine organisms → biodiversity
- 3) Host the oysters, which produce costly pearls (eg:- Gulf of Mannar).
- 4) Oldest & most sensitive ecosystem → an indicator of the health of the ocean.

## Types of coral reef

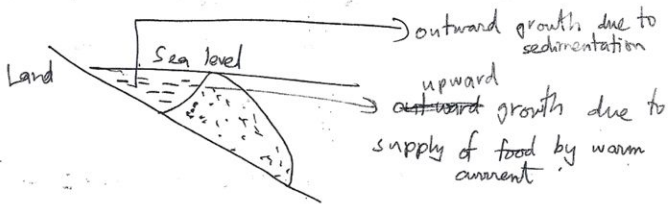
### 1) Fringing reef:



seaward slope is steep & landward slope is gentle.

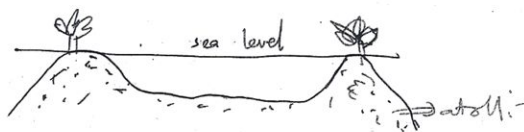
### 2. Barrier reef

- Parallel to coast.
- Largest reefs, highest & widest.
- broken at many places, at riverine areas.



### 3. Atoll.

- A ring of narrow corals of horseshoe shape.
- Crowned with palm trees.
- Found around an is.



## Theory of formation of atolls

(131)

1) Subsidence theory  $\Rightarrow$  DARWIN.  
Darwin  $\Rightarrow$  Fringe, barrier & atoll are seq. stages of evolution.  
Here corals, which can only grow in shallow waters, could go to greater depths? Darwin  $\Rightarrow$

1. Fringing reef grows upward to get food, ~~forming~~  
~~barrier reefs~~.

2. After that the land ~~on~~ which corals grew  
SUBSIDED, taking corals to greater depths, &  
 $\downarrow$   
bcoz of tectonic movement.

3. As the land <sup>(more platform)</sup> subsides, the corals grow upward  
vigorously for food & to get them out of deep water.

4. The growth is more vigorous outward from the coast.  
This forms barrier reefs.

5. The subsidence of land is only gradual.  
Sedimentation along coast prevents corals from growing  
near to the coast. Here a lagoon is formed.

### Evidences

1. <sup>Presence</sup> ~~Absence~~ of cliffs along coast of coral reefs indicates  
 $\Rightarrow$  Stationary landforms would NOT have cliffs.  
that there is SUBSIDENCE.

2. SEDIMENTATION in the lagoon is compensated by  
gradual subsidence of land. This permanency of  
lagoon indicates continuous subsidence.

3. No atolls are found in uplifted ~~beach~~

(where land  $\downarrow$  is <sup>old beach</sup> emerging  
NOT subsiding)

4) Thickness of coral reef increases downward. This shows that these corals at great depth were formed very early, when they were actually in shallow waters (before subsidence).

5) Steep slopes of is. having atolls indicates subsidence, since steep ~~is~~ slope is found only in upper part of is.

### Criticism

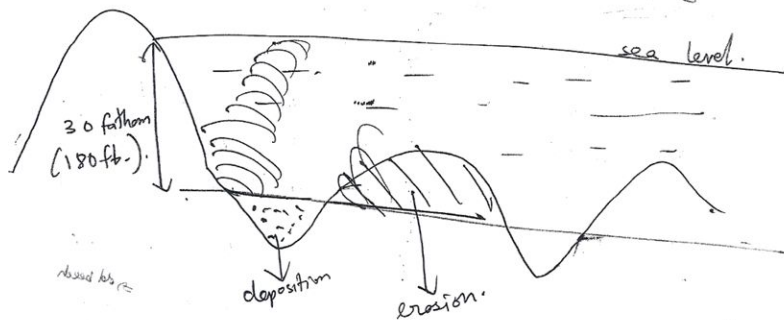
- If fringing, barrier & atolls were taken to be sequential stages of evolution, how do all these three occur at the same level in the same is?

- If subsidence was the phenomenon, all coral reefs must have subsided totally by now.

Stand-still & heavy  $\Rightarrow$  Murray

$\hookrightarrow$  father of modern Oceanography.

- Non-subsidence of land. Land is stand-still  
 $\downarrow$   
stationary.



Permissible of coral  $\rightarrow$  180 ft. (30 fathoms) (133)

1. This depth is attained either by marine deposition or erosion.
2. Once the permissible depth is obtained, the corals <sup>are</sup> formed.
3. Lagoons are formed near coast (b/w coast & barrier) because of dissolution of dead corals.

### Criticism

1. No explanation for atoll formation.
2. A limit of 30 fathoms for deposition & erosion can NOT be accepted.
3. Erosion & deposition CANNOT occur at the same place of ocean.
4. Corals were found even below 30 fathoms.
5. If land is stationary, the lagoon would have been eventually filled with sediments.
6. Dead corals DO NOT dissolve. They also form pelagic deposits.



## Glacial control theory → DALY

- Daly was convinced that all coral reefs were formed during Pleistocene Ice Age.

~~Pleistocene~~ → degl.

Start of Pleistocene

- ~~deglaciation~~ → sea level decreased <sup>by 33 fathoms</sup> & temp. of marine water decreased.  
↓  
due to low temp. (freezing pt.)

So, corals died. (low temp; great depth)

End of Pleistocene

- Deglaciation → sea level increased & temp. also raised.  
↓  
(due to increase of temp.)

Shallow depth of platforms; high temp.

↓  
corals started growing.

- <sup>of uniform depth</sup>  
Lagoons were formed due to uniform lowering of sea level during Pleistocene Ice Age.

- Sea level decreased <sup>was cut</sup> • Platform created, Corals formed.
- Sea level increased. Corals started growing upward.
- Narrow ~~coral~~ platform → fringing reefs
- Wide platform → ~~Atolls~~ Barrier reef.
- Isolated wave-eroded is. → Atolls.

## Coral Criticism

(135)

1. Corals are formed even beyond 33-38 fathoms.

Most accepted theory  $\rightarrow$  Darwin theory

$\downarrow$   
supported by 'Davis' theory of geographic cycle

Why coral atolls are found only on one side of is?

Even along the same coast, one side may have submerged more than the other side. ~~See~~

### OPEN-ENDED 'Coral reef'.

$\rightarrow$  Defn. of coral reef

$\rightarrow$  Conditions

$\rightarrow$  Distribution

$\rightarrow$  Stages of coral reef (types  $\Rightarrow$  fringing, barrier, atoll).

$\rightarrow$  Why coral reef is a significant ecosystem?

$\rightarrow$  How corals can be preserved?

### Conditions for coral reef formation.

$\rightarrow$  Defn. of coral reef

$\rightarrow$  Elaborate each condition with critical explanation & substantiate it with the existing dist. of corals.

$\rightarrow$  Significance  $\Rightarrow$  need to preserve.

### Darwin theory

$\rightarrow$  Defn.

$\rightarrow$  Stages

Coral bleaching → eg:- most of the oysters in Gulf of Mannar, 90% of corals in Palk strait have been destroyed.

