6TH SEMESTER CLASS NOTES (PUJA KARMAKAR)

CORE COURSE-DSE IV-OCEANOGRAPHY

CLASSIFICATION OF MARINE SEDIMENT-Using the broadest scheme possible, we can subdivide sediment into five categories, presented here with their general characteristics:

Terrigenous sediment: *fine and coarse grains that are produced by the weathering and erosion of rocks on land; typically sands and mud.*

Biogenous sediment: *fine and coarse grains that are derived from the hard parts of organisms, such as shells and skeletal debris:typically lime (composed of calcium carbonate) and siliceous (composed of silica) muds.*

Hydrogenous sediment: *particles that are precipitated by chemical or biochemical reactions in seawater near the sea floor; manganese and phosphate nodules are examples.*

Volcanogenous sediment: *particles that are ejected from volcanoes; ash is an example.*

Cosmogenous sediment: *very tiny grains that originate from outer space and tend to be mixed into terrigenous and biogenic sediment.*

FACTORS THAT CONTROL SEDIMENTATION: Two of the most important factors that determine the nature of a sediment deposit are particle-size distribution and energy conditions at the site of deposition. Because these two factors interact to produce the properties of a sediment deposit, a geologist is able to deduce what they were at the time of deposition by exaAmining such properties of even an ancient sediment.

Types of deposits

The types of Ocean Deposits are **Terrigenous materials** and **Biogenous materials.**

Terrigenous materials

In general, the Terrigenous deposits consist mainly of &ndash

a) Material derived from the wear and tear of the land,
b) The remains of animals and plants,
c) Volcanic material.

- On the basis of size, composition and chemical characteristics, Terrigenous sediments are divided into gravels, sands, silt, clay and mud.
- Gravels are further sub-divided into boulders, cobbles, pebbles, granules etc in accordance with their size.
- Mud is finer than clay. Clay is significant cementing element.

Types of mud

Murray has divided mud into 3 types on the basis of colour.

Blue mud

- It includes the materials derived through the disintegration of rocks rich in Iron Sulphide and organic elements.
- It contains 35% of calcium carbonate.
- It predominates in the Atlantic Ocean, Mediterranean Sea, Artic Sea.

Red mud

- The sediments derived through the communition of rocks rich in iron oxides from red mud.
- The reddish colour is mainly due to dominance of iron content.
- It predominates in the Yellow sea, Brazilian coast and the floors of Atlantic Ocean.

Green mud

- It is formed due to chemical weathering wherein the colour of blue mud is changed to green mud due to reaction of sea water.
- It contains green silicates of potassium and Glauconite.
- It contains calcium carbonate between 0 to 56%.

- These are generally found at the depth of 100 to 900 fathoms.
- Green mud are found along the Atlantic and Pacific coast of North America, Japan coast etc.

Biogenous materials

- The source of organic materials is sea itself. They include skeletons of marine organisms and plant remains. These are two categories

a) Neretic matter
b) Pelagic matter

- Neretic matter includes skeletons of marine organisms and plant remains.
- Pelagic matter consists of remains of different types of algae.
- Pelagic materials are oozes which are divided into two groups on the basis of lime and silica contents &ndash

I. Calcareous oozes &ndash

- They contain lime in abundance.
- They are seldom found at greater depth because of their high degree of solubility.
- They are generally found between the depths of 1000 fathoms to 2000 fathoms.

Pteropod oozes &ndash

- They are formed of floating pteropod mollusks.
- They contain 80% calcium carbonate and is mostly found in the tropical oceans and seas at the depth of 300 &ndash 1000 fathoms.
- They practically disappears beyond 2000 fathom depth.

Globigerina oozes &ndash

- They are formed from the shells of a variety of foraminifera but most of such oozes are formed of germs called globigerina.
- When they are dried up they become dirty white powder.
- They contain 64% calcium and 1.64% silica.
- They are found between the depths of 2000 to 4000 fathoms.

II. Siliceous oozes &ndash

- Silica content dominates in the siliceous oozes.
- Silica is derived from a group of protozoa or radiolarians and benthic animals mainly sponges.
- Such oozes are found in both warm and cold water at greater depths.

