E-PG PATHSHALA IN EARTH SCIENCE

Content Writers Template

1. Details of Module and its Structure

Module details	
Subject Name	Earth Science
Paper Name	Stratigraphy and sedimentology
Module Name/Title	**Sedimentary Structures**
Module Id	ES 251
Pre-requisites	Before learning this module, the users should be aware of • The types of sedimentary rocks • Mode of formation of sedimentary rocks • Sediment generation, Transportation and depositional processes
Objectives	**Objectives:** The aim of this lesson is to introduce the sedimentary structures. The objectives of learning this module are to highlight the following: a) Identification of various structures on sedimentary rocks b) Mechanism of structures formed in sedimentary rocks c) Pre and post depositional process of sediments. After attending this module, the learner will be able to explain about the various types of sedimentary structures and its importance in stratigraphic construction and geologic interpretation. Sedimentary structures are key to defining depositional environments, geological history, and surface processes.
Keywords	bedding, deformation, deposition, erosion, interbed, intrabed, sediment

2. Structure of the Module-as Outline : Table of Contents only (topics covered with their sub-topics)

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2.0 E-text (as per table of contents)

SEDIMENTARY STRUCTURES

1. INTRODUCTION

Sedimentary structures are important attributes of sedimentary rocks. They occur on the upper and lower surfaces of beds as well as within beds. They can be used to deduce the processes and conditions of deposition, the directions of the currents which deposited the sediments.

Secondary sedimentary structures are those that formed sometime after sedimentation. They result from essentially chemical processes, such as those which lead to the diagenetic formation of concretions. Primary sedimentary structures are divisible into inorganic structures, including those already mentioned and organic structures, such as burrows, trails, and borings.

Sedimentary structures are arbitrarily divided into primary and secondary classes. Primary structures are those generated in sediment during or shortly after deposition.

2. PRIMARY STRUCTURES

Three main groups can be defined by their morphology and time of formation (Table 1.1).

Table.1.1. Classification of Inorganic Megascopic Primary Sedimentary Structures

Group	Examples	Origin
I. Predepositional (interbed)	Channels Sole marks Flute marks Groove marks	Predominantly erosional
II. Syndepositional (intrabed)	Massive Flat-bedding (including parting lineation) Graded bedding Cross-bedding Lamination Cross-lamination	Predominantly depositional
III. Postdepositional (deform interbed and intrabed structures)	Slump Slide Convolute lamination Convolute bedding Recumbent foresets Load structures	Predominantly deformation
IV. Miscellaneous	Rain prints Shrinkage cracks	

The first group of structures is predepositional with respect to the beds that immediately overlie them. These structures occur on surfaces between beds. Geopedants may prefer to term them interbed structures, though they were formed before the deposition of the overlying bed. This group of structures largely consists of erosional features such as scour-and-fill, flutes, and grooves. These are sometimes collectively called sole marks or bottom structures.

The second group of structures is syndepositional in time of origin. These are depositional bed forms like cross-lamination, cross-bedding, and flat-bedding. To avoid a genetic connotation, this group may be collectively termed intrabed structures, to distinguish them from predepositional interbed phenomena.

The third group of structures is postdepositional in time of origin. These are deformational structures that disturb and disrupt pre- and syndepositional inter- and intrabed structures. This third group of structures includes slumps and slides.

2.1. PREDEPOSITIONAL SEDIMENTARY STRUCTURES

Predepositional sedimentary structures occur on surfaces between beds. They were formed before the deposition of the overlying bed. The majority of this group of structures are erosional in origin.

2.1.1. Channels

The largest predepositional interbed structures are channels. These may be kilometres wide and hundreds of meters deep. They occur in diverse environments ranging from subaerial alluvial plains to submarine continental margins. Channeling is initiated by localized linear erosion by fluid flow aided by corrosive bed load.

Channels are of great economic importance for several reasons. They can be petroleum reservoirs and aquifers, they can contain placer and replacement mineral ore bodies, and they can cut out coal seams.

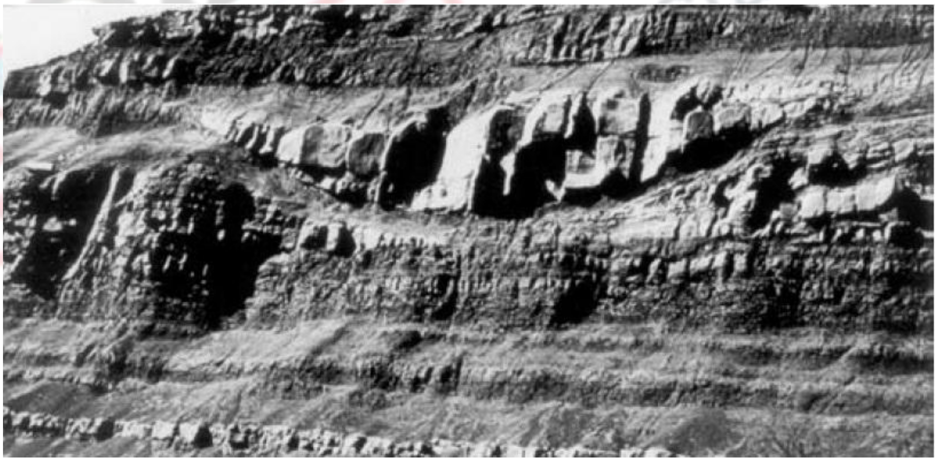

Figure.2.1. Fluvial channel filled with coarse sand, cutting down into finer sandstones and mudrocks.

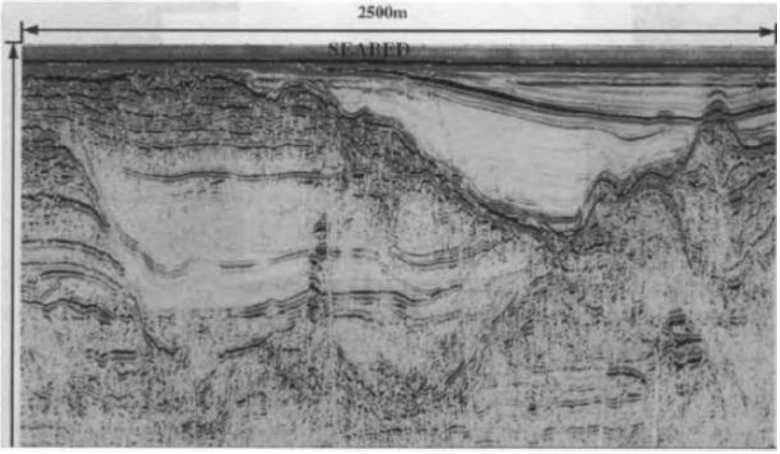

Figure.2.2. Ultra-high-resolution seismic line showing multistory channel structures.

2.1.2. Sole marks

Sole marks are erosional sedimentary structures on a bed surface that have been preserved by subsequent burial

- Scour marks (caused by erosive turbulence)
- Tool marks (caused by imprints of objects)

Figure.2.3. Sole marks

Scour-and-fill

Smaller and less dramatic are the interbed structures termed scour-and-fill. These are small scale channels whose dimensions are measured in decimetres rather than meters. They too occur in diverse environments.

Figure.2.4. Scour-and-fill structure

Tool Marks

Tool marks are erosional bottom structures that can be attributed to moving clasts. These are erosional features cut in soft mud bottoms like flutes and grooves. They are, however, extremely irregular in shape, both in plan and cross-section, though they are roughly oriented parallel with the paleocurrent. In ideal circumstances it has been possible to find the tool which cut these markings at their down current end.

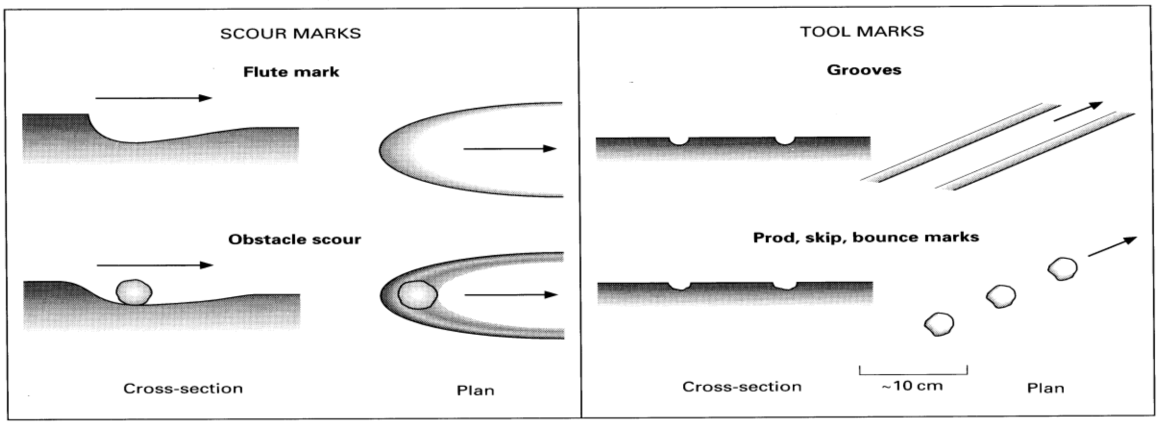

Figure.2.5. Score marks and Tool marks

2.1.3. Flute Marks

Flutes are heel-shaped hollows, scoured into mud bottoms. Each hollow is generally in filled by sand, contiguous with the overlying bed (Fig. 5.7). The rounded part of the flute is at the up current end. The flared end points are down current. Flutes are about 1-5 cm wide and 5-20 cm long.