- There is a symbiotic relationship b/w Coral polyps & Zoo Xanthelles.

• Bleaching → Whitening of coral reefs ⇒ it leads to the death of Zoo Xanthelles (a colouring agent)  
GOVT MEASURES 1) Anti-poaching 2) Good marine sanitation 3) Artificial substratum for regeneration of corals (Indian govt. has done this in 10 islands in Gulf of Mannar).

1. El Nino, carried by west wind drift, bleaches

corals all over the world.  
- Cultivation of an invasive alien ~~seed~~ → *Lappaphysa alvarezii* for commercial purposes  
It fully colonises the seabed blocks the entry of sunlight to corals & chokes them to death.

2. Due to certain diseases  
- bacterial.

- invasive soft corals with high fecundity (rapid reproduction)  
Staghorn coral.

3. Anthropogenic activities

a) Dumping of radioactive wastes ⇒ leads to increase of temp ⇒ death of corals  
Collection of corals for ornamental purposes.

b) Domestic sewage from coastal areas.

c) Global climatic change. (Greenhouse effect) → increase of overall temp.  
fishes eat the corals  
Storm damage, crown of thorns fish → depleted 40% of Great Barrier reef.

d) Developmental activities in oceans

(Gulf of Mannar ⇒ Sethu Samudram project)

Red Sea ⇒

e) Oil spills → changes viscosity & property of ocean water causes

f) OCEAN ACIDIFICATION → Ocean is a <sup>natural</sup> carbon sink. When the sequestered carbon level increases, it acidifies ocean.

# Tamil Nadu

(137)

Capital :- Chennai

↓  
Chennappa naikanur -

1639 ⇒ Madras ⇒ Francis Day

↓  
Fort St. George ⇒ Assembly, Secretariat -  
Famous Institutes  
Integral Coach factory (ICF) → Perambur

CLRI → Adyar.

OTA (off

NIOT (National Instt. of Ocean Tech)

National Biodiversity Authority.

Tourist places

Mahabalipuram → Shore temples, Pancha Pandava Rathas.

Marina Beach → 2<sup>nd</sup> longest beach (13 km.)

First CM of Madras Province → Omandhur.

Thalamuthu Nadarajan <sup>Mooligai</sup>  
→ immolated during Anti-Hindi protests -

Attack by 'Emden' - a German cruiser.

1967 ⇒ non-Congress rule (DMK)

Anti-Hindi agitations

Modern Theatre → Salemi  
(Sundaram)

Self-respect movement ⇒ E.V.R. Periyar.

↳ Social reform

↓  
opposed Brahminism,  
NOT Brahmins.

Madras → Medical capital of India.

COIMBATORE → Manchester of South India.

↓  
• black cotton soil.

• auto sports & diesel engine → Navin Karthikeyan.

• Salim Ali Inst. of Ornithology

↓  
• "bird man of India" → Father of ornithology in India.

• Coimbatore → receives rainfall during N.E. & S.W. monsoon

↓  
(like Kanyakumari)  
but, overall rainfall → deficient,

• Sugarcane breeding research instt.

↓  
flower of sugarcane → arrow

• Coimbatore & Lucknow are the two places where sugarcane flowering is very active,

• Siruvani water → second tastiest water in the world.

↓  
first → Nile.

• Ooty → Kundha hydel electric project

↓  
largest HEP in TN.

Indian Photofilm instt → Ooty.

→ Coonoor → Vaccine production → Pasture instt.


↓  
esp. for Rabies.

## Madurai

(139)

- Capital of 1<sup>st</sup> & 3<sup>rd</sup> Sangam period. ⇒ PANDYA rule.
- Jasmine city ;
- Sleepless city of T.N.
- On the banks of VAIGAI RIVER.
- Temple city of TN ⇒ famous 'Meenakshi temple'.

## Tirunelveli

- Tamirabarani river → perennial river.
- Lord Shiva → 
- Paalayangkottai → historical jail of TN.  
↳ 'OXFORD' of TN.
- Paalayangkottai & Tirunelveli ⇒ Twin cities.
- Geographical Indicator ⇒ Halwa.
- 'Maancholai fight' ⇒ black incident of TN.
- KKNP
- Tourist place ⇒

## Tuticorin

- Pearl city ; Salt city.
- SPIC. (Southern)
- H.O. for Sethu Samudram Project.
- Heavy water plants.
- ~~Kondankulam Nuclear Power Project~~ V.O.C ⇒ Swadeshi movement.

## Tirunelveli

- Maniyazhchi ⇒ Vaanjimathan → first to kill a Dist. Magistrate (collector) ⇒ Lord Hesse in India.
- Largest windfarms in India ⇒ Tirunelveli to Kanyakumari  
Valaimozhi, Muppanthi, Kanyakumari.

## Kanyakumari (cap: Nagercoil)

- S. most part of India mainland. ( $8^{\circ}4' N$ )
- Vivekananda rock. ; 133 ft. Tiruvalluvar statue.
- Gandhi museum.
- part of erstwhile Travancore princedom.
- Sangamam  $\rightarrow$  trijunction of Bay of Bengal, Arabian sea, Indian Ocean.

## Tanjore

- Brahadeswara <sup>arch. marvel</sup> temple  $\rightarrow$  Raja Raja Cholan.
- Largest Shiva linga.
- Kaaveri river.
- Granary of TN  $\Rightarrow$  Rice cultivation. (deltic cultivation; irrigation canals)
- Sarfoji Saraswati Mahal library  $\Rightarrow$  one of the two most significant libraries in India. the other is Kathabakshi lib.  $\Rightarrow$  Patna.
- Geographic indicators  $\rightarrow$  Veena, dancing doll.
- Kallanai Dam  $\rightarrow$  Karikala Chozhan
- $\rightarrow$  Sarfoji rulers  $\rightarrow$  Patronised Bharatnatyam.

## Trichy

- Rock temple.
- Kaaveri river  $\rightarrow$  Sri Rangam  $\rightarrow$  Sri Ranganathasamy temple  
 $\downarrow$   
highest kopura of TN.
- Kollidam  $\Rightarrow$  Kaveri makes distributary. (Coleroon)
- Tiruchi  $\Rightarrow$  centre part of TN.



## Salem

(141)

- Steel industry (mainly from scrap)
  - A  $\Rightarrow$  Aluminium
  - L  $\Rightarrow$  Limestone
  - E  $\Rightarrow$  Electricity (Mettur hydel & thermal <sup>power</sup> project)
  - M  $\Rightarrow$  Mango ("Malkova")
  - Tapioca -
  - Salem  $\Rightarrow$  once the theatre (box-office) capital of TN.
  - Lorry workers, borewell -
  - Large no. of AIDS patients,
  - Female foeticide.
- Namakkal

- Egg city.

~~ENR~~

## Kanur

- TNPL.
- Textile industry.

## Erode

- Turmeric market.
- EVR Periyar
- Bannari  $\rightarrow$  biosphere reserve.

## Nilgiri

↓  
first biosphere reserve in India.