Radiolarian oozes &ndash

They are formed by the shell of radiolarian and foraminifera.

- They are found upto the depth of 2000 to 5000 fathoms.

Diatom oozes &ndash

- They are formed of the shells of very microscopic plants.
- They are found at the depth of 600 &ndash 2000 fathoms.

6TH SEMESTER CLASS NOTES (PUJA KARMAKAR)

CORE COURSE-XIV-SOIL AND BIO-GEOGRAPHY

BIO-GEO CHEMICAL CYCLE

Living organisms, from viruses, bacteria to plants and animals require various kinds of chemical elements such as carbon, hydrogen, nitrogen, sulphur and phosphorus for their growth and life processes. The absorption and utilization of such elements by organisms is compensated by their recycling and regeneration back into the environment. The cyclic path of these elements from environment to organisms and then into the environment are called biogeochemical cycles. In other words, the organic and inorganic substances of the biosphere i.e. various gasses (Carbon, nitrogen, oxygen etc.) from atmosphere, chemical elements (iron, nickel, oxygen, nitrogen, carbon, hydrogen) from lithosphere and water from hydrosphere, move reversibly through various closed system or cycles in such a way that total mass of these substances remain almost the same and these substances are always available for use by the biotic communities. This circulation of various elements in a cyclic manner is termed as biogeochemical cycle. These cycles are called biogeochemical cycles, because they include a variety of biological, geological, and chemical processes. .

Significant features of Biogeochemical Cycles

- Biogeochemical cycles are pathways by which nutrients flow between the biotic and abiotic compartments of the Earth. The abiotic portion of the Earth includes the lithosphere (the geological component of the Earth) and the hydrosphere (the Earth's water) while biotic components include flora and fauna. Ecosystems survive due to biogeochemical cycles. Many of the nutrient elements on which living things depend, such as carbon, nitrogen, and phosphorous are in constant circulation. Essential elements are often stored in reservoirs, where they can be taken out of

Importance of Biogeochemical cycles

An ecosystem survives by combination of energy flow and matter recycling that's why biogeochemical cycles are important in following ways. Biogeochemical cycles are a form of natural recycling that allows the continuous• survival of ecosystems Biogeochemical cycles are pathways by which nutrients flow between the abiotic and• abiotic compartments of the Earth. Biogeochemical cycles regulate the elements necessary for life on Earth by cycling• them through the biological and physical aspects of the world.

1.3 **Types of Biogeochemical** Cycles Biogeochemical cycle is circulating or repeatable pathway by which an element moves through both the biotic (biosphere) and abiotic (lithosphere, atmosphere, and hydrosphere) components of Earth.Biogeochemical cycles are basically of two types: a) Gaseous cycles: In gaseous cycles, the elements have a main reservoir in the gaseous phase, and the reservoir pool is the atmosphere or water. The biogenetic materials involved in circulation pass through a gaseous phase before completing the cycle. E.g. carbon cycle, nitrogen cycle, oxygen cycle b) Sedimentary cycle: In sedimentary cycles, the elements main reservoir pool is lithosphere and the biogenetic materials involved in circulation are non-gaseous. The sedimentary cycles are generally very slow as the elements may get locked up in rocks and go out of circulation for long periods. E.g. sulphur cycle, phosphorus cycle. Major biogeochemical cycles are discussed below.

