PE8402 - fundamentals of petroleum Geology.

Unit-V

1. Give an detail account on plate tectonics.

Plate Tectonics:

Theory of plate Tectonics: The theory of plate tectonics, the crust is broken up into sections/pieces that move on top of the liquid mantle (asthenosphere).

Tectonic plates: These sections/piece of crust are called plates.

* There are 7 major plates on the earth that are moving extremely slowly but continuously.

Major plates: Eurasian; African; Australian - Indian; North American; Pacific; Antarctic and South American.

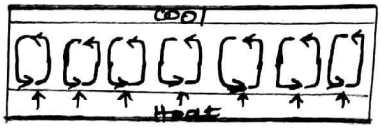
Intermediate plates: Caribbean; cocos, Nazca, Arabian; phillippine; Juan de Fuca and Scotia.

2 main types of plates:

- Oceanic → ocean
- Continental - land.

Convection currents.

- Convection cells in the mantle move the plates.
  - Hot in the center, less dense, magma rises up due to heat.
  - When the magma reaches the surface, it cools and sinks backdown creating a circular pattern of movement.
- This process happens continually.
  - Hot - goes up
  - cool - goes down.



Crust Density:

- Oceanic plates (dense) heavy
  - sink (subduct) underneath continental crust
- continental plate (less dense) - lighter

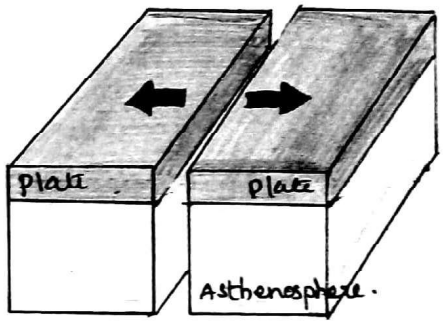
Plate Boundaries

- Border b/w 2 plates.
- 3 Boundary Types:
  - Divergent
  - convergent
  - Transform

Divergent Boundaries:

Seafloor Spreading (oceanic-oceanic)

- The process by which new oceanic crust is created.
- Two oceanic plates move apart and magma comes up.
- As rising magma cools, it forms new oceanic crust



Divergent

(Eg: Mid-Atlantic Ridge)

Magnetic Reversals (Paleomagnetism)

- Evidence of sea-floor spreading.
- Youngest crust is in the center, older as you go out.
- Earth's magnetic poles reverse from North to South.

Mid-Ocean Ridges (Oceanic-Oceanic)

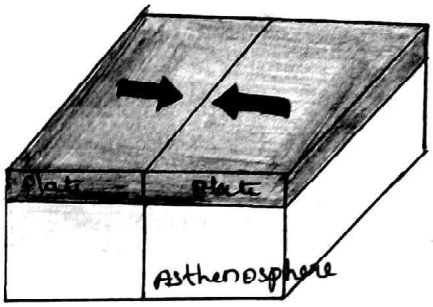
- A mountain under the Ocean
- A mid-ocean ridge forms where Oceanic plates continue to separate

A Rift Valley (continental - continental)

- when continental plates pull apart they form rift valleys.
- Makes Volcanoes and new land
- Eg: East African Rift Valley

Convergent Boundaries:

- plates come together.



Subduction Zones:

- when one plate goes under another plate
- The more dense (heavier) plate goes under.

convergent

Volcanic arc: (subduction: Oceanic - continental)

- More dense (heavier) Oceanic crust goes under the less dense continental crust.
- As the plate moves under the continental plate, the rock melts and rises, creating volcanoes.
- Trenches are also created.

Deep-sea Trench. (Oceanic - continental)

- A depression (hole) in the ocean floor at a subduction zone, It has sand in it.

Volcanic Island Chains (Subduction - oceanic - oceanic)

- when 2 oceanic plates meet and one goes under the other.
- forms Volcanic Islands.

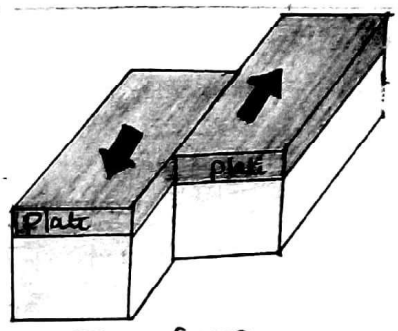
(Eg: Aleutian Islands)

Mountains: (Subduction: continental - continental)

- when 2 continental plates come together.
- The Plates push up and form mountains:
- Eg: Himalayas

Transform fault Boundaries

- plates slide past one another moving in opposite directions.
- Also called Faults.
- Causes earthquakes / tsunamis to occur



Transform.

2. Classify and describe the types of Sedimentary basins.

Sedimentary basin: It is a low area in the Earth's crust, of tectonic origin, in which sediments accumulate.