Figure.2.6. Flute marks on under surface of a siliciclastic turbidity bed

2.1.4. Groove Marks

The second important type of erosional interbed structure is groove marks. These, like flutes, tend to be cut into mud and overlain by sand. They are long, thin, straight erosional marks. They are seldom more than a few millimetres deep or wide, but they may continue uninterrupted for a meter of more (Fig. 5.9). In cross-section, the grooves are angular or rounded. Grooves occur where sands overlie muds in diverse environmental settings.

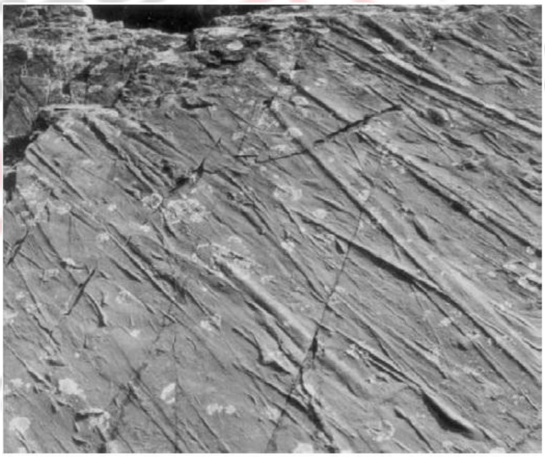

Figure.2.7. Groove marks on under surface of siliciclastic turbidity

2.2. SYNDEPOSITIONAL (INTRABED) STRUCTURES

Syndepositional structures are those actually formed during sedimentation. They are therefore, essentially constructional structures that are present within sedimentary beds.

Bedding, stratification, or layering is probably the most fundamental and diagnostic feature of sedimentary rocks. Bedding is due to vertical differences in lithology, grain size, or, more rarely, grain shape, packing, or orientation. A useful rule of thumb definition is that beds are distinguished from one another by lithological changes. Shale beds thus typically occur as thick uninterrupted sequences. Sandstones and carbonates, though they may occur in thick sections, are generally divisible into beds by shale laminae.

Synsedimentary intra-bed structures are of five categories:

i. Bedding and Lamination
ii. Graded bedding
iii. Cross-bedding
iv. Cross-lamination

An apparent absence of any form of sedimentary structure is found in various types of sedimentation unit. It is due to a variety of causes. First, a bed may be massive due to diagenesis. This is particularly characteristic of certain limestones and dolomites that have been extensively recrystallized. Secondly, primary sedimentary structures may be completely destroyed in a bed by intensive organic burrowing.

2.2.1. Bedding and lamination

Bedding and lamination define stratification. Bedding is thicker than 1 cm whereas lamination is thinner than 1 cm. Bedding is composed of beds; lamination is composed of laminae. Parallel (also called planar or horizontal) lamination is a common internal structure of beds.

Table.2.1. Terminology of bed thickness.

	very thickly bedded
1 m	
	thickly bedded
0.3 m	
	medium bedded
0.1 m	
	thinly bedded
30 mm	
	very thinly bedded
10 mm	
	thickly laminated
3 mm	
	thinly laminated

Beds also vary in their shape and definition so that planar, wavy and curved types are recognised, and these may be parallel to each other, non-parallel or discontinuous

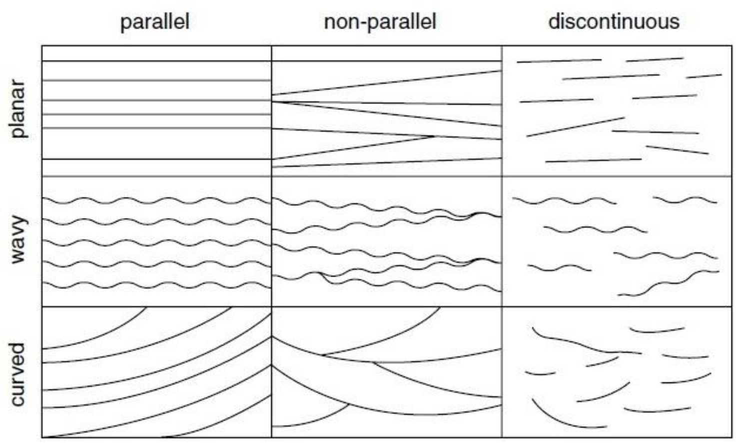

Figure.2.8. Different types of bedding or lamination

Massive Bedding

Genuine depositional massive bedding is often seen in fine-grained, low-energy environment deposits, such as some clay stones, marls, chalks, and calcilutites. Reef rock (biolithite) also commonly lacks bedding. In sandstones massive bedding is rare. It is most frequently seen in very well-sorted sands, where sedimentary structures cannot be delineated by textural variations.

Flat-Bedding

One of the simplest intrabed structures is flat- or horizontal bedding. This, as its name implies, is bedding that parallels the major bedding surface. It is generally deposited horizontally. Flat-bedding occurs in diverse sedimentary environments ranging from fluvial channels to beaches and delta fronts. It occurs in sand-grade sediment, both terrigenous and carbonate. This occurs under shooting flow or a transitional flow regime with a Froude number of approximately 1. Sand deposited under these conditions is arranged with the long axes of the grains parallel to the flow direction.

Moderately well-indurated sandstones easily split along flat-bedding surfaces to reveal a preferred lineation or graining of the exposed layer (Fig. 5.10). This feature is termed *parting lineation*.

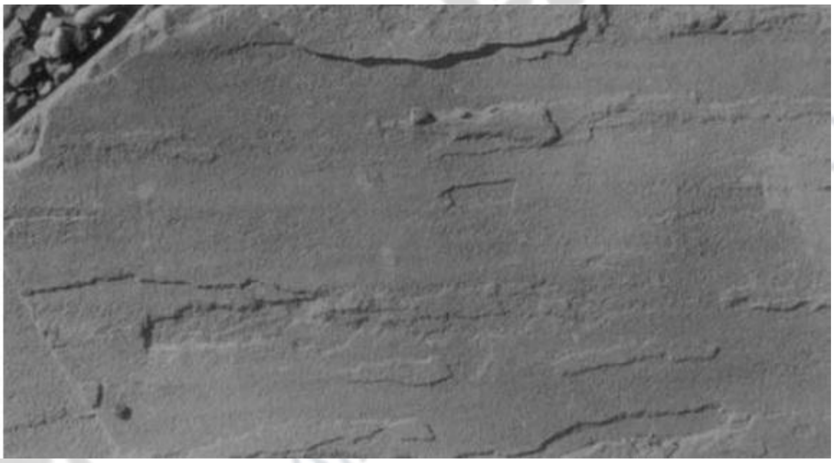

Figure.2.9. Parting lineation (or primary current lineation), trending from top to bottom of the photograph, in flat-bedded sandstone

2.2.2. Graded Bedding

A graded bed is one in which there is a vertical change in grain size. Normal grading is marked by an upward decrease in grain size (Fig. 5.12). Reverse grading is where the bed coarsens upward. There are various other types (Fig. 5.13). Graded bedding is produced as sediment settles out of suspension, normally during the waning phase of a turbidity flow (see Section 4.2.2). Though the lower part of a graded bed is normally massive, the upper part may exhibit the Bouma sequence of sedimentary structures.

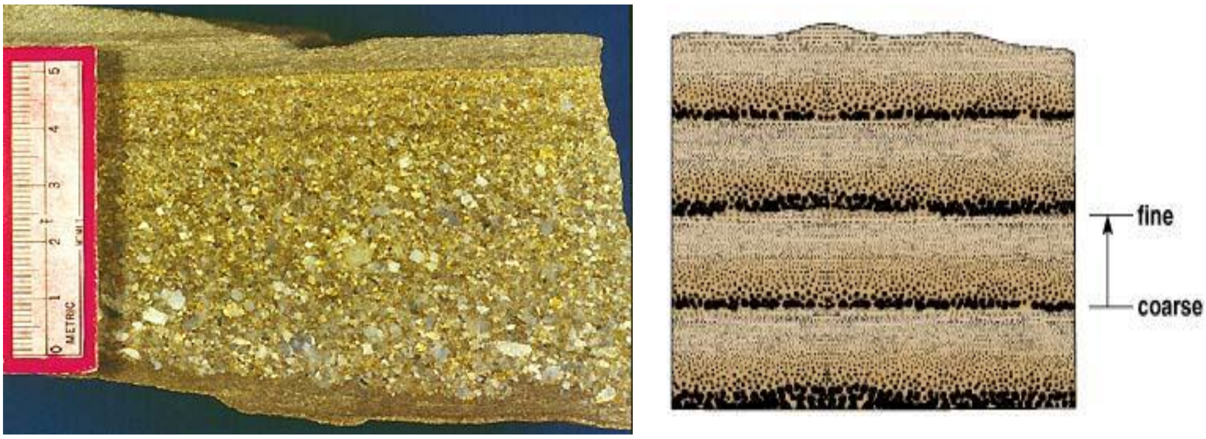

Figure.2.10. Graded Bedding

2.2.3. Cross-Bedding

Cross-bedding is one of the most common and most important of all sedimentary structures. It is ubiquitous in traction current deposits in diverse environments. Cross bedding, as its name implies, consists of inclined dipping bedding, bounded by sub horizontal surfaces. Each of these units is termed a set. Vertically contiguous sets are termed cossets (Fig. 5.14). The inclined bedding is referred to as a foreset. Foreset may grade down with decreasing dip angle into a bottom set or toe set.