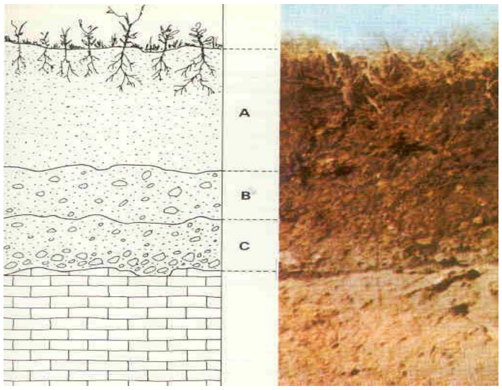
Carbon Cycle Carbon is important for all life on Earth. All living things are made up of carbon. Carbon is produced by both natural and human-made (anthropogenic) sources. Natural Sources 1. Atmosphere: Carbon is found in the atmosphere mostly as carbon dioxide. Animal and plant respiration place carbon into the atmosphere. 2. Lithosphere: Carbon is found in the lithosphere in the form of carbonate rocks. Carbonate rocks came from ancient marine plankton that sunk to the bottom of the ocean hundreds of millions of years ago that were then exposed to heat and pressure. Carbon is also found in fossil fuels, such as petroleum (crude oil), coal, and natural gas. Carbon is also found in soil from dead and decaying animals and animal waste 3. Hydrosphere: Carbon is found in the hydrosphere dissolved in ocean water and lakes. Carbon is used by many organisms to produce shells. Marine plants use carbon for photosynthesis. The organic matter that is produced becomes food in the aquatic ecosystem. 4. Biosphere: Carbon is found in the biosphere stored in plants and trees. Plants use carbon dioxide from the atmosphere to make the building blocks of food during photosynthesis. Anthropogenic Sources 1. Deforestation: After deforestation, plants are no available to remove carbon dioxide from the air. Thus deforestation results in extra carbon dioxide placed in the atmosphere. 2. Wood burning: When wood is burned, the carbon that is stored in the trees converts into carbon dioxide and enters into the atmosphere. 3. Combustion of fossil fuels: When fossils fuels (coal, oil, and natural gas) are extracted from the ground and burn for energy at power plants, this burning of fossil fuels is called combustion which releases carbon dioxide into the atmosphere. Steps of the Carbon Cycle: Carbon cycle in the biosphere involve following steps. (Fig. 5) 1. Carbon enters the atmosphere as carbon dioxide from respiration by animals and combustion of fuels. 2. Carbon dioxide is absorbed by producers and converted into carbohydrates by process called photosynthesis. 3. Animals consume the plant passing the carbon compounds along the food chain. Most of the carbon they consume is exhaled as carbon dioxideformed during respiration. 4. After the death of the animals and plants, they are eaten by decomposers and the carbon in their bodies is released to the atmosphere as carbon dioxide. In some conditions decomposition is blocked. The plant and animal material may then be available as fossil fuel in the future for combustion. Fig. 5: Carbon Cycle Source: https://www.sciencelearn.org.nz/image_maps/3-carbon-cycle **Nitrogen Cycle** Nitrogen is very important for all life forms in the biosphere because it is an essential part of the amino acids which make up proteins. Although nitrogen constitutes the largest proportion of atmospheric gasses by volume, but living organisms cannot use nitrogen directly rather they obtain nitrogen in the form of ammonia salts and nitrates. Sources of Nitrogen: Natural sources of nitrogen include some of the nitrogen in the atmosphere, instream sources (e.g. salmon carcasses and litter fall), and vegetation (e.g. from N-fixing plants). Nitrogen is also a by-product of many natural biogeochemical processes that occur in watersheds, rivers and streams, such as the decomposition of plants and organisms. Steps of Nitrogen Cycle In general, the nitrogen cycle has five steps: (Fig.6)

1. Nitrogen Fixation Nitrogen fixation is the process by which gaseous nitrogen (N2) is transformed to ammonia (NH3 or NH4+) through biological fixation or nitrate (NO3-) through high-energy physical processes. Gaseous Nitrogen can be converted directly into nitrate through processes that exert a tremendous amount of heat, pressure, and energy such as combustion, volcanic action, lightning discharges, and industrial means. However, a larger amount of biologically available nitrogen is naturally created through the biological fixation of Nitrogen to Ammonia and Ammonium. A small group of bacteria Known as Rhizobium that live in nodules on the roots of legumes and some other woody plants are capable of breaking bonds among the molecular nitrogen and combine it with hydrogen, using the enzyme nitrogenese.
2. Nitrification Nitrification is a two-step process in which ammonia is converted to Nitrate. First, the soil bacteria Nitrosomonas and Nitrococcus convert Ammonia to Nitrite, and then another soil bacterium, Nitrobacter, oxidizes Nitrite to nitrate. These bacteria gain energy through these conversions, both of which require oxygen to occur.
3. Assimilation In the assimilation process plants and animals incorporate the Nitrate and ammonia formed through nitrogen fixation and nitrification. Plants take these forms of nitrogen by their roots, and integrate them into plant proteins and nucleic acids. After assimilation, animals are then capable to use nitrogen from the plant tissues.
4. Ammmonification Ammonification is the process in which microorganisms such as bacteria break down organic nitrogen including proteins and amino acids into ammonia.The ammonia produced by this process is excreted into the environment and is then available for either nitrification or assimilation.
5. Denitrification Denitrification is the conversion of Nitrates to gaseous Nitrogen by anaerobic bacteria. This process only occurs with the little or no presence of oxygen, such as deep in the soil near the water table. Hence, areas such as wetlands provide a valuable place for reducing excess nitrogen levels via denitrification processes.