Gulf of M

## Rameshwaram

- Ram + Es <sup>hwaran</sup>.
- Pamban bridge  $\Rightarrow$  Rameshwaram to Thalai Mannar.
- Adam's bridge  $\Rightarrow$  Ram Sethu  
 $\downarrow$   $\hookrightarrow$  limestone deposits  
Sethu Samudram Project.

PONGAL FESTIVAL  $\Rightarrow$  'Harvest festival' of TN.

Thoda tribes  $\rightarrow$  Nilgiri  
 $\hookrightarrow$  polyandry; (since they believe to be descendants of Paandaras).  
Baduga tribes.

DANCE  $\rightarrow$  Bharat Natyam. (famous dancers  $\rightarrow$  Padma Subramaniam)

## Folk dances

1. Karagaatam
- 2) Poi kaal kutthirai
- 3) Oyilattam.

Writers (novelists - modern writers)

J. Krishnamurthy (novelists), Jayakanthan (Gnanith), T. Janakiraman.  
(numerous other novelists)

26/08/12 Andhra Pradesh

Andhra — { Telangana (north)  
Rayalseema (south)  
Coastal Andhra

• Tirupati  $\Rightarrow$  one of world's ~~largest~~ richest temples.  
 $\downarrow$   
Lord Venkateshwara.

• Kaalahasathi  $\Rightarrow$  foothill of Tirupathi;

• G-I of Tirupathi  $\Rightarrow$  'Ladnoo'.

• Pulicat lake → lagoon

↓  
Sriharikota IS.

↓  
Satish Dhawan Space Centre → rocket launching station.

Nellore → rice cultivation.

Ongole → 'cattle breed'.

Runtur → chilly ;

↳ red chilly (pungent native)...

Rajmundry → Tobacco cultivation

↳ Tobacco research mtt.

Vijayawada → located on 'Krishna river'.

Kolleru lake → wetland → bird sanctuary.

Machilipatnam (Masulipatnam) → first British factory

↓  
in S. India.

Important port for Dutch, British.

Kakinada → imp. port during British rule.

Vishakhapatnam / Vizag

• Ship building (Hindustan Shipbuilding Ltd.).

• Port

• ISPAT Nigam Ltd. → Vizag iron & steel plant.  
↳ (Iron & Steel Co.)

SRIKAKULAM → hazalite / mining mafia

↓  
• forest area granite

almost not under govt. control.

KOTTA GUNDAM → ~~the~~ Sponge iron production

RAMAGUNTA → Thermal power plant.

Hyderabad & Secunderabad → separated by Hussain Sagar lake.

→ Twin cities of South India.

H.Q. of South Central Railways.

• ICRIAT → Intl. Crop Research Instt. of Semi-Arid Tropics.

• DNA finger printing

• Tsunami warning centre → INCOIS.

• Sardar Vallabhbhai Patel IPS training academy.

• Ramoji film city.

• MUSHI river → Comm. of Hyderabad.

• NALSA

HAL

Heavy water

Printing press

• Char Minar

• Library → SALARJAN MUSEUM  
↳ national importance

• Golkonda fort.

• IIT coaching

• famous for 'Hyderabadi Dhum Biryani'.

• Hyderabad founded by Nizam ul A

↓  
last Nizam → Osman Ali Khan → Razakar movement.

↓  
Hyderabad brought into Indian Union by Police Action ⇒ Operation lightning.  
Osmania University.

↓  
Hyderabad — predominantly a Muslim area.

WARANGAL → imp. railway station  
infamous for farmer suicide.

(145)

Hyderabad & Warangal ⇒ Telangana region.

Mahabubnagar ⇒ Naxalite

Anantapur ⇒ largest dist. of Andhra

Puttaparthi ⇒ Sai Baba.

Kadappa ⇒ Stone (శిలీకర శిల)

Chittoor ⇒ National Centre for Atmospheric study (ISRO).

Puttur ⇒ A.P - TN border ⇒ plaster of paris ⇒ గుంటురు (6)  
పట్టణం (6).

Thummanapalli ⇒ Uranium

Gold ⇒ Ramagiri, Yeppamara.

Nizam Sagar Dam ⇒ Godavari

Godavari ⇒ 'Dakshin Ganga' (Ganga of the South).  
granary of South India.

Peninsular India ⇒ made of Gneiss & granite.

↓  
disintegration  
Red soil

Good for tobacco & groundnut cultivation

Coastal Andhra ⇒ alluvial soil.  
(Gujarat & Andhra).

Andhra ⇒ spicy food → Gongra pickle → made of Gongroo & spinach.

TRIBE ⇒ Chenchu tribe ⇒ famous for \* lambadi?

SRI SAILAM

- Famous Shiva temple (biggest NANDHI in the world)
- National park.

## Famous leaders of Andhra.

• Potti Sri Ramulu → died in a hunger-strike (during 1950s) for a separate ~~ANDHRA~~ ANDHRA on a linguistic basis.

• VENKAIACH → gave final shape to our NATIONAL FLAG design.

• MG Ranga → 1924 → All India Kisan Sabha Movement.

(That is why, Andhra's agri <sup>university</sup> ~~univ~~ is called MG Ranga Agri university.)

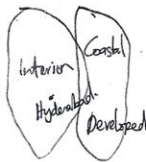
• NT Rama Rao → Actor-turned - CM.

↓  
Bros in Kannan movie -

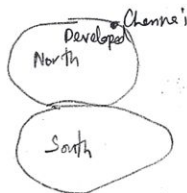
DANCE → Kuchipudi;

## Regional disparities

### Andhra



### TN



### Karnataka



### Tamil Nadu

#### Agri

M.S. Swaminathan → Agri - scientist

C - Subramaniam → Agri minister, Govt

Srinivasan → Agri Secretary, Govt

triple 'S'.

} during Green Revolution.

Kakkan → education min. during Kamraj regime in TN

• Initiated several infra. projects.

• Died in a govt. hospital -

# KARNATAKA

(147)

Capital :- Bangalore.

→ BELGAUM ⇒ (bordering Maharashtra).

↓  
1924 Congress session ⇒ President Cordhiji  
leather industry.

NH 4 ⇒ Hubli (Vijaya Nayan empire)  
↓  
Railway headquarters.

## MINING

Chitradurga → iron ore mining  
Tumakuru

## BANGALORE

- Silicon valley of India, electronic city.
- Hub of Indian IT industry.
- 'Bangalore' ⇒ a word for 'outsourcing'.
- Cool climate <sup>(bcoz of high alt. from sea level)</sup> ⇒ Garden city of India, wide roads.
- well planned city.
- Manipal university.
- National Instt. for Mental Health & Neural Sciences (NIMHANS)
  - ↓  
recently given greater autonomy by NIMHANS bill, Min. of Health & Family welfare
  - ↓  
produces quality PSYCHIATRISTS.
- IISc → Indian Instt. of Sciences Bangalore.
- BEML → Bharat Earth Movers Ltd.
  - ↓  
supplies tanks, trucks & heavy vehicles to Indian Army.
  - ↓  
recent 'TATRA' truck scandal.
- BEL → Bharat Electronics Ltd.
  - ↓  
manufactures EVMs (Electronic Voting Machines).
- PARKS ⇒ Kappan park, Lal Bagh.