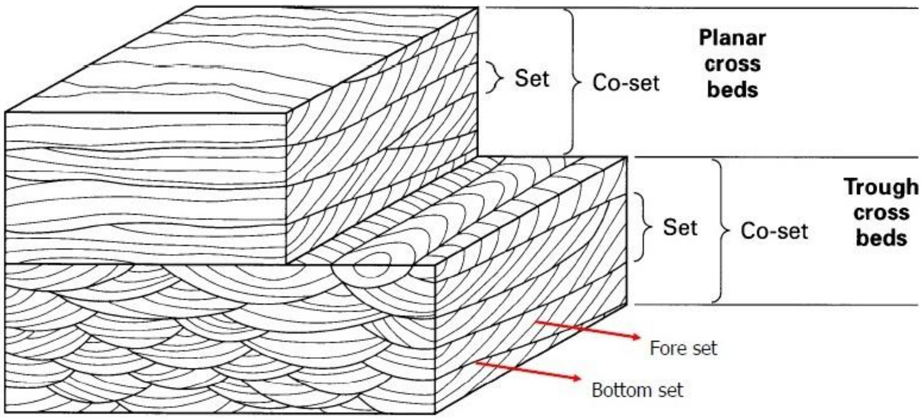

Figure.2.11. Tabular and Trough Cross beddings

Basically, two main types of cross-bedding can be defined by the geometry of the foreset and their bounding surfaces:

i. Planar or Tabular planar cross-bedding, and
ii. Trough cross-bedding.

In tabular planar cross-bedding, planar foreset are bounded above and below by sub parallel sub horizontal set boundaries (Fig. 5.15).

In trough cross-bedding, upward concave foreset lie within erosion scours which are elongated parallel to current flow, closed up current and truncated down current by further troughs.

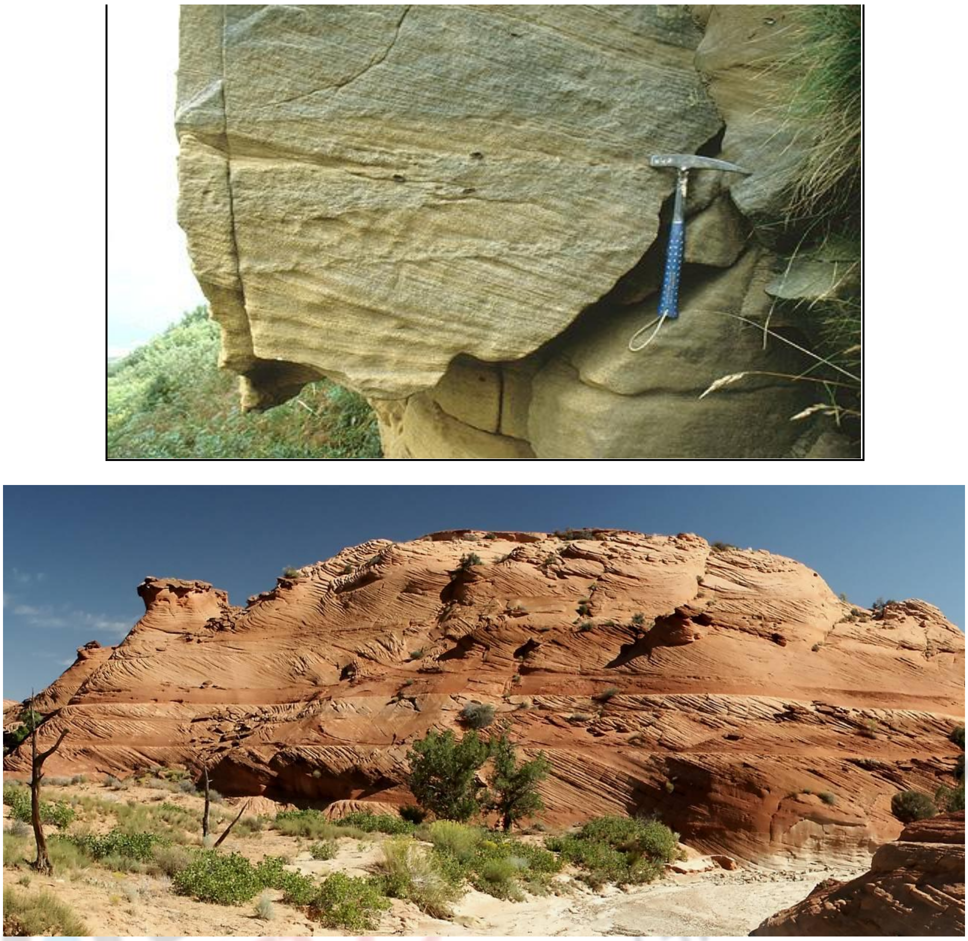

Figure.2.12. Cross bedding structures

Cross bedding is commonly found in

- Arenaceous Sediments
- Oolitic limestone
- Some type of Clastic limestone

2.2.4. Ripples and Cross-Lamination

Ripples are a wave-like bed form that occurs in fine sands subjected to gentle traction currents (Fig. 5.24). Migrating ripples deposit cross-laminated sediment. Individual exceed 2-3 cm in thickness, in contrast to cross-bedding, which is normally >50 cm thick. In cross-section ripples are divisible into those with symmetric and those with asymmetric profiles.

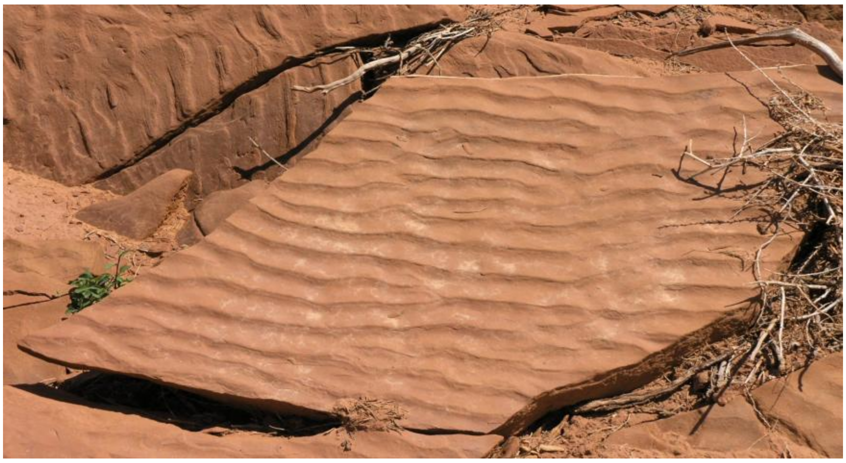

Figure.2.13. Ripple structure

Symmetrical ripples, also called oscillation or vortex ripples, are commonly produced in shallow water by the orbital motion of waves. In plan view they are markedly sub parallel, but occasionally bifurcate.

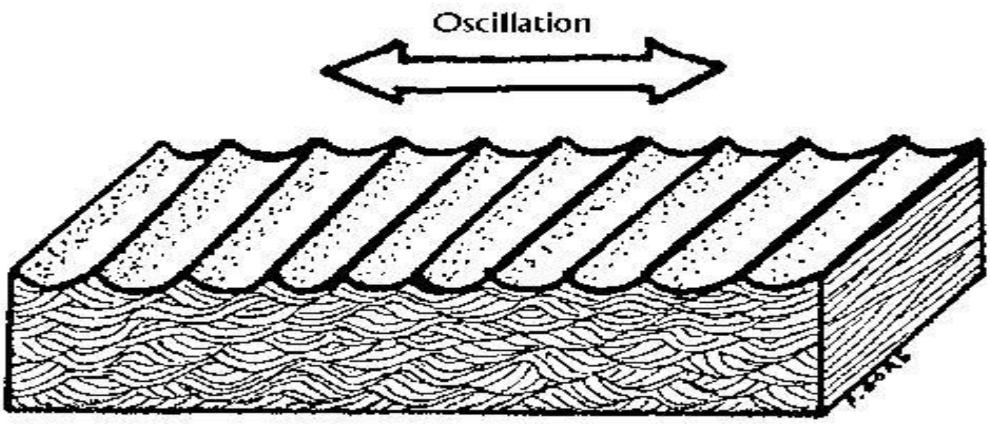

Figure.2.14. Symmetric ripple structure

Asymmetric ripples, by contrast to symmetric ones, show a clearly differentiated low angle stoss side and steep-angle lee side. Internally they are cross-laminated, with the cross-lamina concordant with the lee face. Asymmetric ripples are produced by unidirectional traction currents as, for example, in a river channel.