FORMATION AND PROFILE CHARECTERISTICS (LATERITE,PODSOL,CHERNOZEM)

Laterites

are the products of intensive and long lasting tropical rock weathering which is intensified by high rainfall and elevated temperatures. Formation of most of the laterites started in the Tertiary. For a proper understanding of laterite formation we must focus on the chemical reactions between the rocks exposed at the surface and the infiltrated rain water. These reactions are above all controlled by the mineral composition of the rocks and their physical properties (cleavage, porosity) which favour the access of water. The second relevant factor for the formation of laterites are the properties of the reacting water (dissolved constituents, temperature, acidity pH, redox potential Eh) which are themselves controlled by the climate, vegetation and the morphology of the landscape.



Chemical weathering slows down in dry seasons at least above the fluctuating water table. Aqueous dissolution of minerals proceeds when a chemical equilibrium is not arrived i.e. when the dissolved constituents are removed in the water.

The principal effects of the various factors on laterite formation are well known but it is difficult to determine them in space and time in the field. In the practise of laterite research most valuable informations are obtained by detailed studies of complete weathering sections (laterite profiles) reaching from the unweathered parent rock to the strongly altered surface layer. Sections showing physical disturbances as erosion or importation of transported material should be omitted to exclude effects other than weathering. An adequate number of laterite profiles on different parent rocks has been analysed which enable a clear understanding of the basic processes of lateritization.

The chemical and mineralogical results have shown that the primary minerals are generally not fully dissolved but partially transformed in secondary minerals which are more stable under the intensive weathering conditions. The elements in the primary rock minerals are released and show different reactions in the aqueous solution. The elements Na, K, Mg and Ca do not react with other elements and are removed in the percolating water. The initial dissolution is predominantly promoted by a higher acidity (lower pH) of the water. A high percentage of the dissolved Si is equally removed but another part reacts with dissolved Al and forms the clay mineral kaolinite. The aluminium hydroxide gibbsite is formed if the concentration of dissolved Si is extremely low due to a very strong drainage. Dissolved Fe is very reactive with hydroxyl ions and forms after oxidation goethite and hematite which cause the red-brown colour of laterites. Thus the dominant process of laterite formation is the residual (or relative) enrichment of iron and frequently of aluminium by removal of silica, alkalis and alkaline earths..

Charecteristic-

1.Laterite is a soil and rock type rich in iron and aluminium and is commonly considered to have formed in hot and wet tropical areas. Nearly all laterites are of rusty-red coloration, because of high iron oxide content

2.The transformation of rock into laterite proceeds in general gradually as indicated by the steady increase of iron and decrease of silica in laterite profiles above the parent rock.

3. Redbrown laterites on granites, granitic gneisses, clays and shales are generally hard or harden after drying, whereas laterites an basalts are commonly friable and show an intensive reddish color

4. This type is mostly developed on a basement of limonitised rocks. It is orange, brown, brick red or steel 61 grey in colour.

5. When water is, added to the lateritic soils it tends to disintegrate the particles into smaller ones with an increase in the specific surface.