HASSAN → <sup>ISRO</sup> MCF (Master Control Facility)  
2nd MCF to come up at Bhopal.

Mangalore → port  
Tulu people  
"Rai" belt.

Udupi → Krishna temple

Shravana Bela Gola → Gomateshwar temple.

Jog falls → highest waterfall in India

↳ on Sharavathi river.

National parks

DANDELI NATIONAL PARK, <sup>(Tiger)</sup> Bandipur national park.

Nagarhole <sup>(Tiger)</sup> / Bannerghatta, Ranganthetta <sup>(bird sanctuary)</sup>

Karwar → India's Naval ship building yard.

↳ northernmost coast of Karnataka.  
Operation 'Seabird'.

### MYSORE

- NECC → National Egg Coordination Commission.
- Sandalwood → G.I. → Mysore Sandal Soap.
- famous for incense sticks.
- Mysore palace ; Vrindavan gardens

Famous river → Kaveri → Krishna Raja Sagar dam.

↓ <sup>(Gowri Sagar)</sup>  
originates in Madhikeri (or) Coorg

↓ built by civil engineer  
Badravati dam → Vishweshwaraya

his bday is celebrated as India's Engineer Day.

## MINERALS

Gold  $\Rightarrow$  Kolar gold mines. (but amt. of gold extracted from ore is very low. So, it is almost closed). <sup>(199)</sup>  
Cost of extraction  $\rightarrow$  high.

Manganese  $\rightarrow$  Belgaum.

Iron ore  $\rightarrow$  Kudremukh, Shimoga, Bellary.

$\rightarrow$  (transported through pipeline to Mangalore port)

Badravati iron & steel plant  $\Rightarrow$  India's 2<sup>nd</sup> iron & steel plant  
(1<sup>st</sup>  $\Rightarrow$  Tata  $\Rightarrow$  Jamshedpur).

• Baba Budan Hills

• Coorg

Chickmagalur

} known for COFFEE

India  $\downarrow$  Gandhi's MP constituency.

Karnataka  $\rightarrow$  Mala Nadu / Mal Ekan

$\downarrow$   
Cult. & sprog. nature of Karnataka.

Mandhira dist.  $\Rightarrow$  place where 'Kaveri' water is opened to TN.

Gen K.M. Cariappa  $\rightarrow$  India's 1<sup>st</sup> Field Marshall.  
 $\downarrow$  from Coorg

Coorg  $\rightarrow$  ppl can have gun without license.

Karnataka tourism  $\Rightarrow$  'one country, many worlds'  
Spl. tourism train  $\rightarrow$  'Golden chariot'.

Hospet, Hampi  $\rightarrow$  Vijayanagar Empire  
 $\rightarrow$  temple.

'Bellary'

SOIL  $\rightarrow$  Red lateritic soil; Crops  $\Rightarrow$  Ragi, Coffee, Onion

Famous historian 'Sri Chandra Ghatge'  $\Rightarrow$

Trinity of Carnatic Music  $\Rightarrow$  Bangalore, Mangalore, Chennai.

## Significance of glaciers

(177)

- 1. Leaching of soil → no support to vegetation;
- 2. Outwash plains → boulder clay alluvium → most fertile agri.  
eg: - Midwest ~~USA~~ USA plains.
- 3. Lakes formed due to glaciers → Inland waterways  
eg: - Great Lakes of N. America
4. ~~Hydroelectric~~ Hanging valleys → Hydroelectric energy.  
eg: - Swiss, Canada
5. Eskers → sands & gravel for construction
6. Snow-cover → tourism — skiing, sight seeing.  
eg: - French, Italian Alps.
7. Cutting by glaciers → natural routeways across mountains
8. Strategic high points → Siachen
9. Avalanche → death & destruction
10. Source of perennial rivers → Ganges, Indus, Yamunotri, ..

151

→ Critically examine the concept of geomorphic cycle and discuss the views of Davis & Penck.

### Geomorphic cycle

The period of time during which an uplifted landmass undergoes its transformation through the process of land sculpture ending in a low featureless plain (peneplane) is called Geographical cycle.

This cyclic 'nature of earth history' was first propounded by James Hutton. He stated that

- i) There is no vestige to the beginning.
- ii) No prospect of an end.
- iii) Present is key to the past.

It led to the theory of Uniformitarianism  
"All The same physical processes and laws that operate today; operated throughout the geologic time. although not necessarily with the same intensity as now".

Sequential changes of landforms are due to endogenetic forces and exogenetic forces. While the endogenetic forces create vertical irregularities, <sup>creating relief of uplifted landforms.</sup> the exogenetic forces try to remove these vertical irregularities to form a low featureless plain.

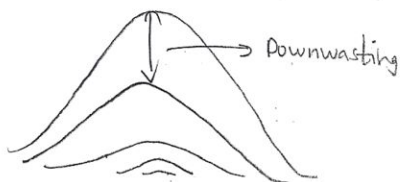
Two of the most famous theories of geomorphology of erosion are by i) Davis & ii) Penck. — <sup>(uniformitarianism)</sup>

Aim:

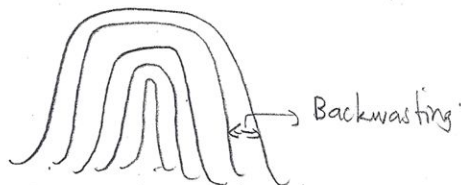
Davis theory tried to provide a basis for a systematic description and <sup>show it originated</sup> genetic classification of landforms; whereas Penck brought out a morphological analysis of landforms.

Basis of the theory

Davis believed that erosion decreased the gradient of the slopes by a process called DOWNWASTING. The summit of ~~the peak~~ was eroded gradually.



Penck believed that all slopes were made of straight slope segments and they underwent parallel retreat by BACKWASTING. The rate of retreat was proportional to the gradient of the slope.



Factors affecting landform

Davis gave a trio of factors affecting landform: <sup>nature</sup> structure (consistency, permeability), <sup>altitude (fold, fault, joints)</sup> process (agents of erosion), and <sup>stages - youth, mature or old</sup> time. But, he eventually ignored the other two factors and gave too much

importance to time - time dependent model.

(153)

Penck pleaded for a time-independent model. He stated that 'landform was a result of the rate and phase of degradation and rate and phase of upliftment'.

### Cyclical theory

According to Davis, erosion followed upliftment and resulted in a sequential degradation of landform in a hypothetical crustally stable landmass. But, in nature, whenever there is uplift, there will be erosion and they will be simultaneous. Moreover, there are no areas with indefinite crustal stability. Single cycle of erosion.

Penck realised that both erosion & upliftment are simultaneous but differ only in their rate. He also took into account the crustal movements of earth. But, his concept of continuous crustal movement was heavily criticised. <sup>(but, this ~~theory~~ was accepted only after the advent of plate tectonics)</sup> This throws the possibility of second cycle of erosion & polycyclic landforms.