*Sedimentary basins range in size from as small as hundreds of meters to large parts of Ocean basins.

*The essential elements of the concept is tectonic creation of relief, to provide both a source of sediment and a relatively low place for the deposition of that sediment.

Tectonics and Sedimentation:

*Tectonics is the most important control on Sedimentation : climate is a rather distant second.

*The important effects of tectonics on sedimentation direct or indirect, include the following:

- ✓ Nature of Sediment
- ✓ rate of sediment supply
- ✓ rate of deposition
- ✓ depositional environment
- ✓ Nature of source rock
- ✓ Nature of vertical succession.

*In the one sense, the origin of sedimentary basins boils down to the question of how relief on the earths is created. Basically, there are only a few ways, described in the following Sections.

1) local
2) Regional

Classification

1. Intracratonic Basins.

Location and tectonic setting: In anorogenic areas on cratons.

Size and Shape: rounded, equidimensional, hundreds of kilometers across.

Sediment fill: Shallow-water cratonal sediments, thicker and more complete than in adjacent areas of the carton but still relatively thin, chundreds of meters.

2. Aulacogens Basin:

Location and tectonic setting: extending from the margins toward the interiors of cratons

Size, Shape: Long, narrow, linear; tens of kilometers wide, many hundreds of kilometer long.

Sediment Fill: very thick (up to several thousand meters); coarse to fine silici-clastics, mostly coarse, minor carbonates; mostly nonmarine, some marine; contemporaneous folding and faulting. The succession often passes upward with or without major unconformity.

3. Rift Basins:

Location and tectonic setting: within continental lithosphere cratons

Size, Shape: long, narrow, linear, tens of 168 kilometer wide; up to a few thousand 168 kilometers long.

Sediment fill: coarse to fine silicidastics, usually non-marine; often lacustrine sediments; intra bedded basalts.

4. Oceanic Rift Basins:

Location and tectonic setting: In a narrow and newly opening ocean.

Size, Shape: long, narrow, straight or piecewise straight, tens to a few hundreds of kilometers wide, up to a few thousand kilometers long.

Sediment fill: mafic volcanics and coarse to fine nonmarine siliciclastics, as in intracratonic rift basins described above, passing upward and laterally into evaporites, lacustrine deposits and fine marine sediments, often metal-rich from hydrothermal activity at the spreading ridge.

5. Trenches Slope basin:

Location and tectonic setting: In the abyssal ocean at the line of initial downbending of the subducted oceanic-crust plate in a subduction zone.

Size, Shape: small; linear; elongated parallel to the trench.

Sediment fill: Deep marine silts and muds sedimented directly into the basins or slumped into the basins from higher on the slope; also coarser siliciclastics supplied from farther up slope by turbidity current.

6. passive margin Basins:

Location and tectonic setting: Along passive continental margins, approximately over the transition from continental to oceanic crust formed by

rift and opening of a full-scale ocean basin.

Shape, size: Straight to piecewise straight often with considerable irregularity in detail; a few hundreds of kilometers wide, thousands of kilometers long.

Sediment fill: overlying & overlapping the earlier deposits laid down earlier during rifting and initial opening are extensive shallow-marine siliciclastics and carbonates of the continental shelf, thickening seaward.

7. Fore Arc Basins:

Location and tectonic setting: In subduction zones. b/w the upraised subduction complex just inboard of the trench and the volcanic arc or the overriding continent.

Size Shape: tens of kilometers ~~to~~ over one hundred of kilometers long; commonly arcuate.

Sediment fill: non marine siliciclastic fluvial to deltaic deposits at the arcward margin pass seaward into deep marine siliciclastic, mainly sediment-gravity flow deposits, all interbedded with arc-derived volcanic flows and py-roclastics. Section thickness can be many thousands of meters.

8. Foreland Basins: There are 2 kinds of foreland basins:

1) retro-arc foreland basins
2) Peripheral foreland basins.

Size, Shape: tens to a few hundreds of Km wide; hundreds to 1000 km. of long.

Sediment fill: Coarse fluvial siliciclastics, mainly as alluvial fans, thinning and fining away from the arc or suture, often passing in to shallow-marine sandstone-shale successions if sea level is high enough to flood the basin.

3. Explain the categorization the petroliferous basins of India.

*Based on the exploration carried out so far and status of knowledge in terms of occurrence of hydrocarbon sedimentary basin of India is divided in to 4 categories.

Category I

*The petroliferous basin with proved hydrocarbon reserves and where commercial production has already started.

*These basins are:

- Assam Shelf
- Bombay offshore
- Cambay
- Krishna-Godavari
- Tripura
- Rajasthan.
- Assam-Arakan fold Belt.

