Primary Sedimentary Structures

The sedimentary structures which are formed at the time of deposition but prior to lithification are known as primary sedimentary structures.

Bed internal features:

Stratification: Structural layering form due to variation in colour, composition, hardness, compaction etc or any combination of these.

If the thickness of stratification is

>1cm: Bed
<1cm: Lamination

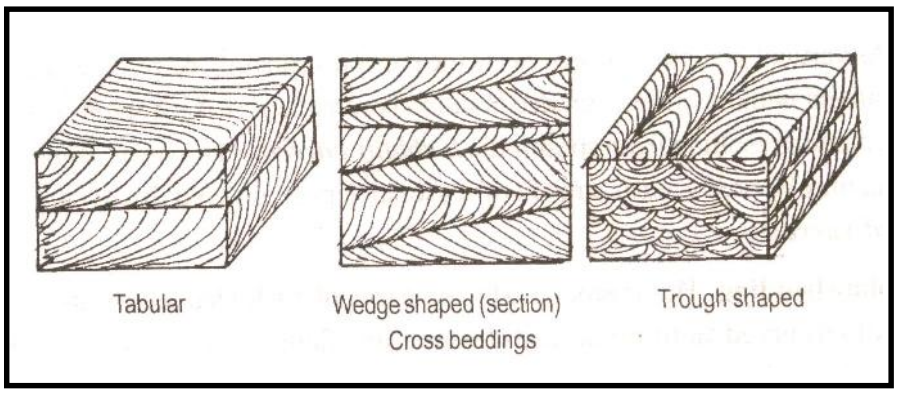
***Bed*:**Single depositional unit and the smallest division of a stratified rock series, marked by a well-defined divisional plane from its neighbors above and below.
***Bedding*:** Condition where planes divide sedimentary rocks of the same or different lithology.

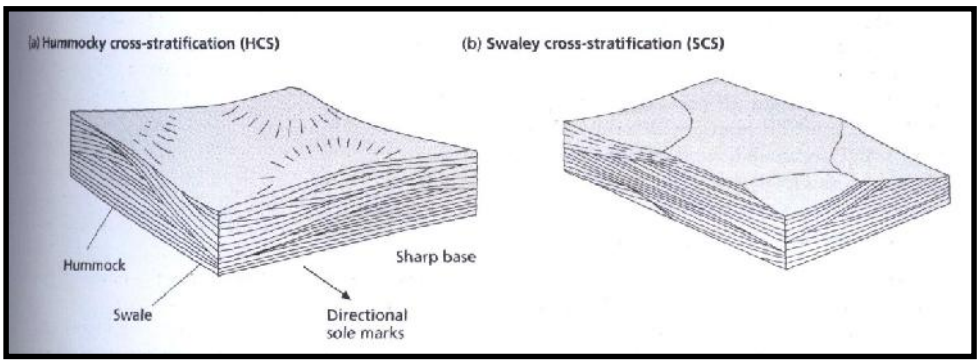
Classification of bedding:

A. **Massive**: devoid of any structures, formed under a constant physico-chemical condition of deposition for a considerable period of bed.
B. **Laminated**:
   i) ***Parallel laminated***: laminations are parallel to the depositional faces.
   ii) ***Cross laminated***: laminations (foresetlaminae) makes an angle with the depositional face. The foresets show truncated top and tangential bottom.The truncated top marks the top direction while the dip direction of the foresets indicates the current direction. These are generally formed by migration of mega ripples or dunes.
   Cross bedding and cross lamination differs in terms of thickness only.

   a) **Tabular cross bedding**: bounding surfaces are planar and parallel.
   b) **Wedge cross bedding**: bounding surfaces are planar but not parallel.
   c) **Trough cross bedding**: bounding surfaces are curved.
   d) **Hummocky cross bedding**: undulating bedding formed by wave generated oscillatory flows or combined flows(waves plus currents) produced by the passage of storms. It is characterized by gently curved, low angle(10-15°) cross lamination arranged in a convex-upward (a ‘hummock’) and concave-downward (a ‘swale’) pattern.
   e) **Herringbone cross bedding**: the foresets in successive sets are directed in opposite directions, so producing a structure which somewhat resembles the bones of a fish. The bipolar orientation of foresets is commonly