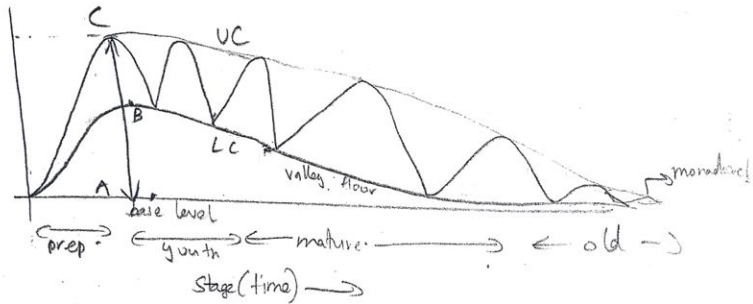
### Rate of Upliftment

Davis was of the view that upliftment was a sudden & rapid process and ~~erosion~~ there is no erosion during upliftment. But, tectonic studies have shown that upliftment is an exceedingly slow process.

Penck's view on upliftment was more logical. He said upliftment was first slow, then accelerated uplift, then accelerated degradation <sup>(waning)</sup>, then slow degradation.

# Stages of development

Davis



AC → initial abs. relief ; BC → initial

UC → summit curve ; LC → valley curve ;

Davis classified his cycle into 4 stages.

## Preparatory stage

This is a stage of sudden & rapid upliftment.

No erosion exists - So, both the absolute relief and relative relief increases.

## YOUTH STAGE:-

Due to the steep slope, kinetic energy & transporting capacity of streams are high and hence vertical erosion is prominent causing valley deepening. So, relative relief increases.

Since there is ~~no~~ uplift ~~is not higher than~~ <sup>lateral</sup> erosion, abs. relief ~~also increases~~ is constant.

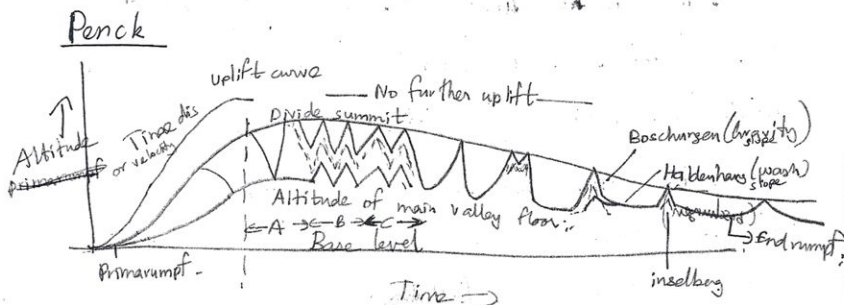
## MATURE STAGE:-

The reduction in gradient reduces vertical erosion (valley deepening) and causes horizontal (lateral) erosion, thus eroding the summits. Therefore ~~it is~~ decrease of relative & abs. relief.



OLD STAGE:  $\Rightarrow$

Entropy of streams is very high - There is almost no valley deepening but there is horizontal erosion causing erosion of summits. So, the abs. & relative reliefs are decreased and brought to ground level with isolated hills called MONADNOCKS standing.



There is no preparatory stage.

WAXING (ACCELERATE) RATE OF DVPT  $\Rightarrow$

The rate of upliftment is initially slow & then rises rapidly. Since the rate of uplift is far greater than erosion, ~~the~~ abs. relief increases. Vertical erosion is more dominant than erosion of slope summit. So, relative relief also increases;

UNIFORM DEVPT.

Phase (a):- Rate of uplift is still higher than lateral erosion of summits. So, abs. relief increases. But, the erosion of summits is equal to valley deepening. So, relative relief is constant.

Phase (D) :- Rate of uplift matches the erosion of summit.  
So, abs. relief is constant. Valley deepening rate & summit  
rate are equal. So, rel. relief is constant.

Phase C :- Upliftment stops completely. So,  $\frac{V}{H}$  ratio decreases due to summit erosion. Due to equal rates of vertical erosion & summit erosion, relative relief is constant.

#### WANNING DEVELOPMENT:

• There is no upliftment. The rate of valley deepening reduces. The summit erosion dominates. So, both absolute and relative relief decreases.

The upper slopes usually are steep and are called <sup>(boschung)</sup> gravity slopes, while the lower slopes are gentle and called wash slopes (holdenung).

#### Language:

• Davis theory is in 'English' and it is very lucid and expressive. It can be applied to all landforms. It has incorporated various views like 'base level', 'gradient of streams' and 'profile of equilibrium' and follows Hutton's cyclical theory of Nature. It has been widely accepted and adopted though its time-dependent & static cycles are criticised.

Penck removed the time dependency and concentrated on structure and it helped to create concept of 'rejuvenated or polycyclic landforms'. But, his obscure terminology, German language and incomplete work have made understanding his theory difficult. His theory is applicable only to these landforms.

→ Highlight the geomorphic features essentially found in <sup>(157)</sup> topographies under second cycle of erosion.

Second cycle of erosion occurs when there is a topographic discordance due to some changes like

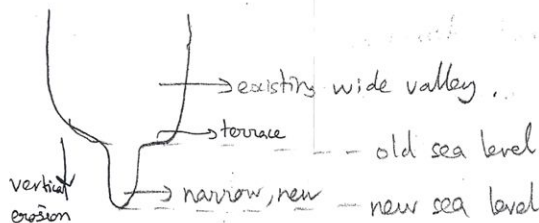
- i) Glaciation or deglaciation
- ii) Increase or decrease in sea level
- iii) Tectonic upliftment of landmass
- iv) Hydrological changes.

~~So~~ These disturbances increase the period of the cycle of erosion by rejuvenation (~~due to~~ older land form converted to YOUNG stage). These are also called polycyclic as there is more than one cycle of erosion.

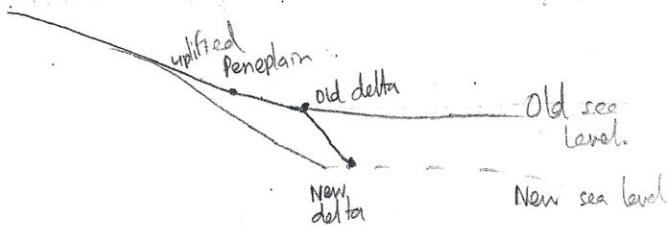
Some of the polycyclic or rejuvenated landforms are:-

### 1) Valley in valley topography.

When there is a sudden decrease in sea level or increase in speed of stream, it causes further vertical erosion producing a narrow, deep valley under the existing wide, shallow valley. The new narrow, deep valley ~~is~~ contains a pair of terraces above it, indicating the end of the old valley.