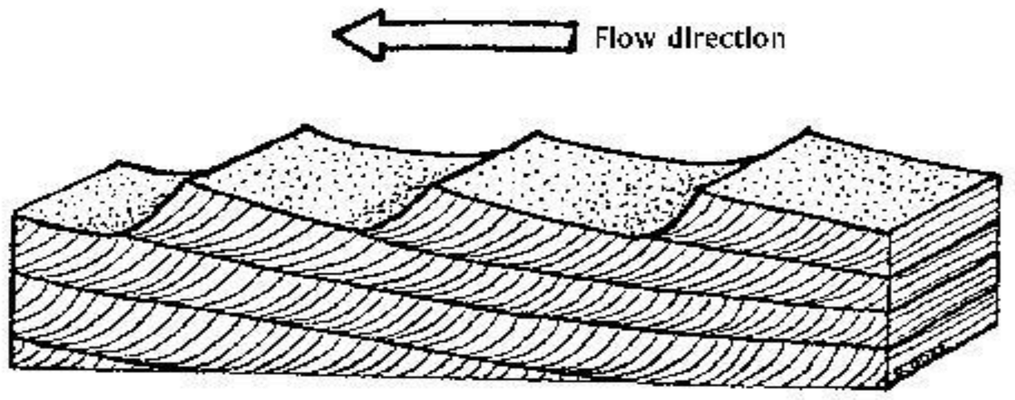

Figure.2.15. Asymmetric ripple structure

If a ripple is pointing downward it is called "Lunate"

If a ripple is pointing outward it is called "Linguoid"

The Characteristics features of ripples depending up on

- Current Velocity
- Particle Size
- Persistence of current direction
- Whether the fluid is air or water

2.2.5. Flaser, lenticular and wavy beddings

Flaser bedding

Flaser bedding is where cross-laminated sand contains mud streaks, usually in the ripple troughs. These are commonly forms in relatively high energy environments (sand flats).

Wavy bedding

Wavy bedding is where thin-ripple cross-laminated sandstones alternate with Mudrock are commonly forms in environments that alternate frequently from higher to lower energies (mixed flats).

Lenticular bedding

Lenticular bedding is where mud dominates and the cross-laminated sand occurs in lenses. They are commonly forms in relatively low energy environments.

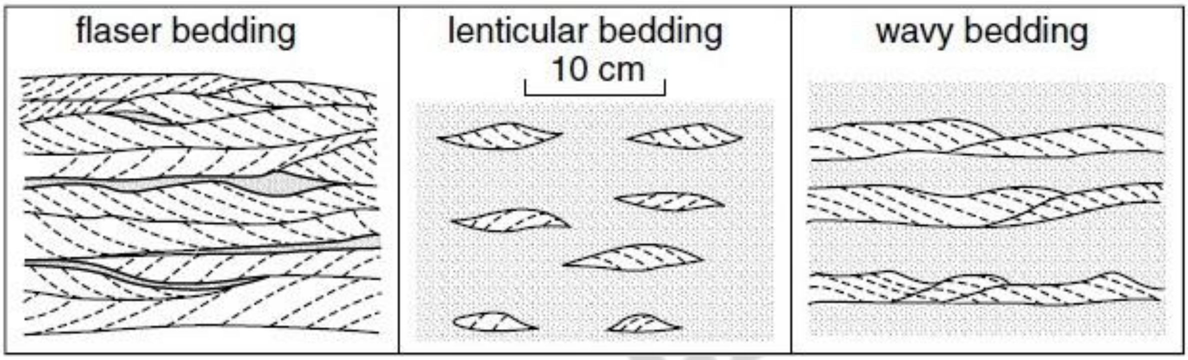

Figure.2.16. Sketches of flaser, lenticular and wavy bedding

2.2.6. Reactivation surfaces

With some cross-bed sets, careful observation will show that there are erosion surfaces within them, cutting across the cross-strata. These *reactivation surfaces* represent short-term changes in the flow conditions which caused modification to the shape of the bed form.

2.2.6.1. Tidal cross-bedding

There are several features of cross-bedding which indicate deposition by tidal currents. Herringbone cross-bedding refers to bipolar cross-bedding, where cross-bed dips of adjacent sets are oriented in opposite directions. Herringbone cross-bedding is produced by reversals of the current, causing dunes and sand-waves to change their direction of migration.

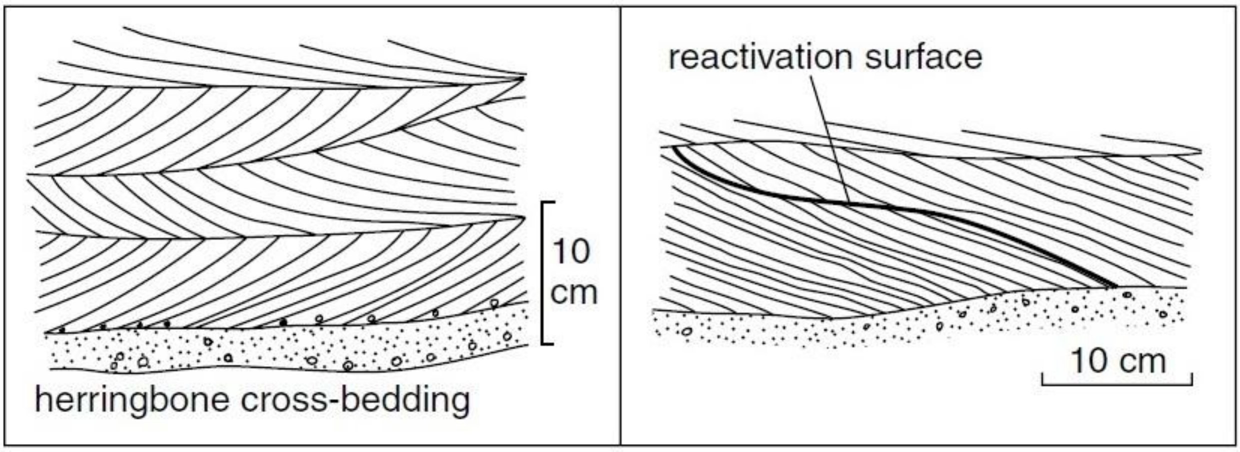

Figure.2.17. Herringbone cross-bedding and a reactivation surface incross-bedding

2.2.6.2. Storm bedding: hummocky cross-stratification (HCS), swaley cross-stratification (SCS)

HCS and *SCS* are two particular types of cross-stratification in sand-grade sediment, widely thought to be the result of storm waves and deposition in the outer shore face and transition zone between fair-weather wave-base and storm wave-base.

Hummocky cross-stratification (HCS) is characterised by a gently undulating low-angle (<10–15◦) cross-lamination with the convex upward part the hummock and concave-downward part the swale (Figs 5.27 and 5.28). The spacing of the hummocks is several tens of centimetres to 1 m or more and in plan view they have a domed shape.

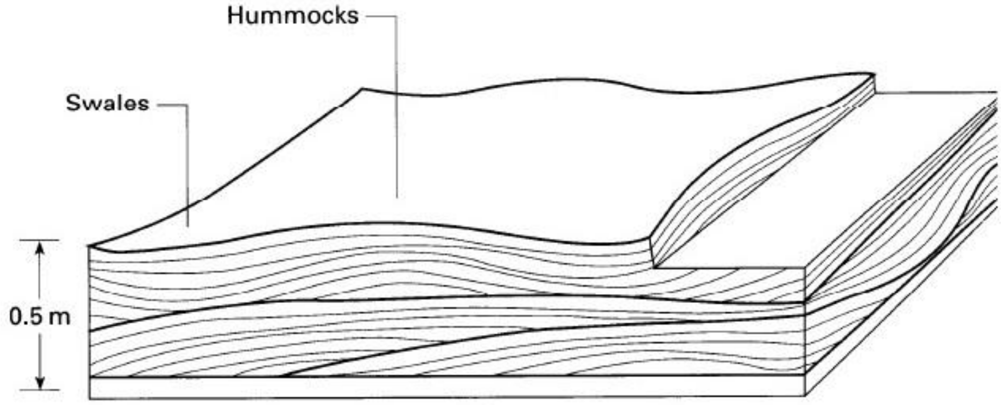

Figure.2.18. Hummocky cross-stratification structure

2.2.7. Gravity-flow deposits

2.2.7.1. Debris-flow deposits

Debris-flow deposits are typically poorly sorted, matrix-supported sediments with random clast orientation and no sedimentary structures; thickness and grain size commonly remain unchanged in a proximal to distal direction