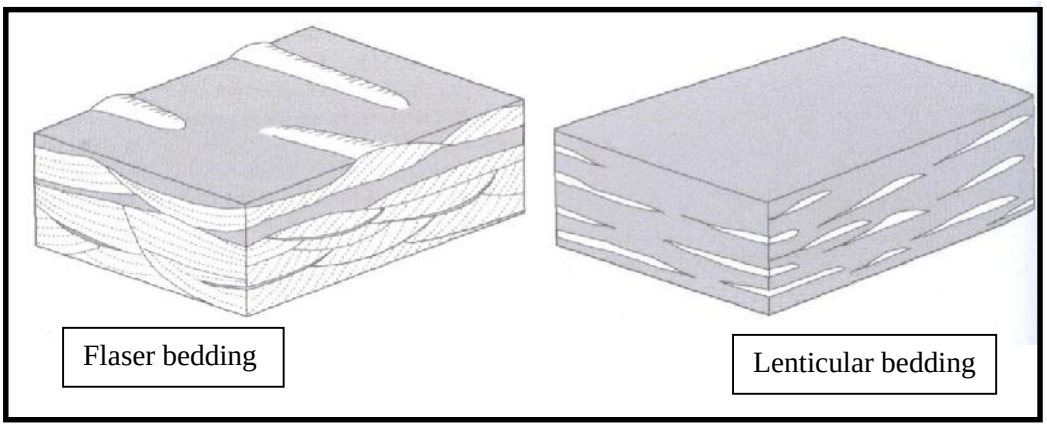
generated by the bipolar currents/reversing currents developed in tidal environments.





iii) ***Flaser bedding:*** mud streaks are preserved completely in troughs and partly on the crests. It is produced in the environments in which condition for deposition and preservation of sand is more than the mud.

iv) ***Lenticular bedding:***well preserved sand lenses embedded within the muddy layers.It is produced in the environments in which condition for deposition and preservation of mud is more than the sand.



C. Repetitive:

i) ***Varbe***: The classic varve deposit a light / dark coloured couplet deposited in a glacial lake. The light layer usually comprises a coarser laminaset of silt and fine sand deposited under higher energy conditions when meltwater introduces sediment load into the lake water. During winter months, when meltwater and associated suspended sediment input is reduced, and often when the lake surface freezes, fine clay-size sediment is deposited forming a dark coloured laminaset.

ii) ***Graded bedding***: beds showing gradation in size.

a) **Normaly graded**:grain size change from coarse to fine upward from base to top of the bed. This is generally formed in sub-aqous condition by the waning action of current or through suspention fall out.

b) **Reverse graded**: grain size change from fine to coarse upwardfrom base to top of the bed. This is formed generally in sub-airial condition by kinetic sieving or due to Bagnold effect.

c) **Coarse tail grading**: In coarser fraction a normal grading present from base to top while the finer particles present through out the bed. High velocity or high density turbidity current form this structure.

D. Growth:

Formed by insitu organic activity or chemical activity.

Stromatolites:

Laminated organo-sedimentary structures formed by the activity of algal mat by binding fine sediments. These are usually calcareous. In form they range from mound like forms to columner, digitate and branching forms. Free rolling or mobile forms with concentrically structured bodies are known as **Oncolites**. Stromatolites range from ~3.5b.y in West Australia to modern. These are excellent indicators of extremely shallow water and inter-tidal shore facies.