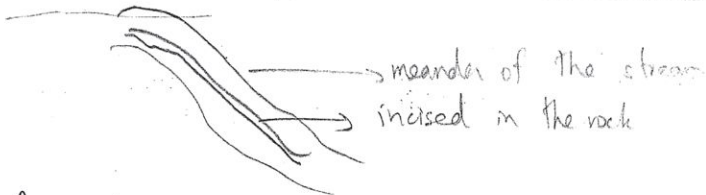
## 2) Uplifted peneplain



When sea level decreases, a new delta <sup>be river bed</sup> is formed at a lesser height in accordance with the sea level. As the existing peneplain is at a higher level than this newly formed plain, it looks uplifted.

## 3) Incised meanders:

Streams come down steep slopes with high velocity. Due to this high kinetic energy, most of the weight of the stream is concentrated in the channel bottom (middle) vertically eroding the rocks & producing incised meanders.



## 4) Paired terraces:-

Terraces are valley in valley topographies - In case of multiple sea level <sup>level</sup> changes, each of the old sea level is denoted by a terrace. If two

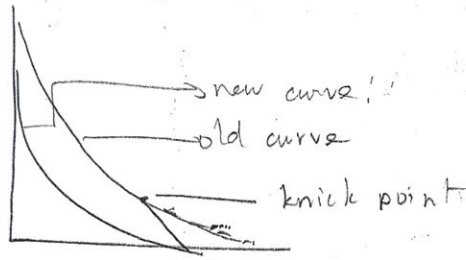
(159)

terraces are present at the same elevation, then they are paired terraces. They occur in areas of sudden decrease in sea level. Parallelism of terraces denote that they belong to the same period.



### 5) Knick points.

When the smooth longitudinal profile of a river is disturbed by tectonic or hydrological changes, a discontinuity in the profile called Knick Point is formed.



→ Explain the sequential devpt. of landforms associated with coastal areas.

Landforms in coastal areas are formed by the action of waves. The actions of waves are

- i) Corrasion :- erosion of "a steep rocky cliff by waves' action."
- ii) Attrition :- particles carried by the waves collide with each other and are ground to finer particles.
- iii) Hydraulic action :- water may enter into cracks of cliffs and when they come out, the compressed air explodes breaking the rocks.
- iv) SOLVENT ACTION :- Dissolves  $\text{CaCO}_3$  in limestone beaches.

Landforms of erosion (in rocky cliffs) (in submerging coasts)

Youth stage:-

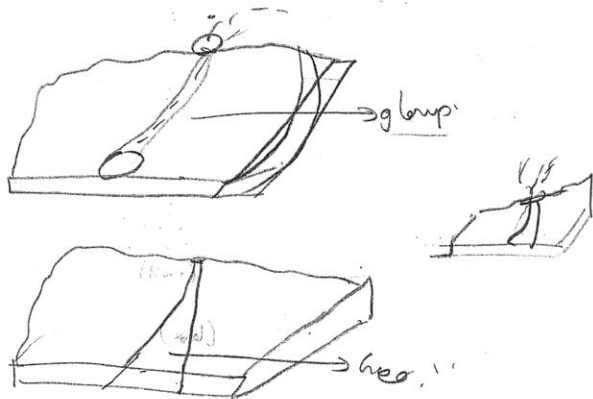
Cliffs:- & Wavecut terraces

Steep rocky cliffs stand in the land adjoining the sea.

The waves by their constant corrasive action erode the cliffs and the cliffs recede resulting in wave-cut platforms. The eroded material is deposited as wave-built platforms.

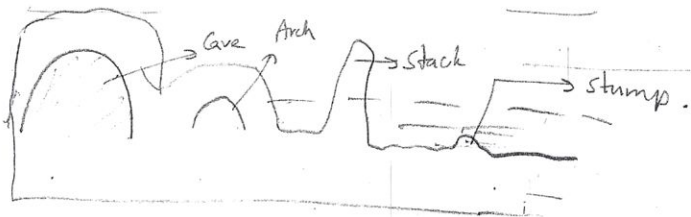


The cliffs are further eroded. Water enters into the cracks in the rocks through long shafts called gloups. By hydraulic action, it results in the weakening of rocks & it breaks down forming a deep cleft called GEOS.



### Caves, archs, stack & stumps

Hydraulic action & corrosion may produce deep hollow space in rocks called CAVES. Two caves join together to form arch. Sometimes, only one upstanding portion is left uneroded. This is stack. When the stack is submerged, it is called a stump.

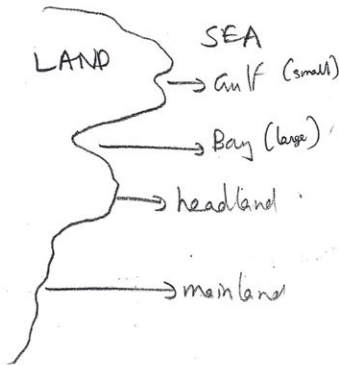




## Landforms in low-sedimentary coast (emerging coast)

Bays, gulf

Sometimes, due to differential erosion, the some part of mainland is protruded into the sea as headland. Water enters into the mainland. This inlet is called bay, if it is large and gulf if it is small.



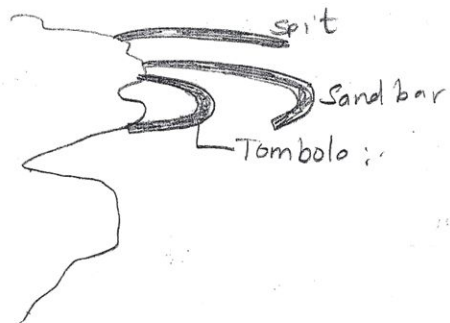
## Landforms due to deposition

Spits, sand bars, tombola, sand barriers,

Wave breakers due to their churning action deposit sand and shingles (pebbles) in the coastal sea.

These shingles connecting the land with the sea are called SPITS. Due to wave action, this gets curved towards the coast. This is SAND BAR. If the sand bar emerges from the sea, it is called

SAND BARRIER. If the sand bar connects two landmasses, it is called TOMBOLA.



Beeches

Attrition by waves deposit fine sand on the coast. These form sandy beeches. If pebbles are deposited, it is called a shingle beach.

Marine dunes

The sand deposited is carried by offshore winds and accumulated as sand dunes along the coastline.

Mature stage:

Deposition & erosion become equal. The sand bars and tombolos are destroyed. The coast is plain.

Old stage:

This is a theoretical or hypothetical stage, since this stage doesn't occur due to either submergence or emergence.

## → Karst landforms:

Karst landforms are made up of limestone (calcite) rocks or mixed with little magnesium (dolomite). In such areas, the solvent and precipitation action of surface and ground water are high.

### Distribution

Karst landforms are found in N.W. Yugoslavia (Karst district), Kentucky in USA, Yucatan peninsula in Mexico, south of Great Victoria desert in Australia and Pennines in Britain.