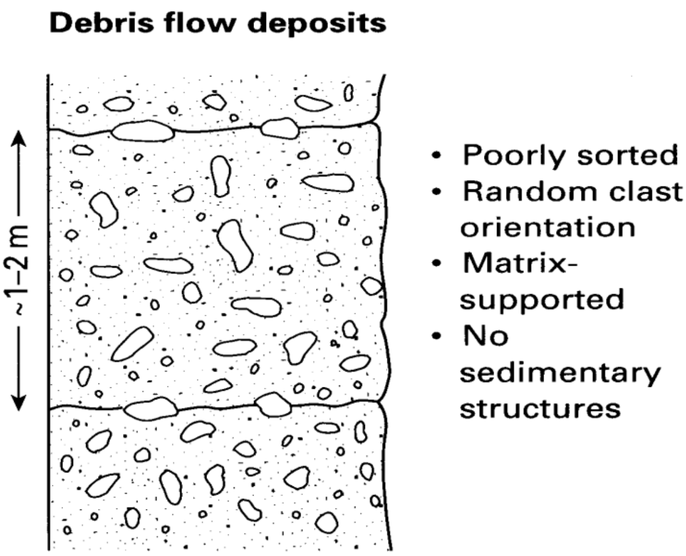

Figure.2.19. Debris-flow deposits

2.2.7.2. Turbidites

These deposits formed by turbidity currents, are typically normally graded, ideally composed of five units (Bouma-sequence with divisions ‘a’-‘e’), reflecting decreasing flow velocities and associated bed forms

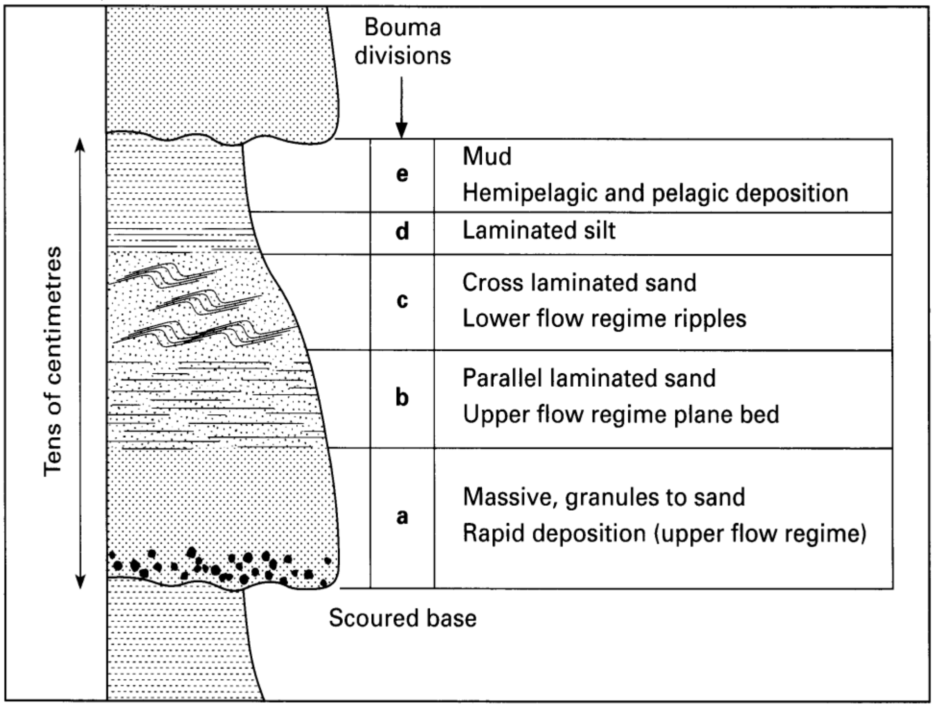

Figure.2.20. Turbidites

2.2.7.3. Imbrication

Imbrication commonly occurs in water-lain gravels and conglomerates, and is characterized by discoid (flat) clasts consistently dipping upstream

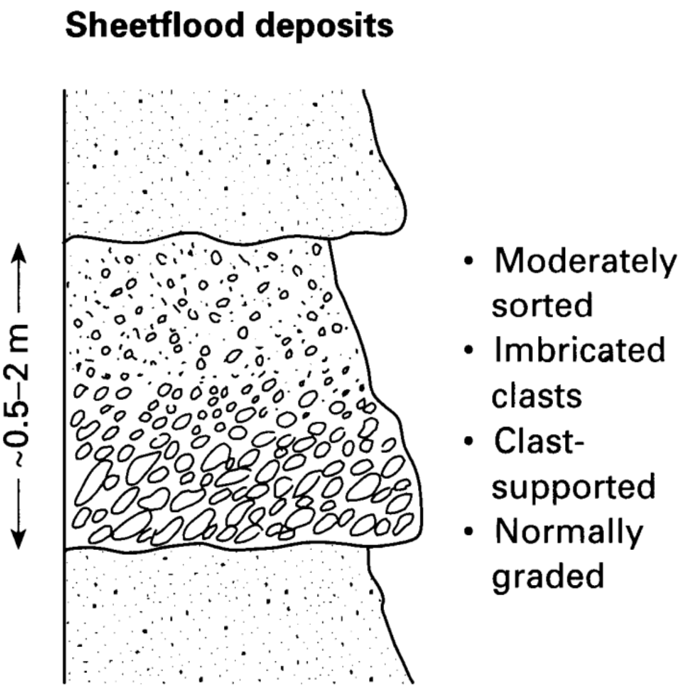

Figure.2.21. Imbrication structure

2.3. POSTDEPOSITIONAL SEDIMENTARY STRUCTURES

The third main group of sedimentary structures is a result of deformation. These may be termed postdepositional because, obviously, they can only form after sediment has been laid down.

Table.2.2. Classification of Postdepositional Deformational Sedimentary Structures

Sense of movement	Structure	Nature of deformation
Dominantly vertical	Load casts, Dish structure, and Ball and Pillow structures, Convolute bedding, recumbent foresets, convolute lamination	Plastic (sediments lack shear strength)
Dominantly horizontal	Slumps Slides	Brittle (sediments possess shear strength)

2.3.1. Vertical Plastic Deformational Structures

Deformational structures that involve vertical plastic movement of sediment are of two main types. One group occurs within sand beds and may be loosely referred to as quicksand structures. Structures of the second group develop at the interfaces of sand overlying mud.

A variety of structures develop where sands overlie muds. The mud: sand interface is often deformed in various ways. Most typically irregular-rounded balls of sand depend from the parent sand bed into the mud beneath. These structures are variously termed load casts, ball and pillow structures, etc. They are a variety of the broad group of structures termed sole markings or bottom structures.

2.3.1.1. Load Structure: Load Cast Generation

- Sole marking generally preserved on the lower side of the sand layer overlying the mud layer
- Often associated with turbidities with a thin layer of coarser sediment on the top.
- Can also be defined as a bulbous depression formed on the base of a bed of sediment
- Developed by the differential sinking of the sediment, while still soft, into less dense sediment below.

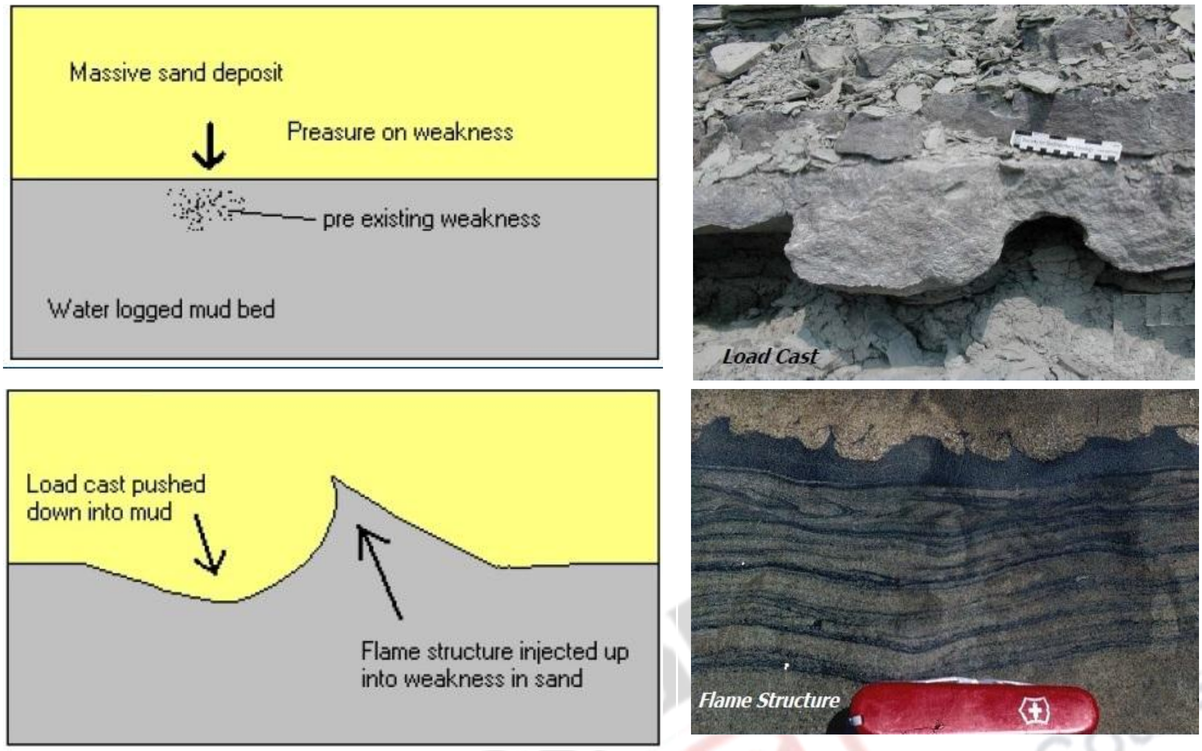

Figure.2.22. Load Structure: Load Cast & Flame Structure

2.3.1.2. Dish structure

These consist of concave-up laminae, generally a few centimetres across, which may be separated by structureless zones (the pillars). Dish structures and dish-and-pillar structures are formed by the lateral and upward passage of water through sediment.