Podzol

- Process of soil formation resulting in the ***formation of Podzols and Podzolic soils.***
- Podzolization encompasses ***the downward migration of Al and Fe, together with organic matter, from the surface areas and their accumulation in the profile's deep areas.***
- The bases other than Calcium are removed and the ***whole soil becomes distinctly acidic*** (implies acid leaching)**.**

This process is characterised by a strong acidity that causes the slow development of organic (which releases abundant organic compounds with an acidic nature) and an extreme alteration of the mineral phase (releasing abundant elements that are lixiviated by the drainage waters, while the medium is enriched with insoluble elements, such as Fe and Al, which are migrated downward by the organic compounds towards deeper horizons).

i) ***Climate:*** A cold and humid climate is most favorable for podzolization
ii) ***Parent material:*** Siliceous (Sandy) material, having poor reserves of weatherable minerals, favor the operation of podzolization as it helps in easy percolation of water.
iii) ***Vegetation:*** Acid producing vegetation such as coniferous pines is essential.
iv) ***Leaching and Translocation of Sesquioxide***:The humus and Sesquioxide become mobile and leached out from the upper horizons and deposited in the lower horizon.

As iron and aluminium move about, the A horizon gives a bleached grey or ashy appearance. The ***Russians used the term Podzols (pod means under, the Zola means ash like i.e. ash-like horizon appearing beneath the surface horizon) for such soils.***

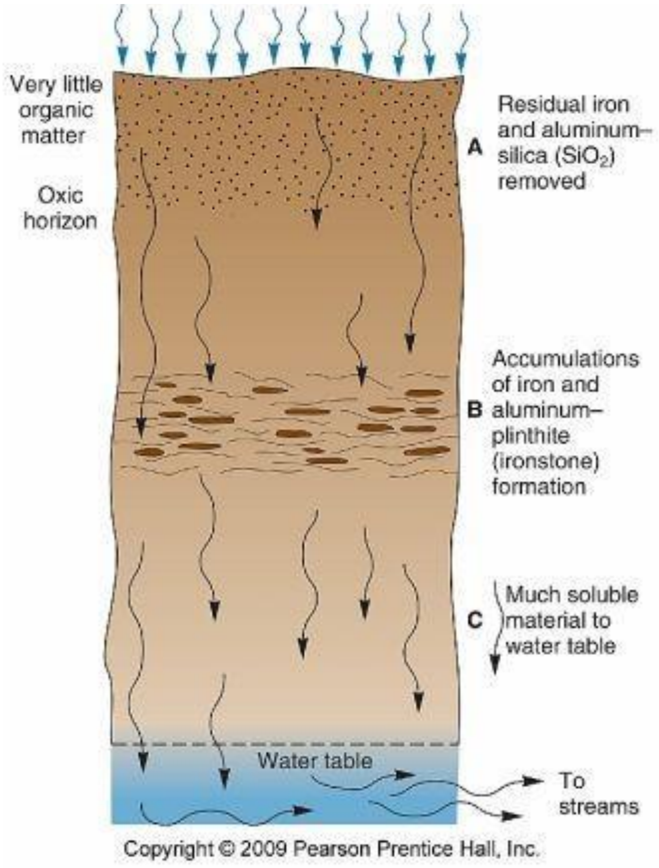


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Fig: Podzolization

Podzols commonly occur on highly permeable sandy parent materials that are poor in base cations and iron and develop in cool humid climates under forest or heath vegetation. Such conditions favor the development of a thick organic (mor) layer, overlying a weathered eluvial (E) horizon. The deeper illuvial horizon is dark in color (reddish brown or dark brown to black) and enriched in Al, Fe, and organics (Buurman and Jongmans, 2005This is the oldest and the most widely accepted theory that is based on the common finding that ~80% of soluble Al and Fe in the eluvial horizons of the Podzols can be bound to the organic matter. The theory suggests that Fe,)Al, and Si form metal–organic complexes that are highly mobile and freely move down the profile along with the percolating water. They further precipitate in the B horizon due to the saturation of the organic molecules through metal complexation (Buurman and Jongmans, 2005).

Charecteristic of podsol-

1. Podzols develop mainly in cool and wet climates, especially in the boreal zone
2. The parent material is of crucial importance for the formation of Podzols. They are found only in coarse-textured and base-poor parent materials—most often sands, sandy tills, and Precambrian Shield granites/gneisses

3. Podzol development is mainly favored by vegetation producing slowly degradable and nutrient-poor litter such as coniferous forest and ericaceous shrubs. However, Podzols are also identified under deciduous forests

Chernozems

The `typical' Chernozem has formed in uniformly textured, silty parent material (loess), under tall-grass vegetation with vigorous growth. The above ground biomass amounts to some 1 to 1.5 tons of dry matter per hectare; the corresponding root mass, already incorporated in the soil, weighs 4 to 6 tons/hectare.