### Conditions necessary for Karst landforms

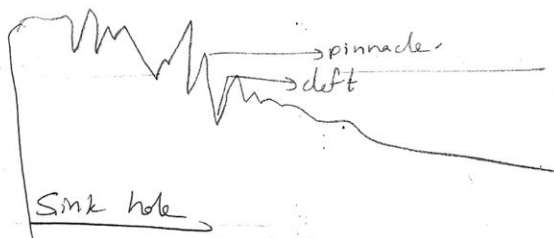
→ The limestone rocks must be thick and well jointed. They shouldn't be porous but only the joints should be permeable. They should be present near the surface of earth and plenty of rainfall should be available for solvent action. There must be wide in area and depth and must have folds or fractures for water stagnation & action.

### Landforms in Karst region:

i) Erosional landforms.

#### Lappies

Lappies are irregularities on the limestone surface due to differential solvent action of water.



Small, funnel shaped holes, formed initially at the top of the limestone surface.



### Swallow holes

Beneath the surface, the sink holes widen and form large swallow holes.

### Dolines

Dolines are collapse sinks (like quick sand (Changsha)).

### Uvales (Sink valley)

Uvales are sink valleys. Swallow holes combine with dolines to form uvales.



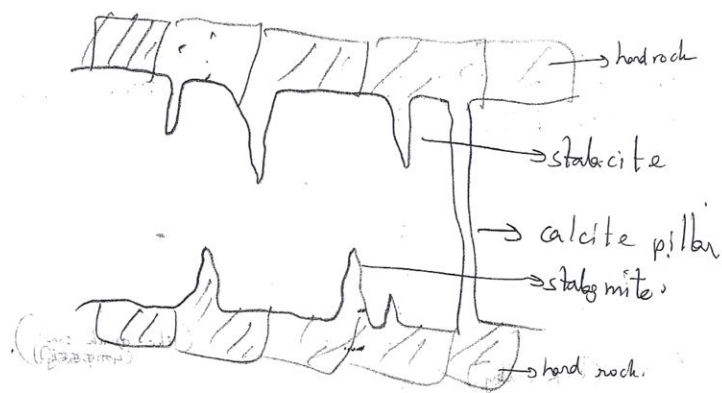
### Polijes

Several uvales combine to form large depressions called polije.

## Deposits Caves

When alternating limestones and hard rocks are found, water enters & dissolves the limestone layer leaving hard rocks intact. This results in a hollow space between hard rocks called caves. If both ends are open, it is called a tunnel.

## Landforms of deposition



Hanging icicle like limestone rocks with tapering ends are called stalactites.

When a limestone rock protrudes upward, it is called a stalagmite.

Stalagmite and stalactite join to form a calcite pillar (connection b/w two layers).

## Significance

Not luxuriant vegetation due to absence of surface drainage and thin soil. Only short grass grows. So sheep rearing is practised. Sparse population.

exists. Due to CaCO<sub>3</sub> availability, cement industry thrives. But building a house here is not easy due to the weak limestone bed. Only lead is the mineral found in veins of limestone rocks.

⇒ Discuss the evolution & characteristics of Glacial landforms:-

A large mass of moving ice is called a glacier. Pure ice is not in itself an eroding agent. The rocks & boulders along with the ice cause two types of eroding action.

1) PLUCKING → The glacier freezes the rocks at the fracture, drags and pulls off with it individual blocks, resulting in a rugged terrain.

2) ABRASION → The glacier scratches, scours and erodes, as it moves through resulting in the smoothing.

### Erosional landforms

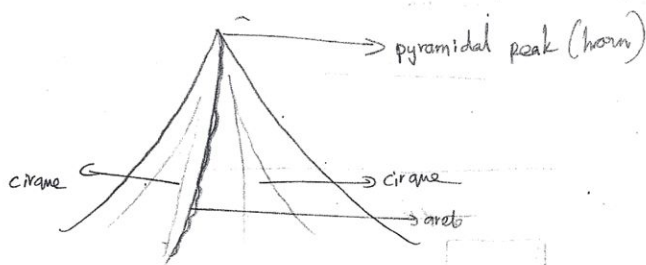
Cirque:- ~~cirques & tarn~~;

When a glacier starts flowing from the head valley, it plucks the steep back-wall of the head valley and as it flows downstream, by the action of abrasion, it erodes and deepens the lower ends of the valley producing a DEPRESSION. This results in a HORSE-SHOE or ARM CHAIR

topography called CIRQUE. At the base, it may form a lake called TARN.

### Arêtes :-

When a mountain is surrounded by two or more cirques, a knife-edged ridge is formed between these cirques called ARETE.



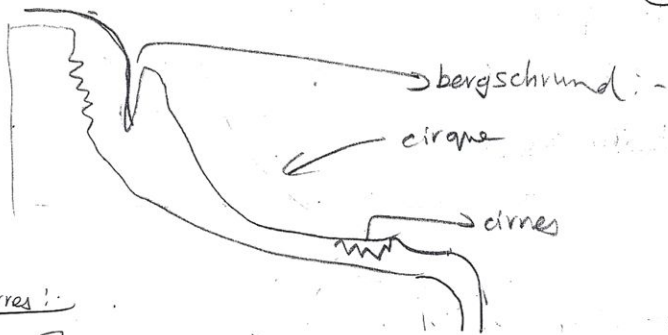
### Pyramidal peak (horn)

When two or more cirques surround a mountain, the peak looks sharp & pyramidal. It is called HORN. If the peak stands above the icy cirques like an island, it is a NONATAK.

### Bergschrund

As the glacier leaves the ~~head~~ valley-head, it produces a deep crack called BERGSCHRUND which is exposed when the ice melts. It is a narrow, deep ridge and is very dangerous to climbers. It is exposed in summer when all ice flows downstream and there is no replacing ice to fill the bergschrund.





### Cirres :-

These are cracks made by the glacier when it encounters a bend downstream.

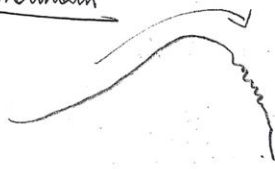
### U-shaped valley :-

When the glacier comes down the valley, it is joined & fed by several other glaciers (just like tributaries). ~~These~~ This glacier as it moves down the valley erodes the valley laterally by abrasion and removes any undulations in its path forming a smooth U-shaped valley.

### Hanging valley :-

In summer, the tributary glacier being small melts. The valley over which these glaciers ran, seems like a HANGING VALLEY. excellent potential of hydroelectric power.

### Roche moutonnée

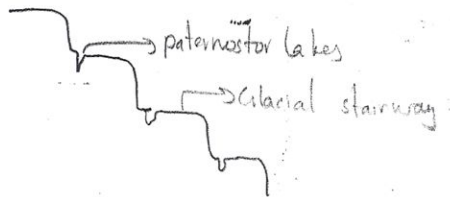


The uphill is smooth & gentle due to the abrasive action of glacier. While it falls down,

It plucks the back-wall of the mountain producing a rugged & steep downslope.

### Glacial Stair case

Sometimes due to continuous hard rocks on the way, the glacier forms a staircase structure. ~~At the~~ <sup>plw, 2 consecutive stairs</sup> the steep end, it produces a narrow depression. This depression when filled with water is called paternoster lakes.



### Crag & tail



The upslope is steep while backward slope is gentle.