Category II

*Sedimentary basin with proved occurrence of hydrocarbons but from which no commercial production has been obtained yet

*These basins are:

- Andaman - Nicobar
- Bengal
- Himalayan Foothills
- Jaisalmer
- Kutch
- Mahanadi

Category III

*Sedimentary basins with no significant oil and gas shows but which on Geological considerations are considered to be prospective.

*These basins are

- Bikaner - Nagpur
- Kerala - Lakshadweep
- Saurashtra.

Category IV

*Petroliferous basins with uncertain prospects which require basic data to be generated for prognosis. It includes the basins which bear an analogy with similar hydro-carbon producing basins in the world and may be prospective.

- Arunachal Foothills
- Deccan Syndlne
- Ganga valley
- Gondwana
- Kashmir Vai (kareva)
- Mizoram
- Manipur
- Naymada
- Vindhyan

Proven commercial productivity.

Basin Name	Onland Area	offshore Area	Total
Assam Arakan	1,16,000	-	1,16,000
Cambay	51,000	2,500	53,500
Cauvery	25,000	30000	55,000
Krishna Godavari	28,000	24,000	52,000
Mumbai Offshore	-	1,16,000	1,16,000
Rajasthan	1,26,000	-	1,26,000.

Identified prospectivity

Basin Name	Onland Area	offshore area	Total.
Kutch	35,000	13,000	48,000
Mahanadi	55,000	14,000	69,000
Andaman Nicobar	6,000	41,000	47,000

Potentially prospective Basins.

Basin Name	Onland Area	offshore Area	Total
Bengal	57,000	32,000	89,000
Ganga valley	1,86,000	-	186000
Himalayan Foreland	30,000	-	30,000
Kerala - Konkan Lakshadweep	-	94,000	94,000

Saurashtra	52,000	28,000	80,000
Vindhyan	1,62,000	–	462,000

potentially prospective.

Basin name	onland area	offshore Area	Total
Bastar	5000	–	5,000
Bhima-Kaladgi	8,500	–	8,500
Chattisgarh	32,000	–	32,000
Cuddapah	39,000	–	39,000
Deccan Syncline	2,73,000	–	2,73,000
Karewa	3,700	–	3,700
Narmada	17,000	–	17,000
Pranhita - Godavari	15,000	–	15,000
Satpura - South Rewa - Damodar	46,000	–	46,000.
Spiti - Zanskar	22,000	–	22,000.

Deep water Basins:

* Western offshore basin:

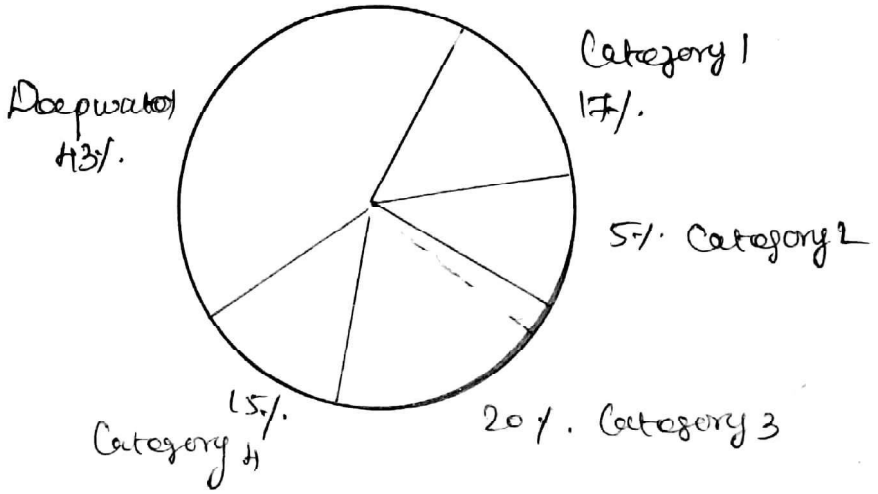
  * Mumbai offshore and Kerala Kankan offshore.

  * In western offshore basin the reservoirs are mainly Carbonates and maximum production of oil is from this basin.

East coast offshore basins.

Cauvery offshore
KG offshore
MBA offshore

In east coast offshore the reservoirs are mainly clastics and is rich in gaseous hydrocarbon.



Deepwater : 1350000 Sq. Km

The Cambay Basin

The cambay basin occupies an area of approximately 54,000 Sq. Km.

The Cambay shale is the main source rock in this basin.

Five tectonic blocks from north to south.

1. Sanchor - patan block
2. Mehsana - Ahmedabad block
3. Tarapur - Cambay block
4. Jambusar - Broach block
5. Narmada - Tapti block

4. Explain in detail about the types and classification of sedimentary basin?

Ref. Q.no.①

5. Discuss in detail about plate tectonics theory & Evidence for plate tectonics.

Ref. Q.no.①.