Deep, humus-rich Chernozems occur in the central part of the steppe zone where the annual precipitation sum is approximately equal to the evaporation sum. Such soils contain 10 to 16 percent organic matter in their surface layers, are neutral in reaction (pH 7.0, and around 7.5 in the subsoil), and highly saturated with bases. Soil fauna is very active in Chernozems, in wet periods predominantly in the upper 50-cm layer but the animals move to deeper strata at the onset of the dry period.

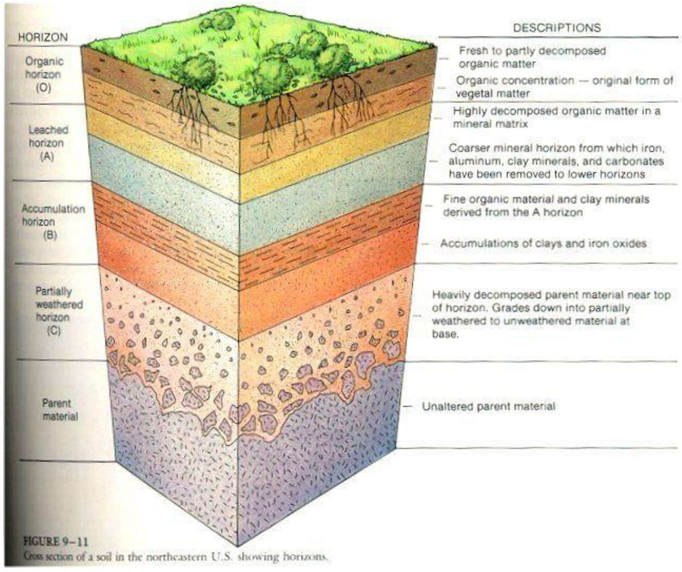

FIGURE 9–11
Cross section of a soil in the northeastern U.S. showing horizons.

The high porosity and favourable structure of the deep, homogenized Ah-horizon explain why deep percolation of rainwater during wet spells is sufficient to flush virtually all readily soluble salts from the soil. There may be some accumulation of gypsum at a depth of 2 to 3 meters from the soil surface (1.5 to 2.5 m in southern Chernozems), and accumulation of lime at a shallower depth, say at about 1 metre from the soil surface. A `*dead dry horizon*' may be present at a depth of about 4 metres, deeper in the north of the Chernozem belt than in the south. This soil layer receives neither percolation water from above nor capillary rise from below. The dead dry horizon needs not to be continuous; its thickness varies and it can even be absent altogether.

Migration of clay has resulted in slightly increased clay contents between 50 to 200 cm from the surface in many Chernozems in the central steppe zone. This indicates that central Chernozems are exposed to moderately strong leaching during wet periods.

Characteristics of Chernozems

Morphological -Virgin Chernozems have a thin leafy litter layer on top of a dark grey to black, crumb, `*vermic*' Ah-horizon.The grass vegetation grades into deciduous forest towards the north of the Chernozem belt where the Ah-horizon may overly an argic B-horizon (Luvic Chernozems) or even tongue into the B-horizon (Glossic Chernozems).

Mineralogical-The mineral composition of Chernozems is rather uniform throughout the profile, in line with the high rate of homogenization of the soil material. The SiO_2/R2O-ratio is high, at about 2.0.

Hydrological- it is widely accepted that Chernozems formed under conditions of good drainage, there are also (Russian) soil scientists who maintain that certain Chernozems passed through a boggy phase of soil formation. Chernozems are well drained, apart from soils in depressions with occasional shallow

Physical-Chernozems possess favourable of pore volume of the Ah-horizon ,humus-rich in Ah-horizon represents a favourable combination of capillary and non-capillary porosity and makes these soils highly suitable for irrigated farming.