### DEPOSITIONAL LANDFORMS

#### Moraines

Moraines are rocks & boulders <sup>pebbles</sup> that are eroded by glaciers by abrasion and imbedded in them and

lateral moraine → The moraines are usually imbedded <sup>carried by the glaciers</sup> in the sides of the glaciers.

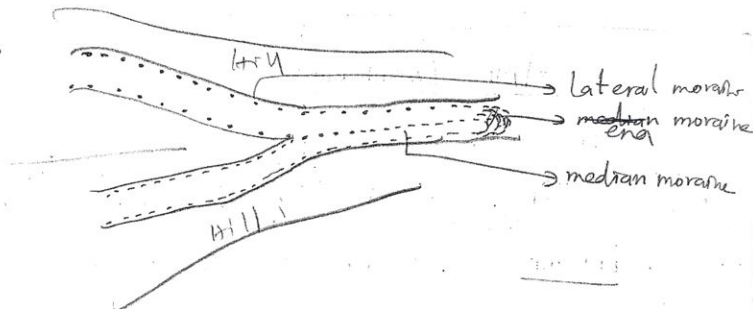
MEDIAN MORaine → When two glaciers join, the lateral

(171)

moraines are moved to the centre part of the glacier and are called median moraines.

### Terminal (end) moraine

When the glaciers reach downstream, the moraines are deposited at the end in snout shape.



### Drumlin: ('deposition' version of crag & tail)

Drumlin is a depositional feature in which boulders or clay are deposited in such a way that it has a steep upslope & gentle downslope. It looks like an inverted spoon. It is placed diagonally to form 'BASKET OF EGGS' topography.



### Eskers

Eskers are long, narrow ridges of stones and gravel deposited by the glacier when it melts. ~~Roads~~ Eskers are the best place to lay roads on glaciers. These stones are used for construction purposes.

## Outwash plains

In summer - glacier melts. The stream carries away all the fine deposits and deposits it in a low-featureless plain called outwash plain. <sup>most fertile plains</sup>

When there are undulations in this plain, water may get stored → KETTLE LAKES.

## ARID LANDFORMS

Arid, desertic landforms are mostly affected by the effect of wind. Wind erodes in 3 ways.

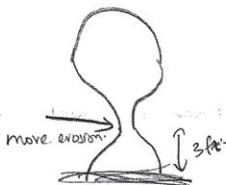
1) DEFLATION → The wind may carry away the sand from a particular place forming a depression. This is called deflation.

2) ABRASION <sup>similar to 'corrosion' of waves</sup> → The sand particles carried by the wind may collide with a rock and erode it heavily by sand-blasting.

3) ATTRITION → The sand & other debris when carried by wind collide with each other & are ground to fine particles.

## Erosional landforms

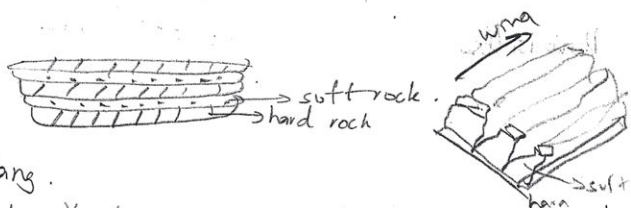
1) Mushroom or pedestal rocks:-



This is because of differential abrasion (173) of wind, the centre portion of the rock is eroded greatly. These rocks with slender filaments are called Mushroom Rocks.

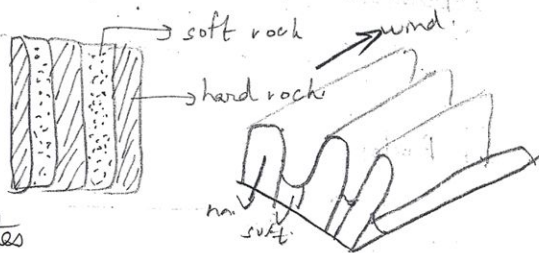
## 2) Zeugen

Alternating horizontal strata of soft rock and hard rocks are placed one above the other. In such cases, the soft rocks are eroded more than the hard rocks.



## 3) Yardang.

In Yardangs, ~~soft~~ vertical strips of hard and soft rocks are found adjacent to one another.



## 4) Mesas & Buttes

~~A table top~~

A high land with a table-like top with lava on the top is called MESA, when it is of a large area and a BUTTE when it is of a smaller area. ~~for~~



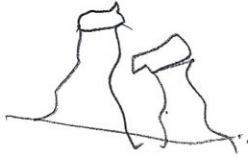
## Inselbergs



Isolated hill-like rocks formed in the old stage of geographic cycle are called inselbergs.

They have steep gravity slopes -  
e.g. - Ares rock in Australia.

## Pinnacles



## Deflation hollows

oases:-

## Depositional landforms

Mostly - the depositional landforms in deserts are dunes.

### 1) Barchans

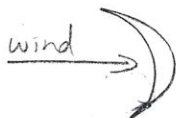
It is a crescent-shaped sand-dune formed with its <sup>(horns)</sup> wings hooked along from the direction of wind. This is because of relatively hard material on the centre of the dunes and the wind splits equally forming the wings of BARCHAN.



## Parabola

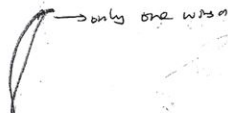
(175)

A parabolic shaped sand dune but with its wings pointed opposite to the direction of wind.



## Seif

Seif is a parabolic dune with a single wing.



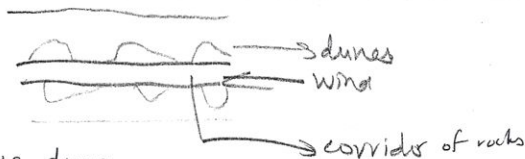
## Longitudinal dunes

~~The~~ Longitudinal dunes are those in which sand in the wind <sup>path</sup> direction is carried away & settled on either side. These form long, narrow, rocky corridors with sand on either side.

These are formed in areas of scanty sand.

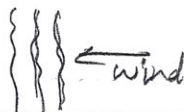
These were the routes taken for navigation in deserts.

eg:- Silk route (China to West Asia)



## Transverse dunes

The sand dunes are arranged perpendicular to the direction of wind. In these places, there is large availability of sand.





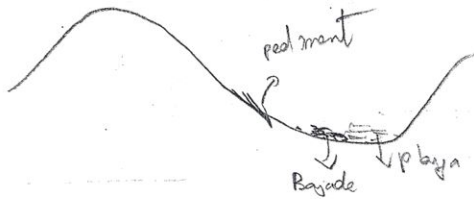
## Loess

The fine sand particles formed by ATTRITION are carried to far away places by the wind and deposited as fine sand. This is called LOESS.

eg :- (Erg) (quidi), (Erg) (gadari).

Fluvial ~~deposits~~ landforms (due to water action)

- 1) Pediment → eroded footplain
- 2) Bayade → depositional footplain
- 3) Playa → depressions (temporary lakes)



## Distribution

~~Sahara~~ Sahara Africa, Great Sandy desert (Australia), Sonoran, Mojave (to N. America)