Dish structure is a particular variant of intra sand deformation. This is seen where lamina or bedding planes are intermittently disrupted and upturned like the rim of a dish. Dish structure is a type of dewatering phenomenon that is particularly characteristic of fluidized sand beds.

Figure.2.22. Dish structure

2.3.1.3. Ball and Pillow structure

As a result of loading, a bed, usually of sand, can sink into an underlying mud and break up into discrete masses, forming the so-called *ball-and-pillow* structure.

Figure.2.23. Ball and Pillow structure

2.3.1.4. Convolute bedding

Quicksand structure involves the deformation of whole beds of sand up to a meter or more thick (Fig. 5.28). It is loosely referred to as *convolute bedding*. On a smaller scale, laminated fine sands and silts also show penecontemporaneous vertical deformation structures termed convolute lamination. This is similar in geometry to convolute bedding, but occurs in finer grained sediment on a much smaller scale; generally in beds only a decimetre or so high.

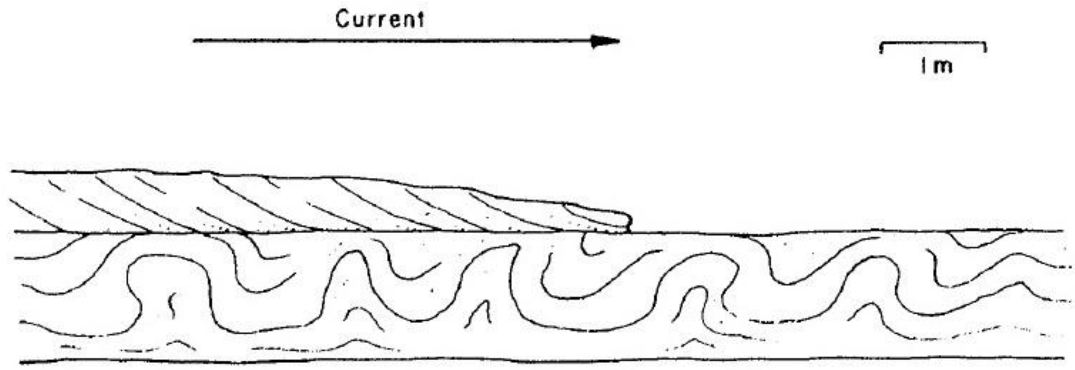

Figure.2.24. Convolute bedding due to the expulsion of pore water from loosely packed sand

2.3.1.5. Recumbent foreset

These structures are caused by the vertical passage of water through loosely packed sand. This water may be due to a hydrostatic head of water, for example, as is seen on an alluvial fan (e.g., Williams, 1970). Alternatively, the water may be derived from the sediment itself. Sand will not compact significantly at the surface, but its grains may be caused to fall into a tighter packing. This results in a decrease in porosity.

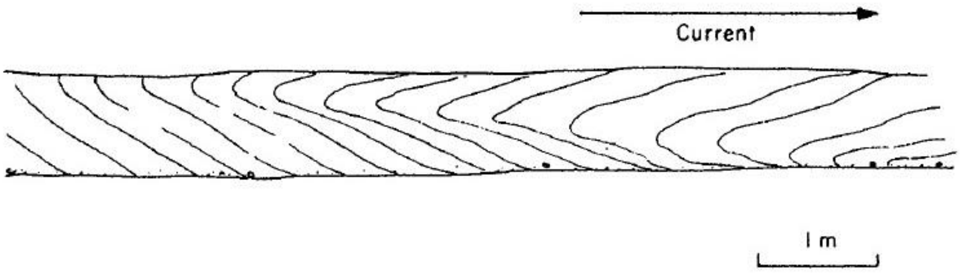

Figure.2.25. Recumbent foreset deformation in fluvial sandstone

2.3.1.6. Convolute lamination

Laminated fine sands and silts also show penecontemporaneous vertical deformation structures termed convolute lamination. This is similar in geometry to convolute bedding, but occurs in finer grained sediment on a much smaller scale; generally in beds only a decimetre or so high. Convolute lamination is especially characteristic of turbidites, involving deformation of both the laminated and cross-laminated Bouma units.

2.3.2. Horizontal Deformational Structures

2.3.2.1. Slumps and Slides

Slump structures, like the structures, involve the penecontemporaneous plastic deformation of sand and mud. Slump folds, however, commonly show clear evidence of extensive lateral movement in a consistent direction. Slump folds are commonly associated with penecontemporaneous faulting and with major low angle zones of decollement termed "slide planes."

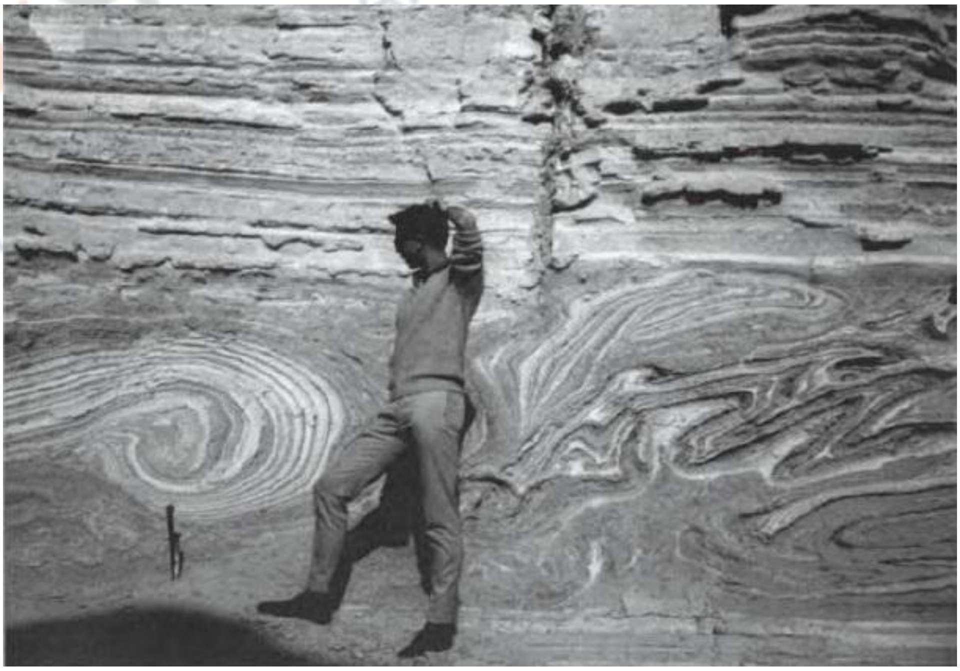

Figure.2.26. Slump structure

2.4. MISCELLANEOUS STRUCTURES

Among the vast number of sedimentary structures that have been observed, many do not fit conveniently into the simple tripartite scheme outlined earlier. These miscellaneous structures include rain prints, salt pseudomorphs, and various vertical dike-like structures of diverse morphology and origin. These include desiccation cracks, synaeresis cracks, sedimentary boudinage, and sand dikes.

2.4.1. Rain Prints

Rain prints occur within siltstones and clay stones, and where such beds are overlain by very fine sandstones. In plan view, rain prints are circular or ovate if due to windblown rain. They are typically gregarious and closely spaced. Raised ridges are present around each print. Individual craters range from 2 to 10 mm in diameter. Rain prints are good indicators of subaerial exposure but are not exclusive to arid climates, though they may have a higher preservation potential in such conditions.

Figure.2.27. Rain spots on surface of mudstone

2.4.2. Salt Pseudomorphs

Salt pseudomorphs occur in similar lithological situations to rain prints. They are typically found where clay stones or siltstones are overlain by siltstones or very fine sandstones.

2.4.3. Desiccation Cracks

A variety of vertical planar structures have been recognized in sediments, these include shrinkage cracks, sedimentary dikes, and Neptunean dikes. Shrinkage cracks are often recorded in muddy sediments. They are of two types. Desiccation cracks form subaerially; synaeresis cracks form subaqueously.

Desiccation cracks, also known as sun cracks, are downward tapering cracks in mud, which are infilled by sand. In plan view they are polygonal. Individual cracks are a centimetre or so wide. Polygons are generally about 0.5 m across

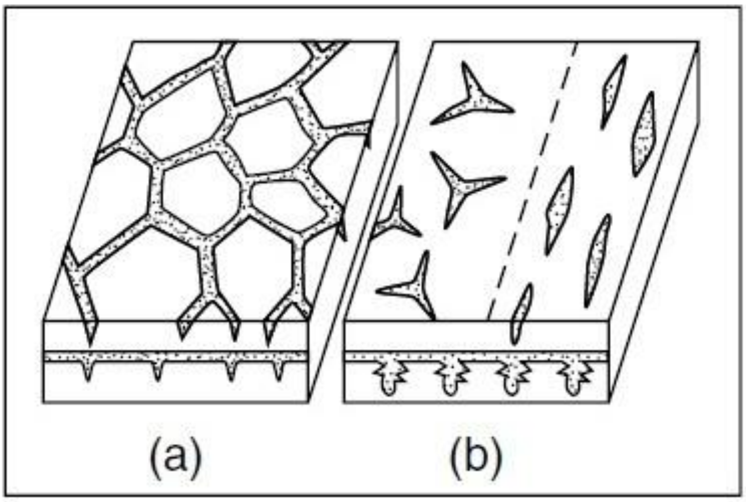

Figure.2.28.Shrinkage cracks: (a) formed by desiccation, (b) formed through syneresis

2.4.3.1. Synaeresis Cracks

Synaeresis cracks are formed in mud by the spontaneous dewatering of clay beneath a body of water (White, 1961; Plummer and Gostin, 1986). They are distinguishable from desiccation cracks because they are infilled by mud similar or only slightly coarser in grade than that in which they grow. Furthermore, synaeresis cracks are generally much smaller than desiccation cracks; typically only 1-2 mm across.

Figure.2.29. Syneresis cracks in muddy limestone

2.4.4. Sand Dikes

Sand dikes are vertical sheets of sand that have been intruded into muds from sand beds beneath. Though they are sometimes polygonally arranged, they can be distinguished from desiccation cracks by their tendency to die out upward and by the fact that they are rooted to the parent sand bed below. Sand dikes are intruded as liquefied quicksand into water-saturated mud. Like desiccation cracks, they often show ptygmatic compaction effects.

3. SECONDARY STRUCTURES

3.1. CHEMICAL SEDIMENTARY STRUCTURES

Chemical sedimentary structures are formed by chemical processes, such as oxidation-reduction, precipitation, evaporation, etc.

3.1.1. Cone in cone structures

It is a structure commonly found in fibrous calcite and fibrous gypsum sediments. It has the appearance of a series of cones packed the one inside the other. This structure appears to be due to pressure.

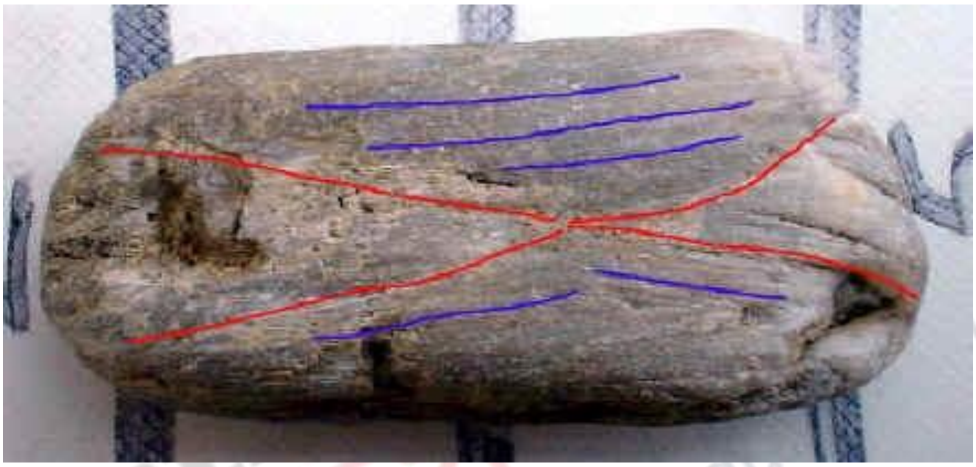

Figure.3.1. Cone in cone structure

3.1.2. Stylolites

It is formed by the erosional activity of ground water. When the Co_2 rich water percolate through the bedding plane of L.st rock, soluble parts are removed and away and insoluble parts exist there. They appear as a irregular structure zig zag line of junction between them. This type of structure is called STYLOLITES.

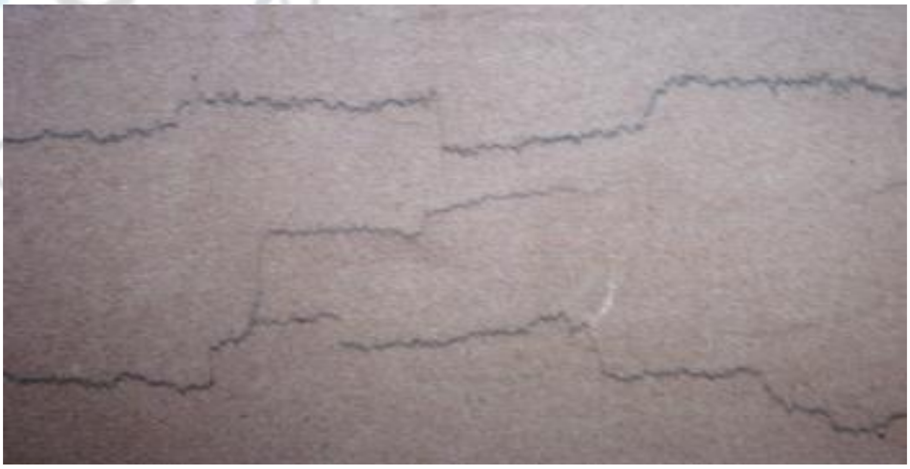

Figure.3.2. Stylolite structure

3.1.3. Concretionary structures

Concretions consist of round or irregular masses of more resistant rock formed as a result of cement precipitating around a core material, usually a fossil or grain of a different composition.

Figure.3.3. Concretionary Structure

There are two types of Concretionary Structures

i. **Oolitic Structures**

Oolites are small (0.1-1mm), concentrically layered, spherical grains composed of primary carbonate materials or replacement phases.

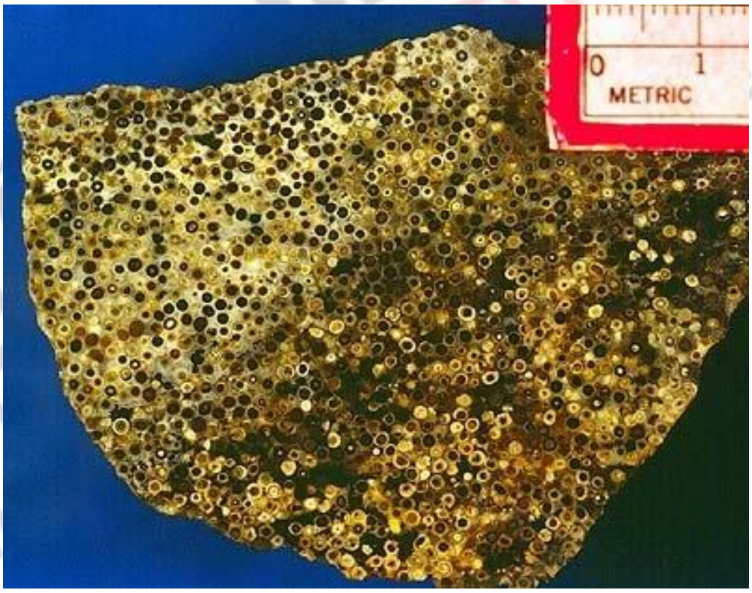

Figure.3.4. Oolitic structure

ii. **Pisolitic Structures**

Individual size of a concretion is like that of a pea nut. Lime stone and Bauxite shows both structure.

Figure.3.5. Pisolitic structure in Bauxite

3.1.4. Geode

It is a structure formed by the depositional activity of ground water. It is a cavity in rocks, lined with well developed crystals of quartz projecting towards the centre.

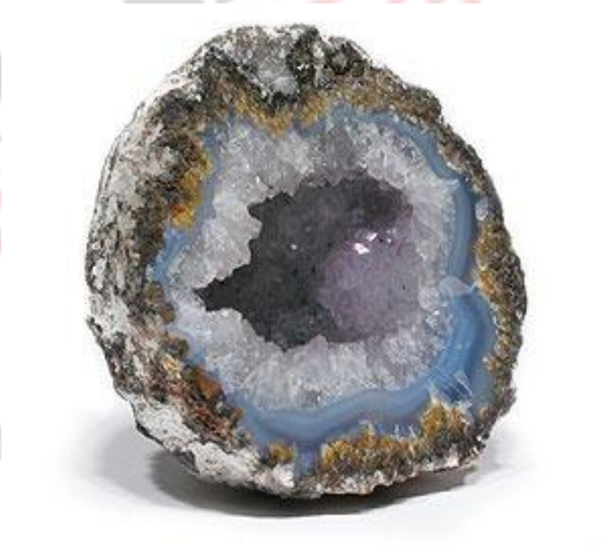

Figure.3.6. Geode structure

3.1.5. Vugh

It is a cavity in a rock usually with lining of crystalline minerals. The term used especially of cavities in mineral veins.

Figure.3.7. Vugh structure

3.1.6. Crystal casts

Crystal casts are formed when a soluble crystal (i.e. salt) dissolves in solution, followed by filling of mud or sand in its place.

Figure.3.8. Crystal casts

3.2. BIOGENIC SEDIMENTARY STRUCTURES

Biogenic sedimentary structures are features which are formed by biological activity.

3.2.1. Stromatolites

These are biogenic laminated structures which have a great variety of growth forms. They develop through the trapping and binding of carbonate particles by a surficial *microbial mat* ('algal mat') composed mainly of cyanobacteria (formerly called blue-green algae) and other microbes, and the biochemical precipitation of carbonate. Stromatolites are very common in Precambrian carbonate successions but they also occur in many Phanerozoic limestones, particularly those of peritidal origin.

Stromatolites are finely laminated algal accumulations (>10cm in diameter) that result when algae grow upwards trapping carbonate mud into thin layers.

Figure.3.9. Stromatolite structure

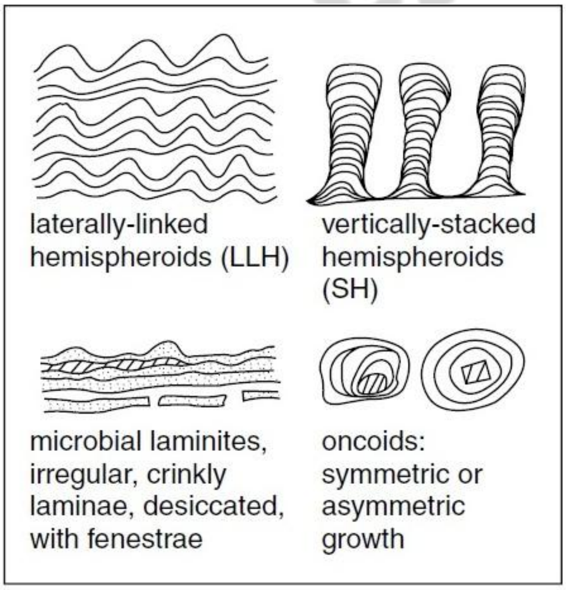

Figure.3.10. Four common stromatolitic structures: domal, columnar and planar stromatolites, and oncolites.

3.2.2. Escape structures

Escape structures are columns, holes, or tubes that cut across bedding and are in filled with sediment after the escape of water or a burrowing organism that had been trapped beneath a newly deposited sediment layer.

Figure.3.11. Escape Structure

3.2.3. Reefs

Reefs are dome to elongate, massive to bedded forms built during carbonate deposition by organisms that biogenetically precipitate carbonate materials.

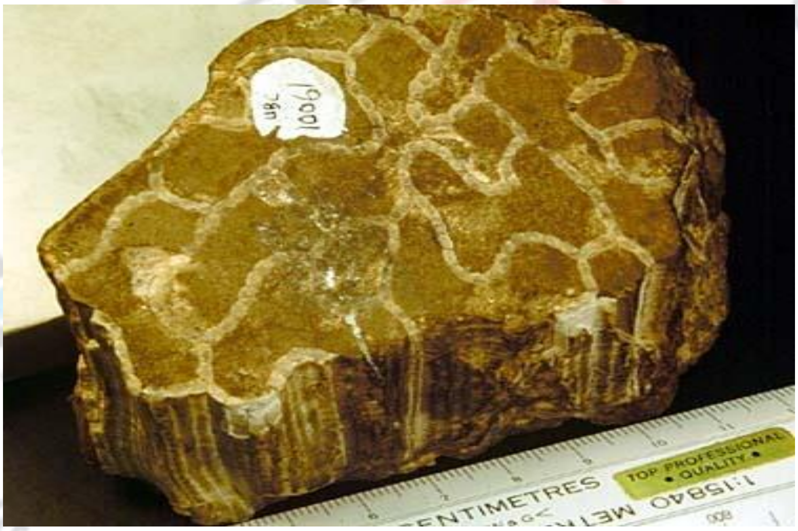

Figure.3.12. Reef Stricture

3.2.4. Casts and moulds

Any depression formed on the bottom of a body of water may become a *mold* for any sediment that later gets deposited into the depression. The body of sediment that takes on the shape of the mold is referred to as a *cast*.

3.2.5. Tracks

Tracks or footprints are impressions on the surface of a bed of sediment produced by the feet of animals.

Examples include dinosaur footprints or bird tracks.

In some cases, tracks are found as sole marks on the bottoms of beds, where sediment has infilled the tracks, and preserved them as casts.

Figure.3.13. Tracks on the surface of a bed of sediment

3.2.6. Trails

Trails are groove-like impressions on the surface of a bed of sediment produced by an organism which crawls or drags part of its body. Trails may be straight or curved.

Figure.3.14. Trails on the surface of a bed of sediment

3.2.7. Burrows and Borings

Burrows are excavations made by animals into soft sediment. Burrows may be used by organisms for dwellings, or may be produced as a subterranean organism moves through the soil or sediment in search of food.

Burrows are commonly filled in by sediment of a different color or texture than the surrounding sediment, and in some cases, the burrows may have an internally laminated backfilling. Burrow fillings may become cemented and hard, weathering out of the rock in rope-like patterns.

Figure.3.15. Burrow structure in Triassic rocks

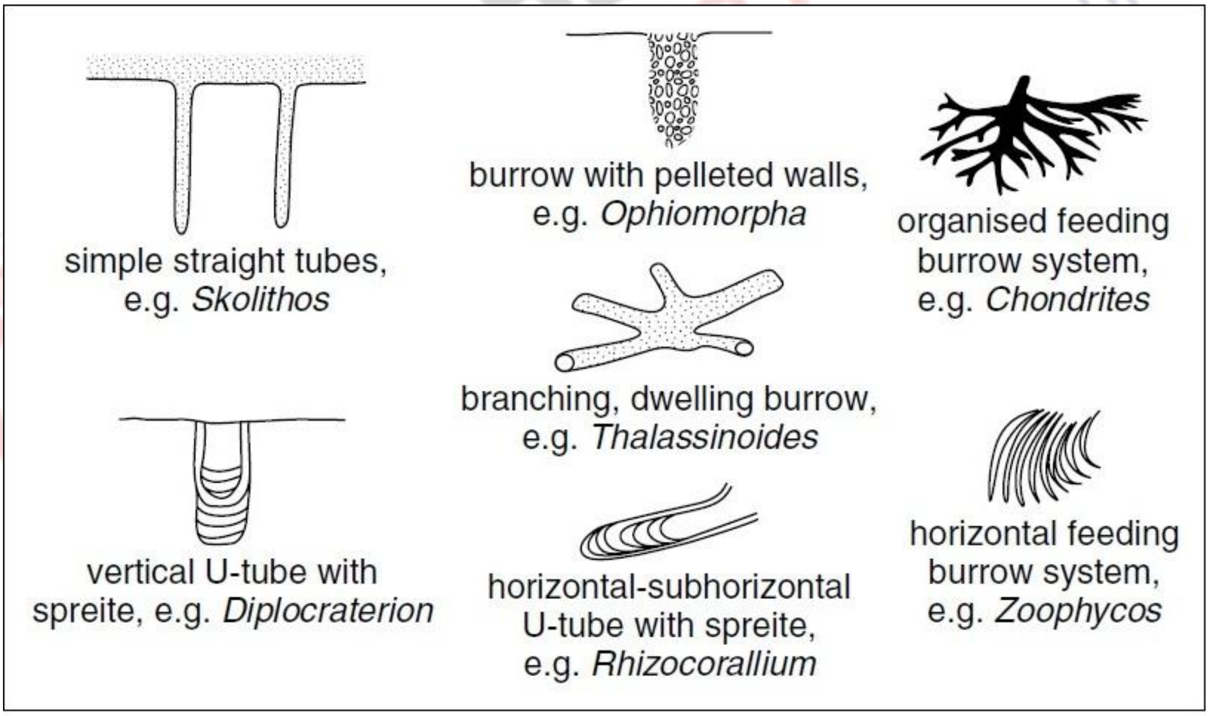

Figure.3.16. Types of common dwelling and feeding burrows

Borings are holes made by animals into hard material, such as wood, shells, rock, or hard sediment. Borings are usually circular in cross-section.

3.0 Summary

Sedimentary structures are macroscopic three-dimensional features of sedimentary rocks recording processes occurring during deposition or between deposition and lithification. They are probably the most critical means of interpreting sedimentary and post-depositional processes. Their recognition and application are key to defining depositional environments, geological history, and surface processes. Sedimentary structures function as, a.Geopetal structures: indicators of original verticality, b. Directional structures: indicators of current direction and c.Identifiers of the agent of transport. Primary sedimentary structures are occur in clastic sediments and produced by the same processes (currents, etc.) that caused deposition. This includes plane bedding and cross-bedding. Secondary sedimentary structures are caused by post-depositional processes, including biogenic, chemical, and mechanical disruption of sediment.

4.0 Name of the ppt file attached : Sedimentary Structures