Bed top features:

A. Ripple: These are periodic undulations formed due to wave or current action. These are of two types:

i) **Wave ripple/Oscillation ripple:** characterized by a symmetric profile and straight continuous sharp crests and broad rounded troughs. Sharp crests denote the top direction. Crests commonly bifurcate.

ii) **Current ripple:** characterized by asymetric profile with a steeper, downstream-facing lee side and a gentle upstream facing stoss side. Both crests and troughs are rounded.

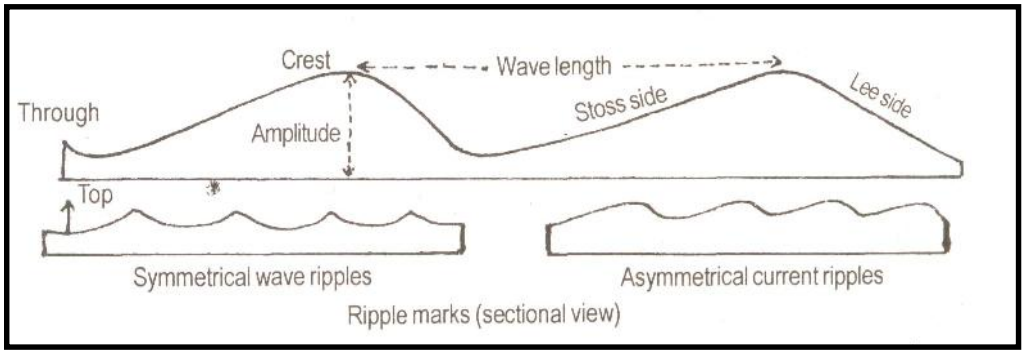
Ripple index (R.I): wavelength/height

R.I of wave ripple=6-10

R.I of current ripple=8-20

Based on size , the ripples are classified as small(30-60cm),mega (>60cm) and giant (>30m).

Based on shape ripples are classified as straight crested, sinuous, catenary, lunate and linguoid.



B. **Mud-cracks/Shrinkage-cracks/sun-cracks**: These cracks typically in clayey sediments due to prolonged exposure to the atmosphere. They are wider at the top but tapers towards the bottom.

C. **Rain imprint**: These are shallow circular to elliptical depressions surrounded by a low ridge formed by the impact of the rain drops.

Bottom surface features:

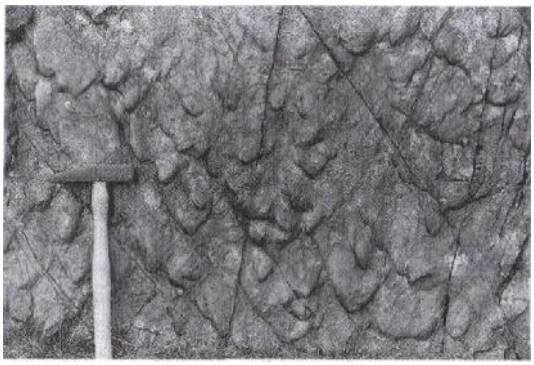
A. Sole features:

i) ***Flute cast*:** Slightly elevated elongated features with bulbous up-current nose and tapering down-current end. This asymmetry indicates the flow direction. Current

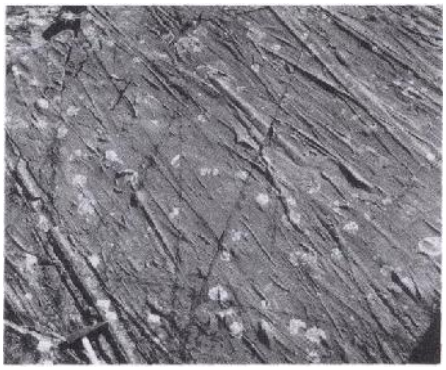
produced scour on the underlying mud bed becomes filled with sands and welded to the overlying sand bed and produce flute casts.

ii) ***Tool marks***: lines indicating dragging of some objects.

iii) ***Groove casts***: parallel lines produced by strong linear current.



Flute cast



Groove casts

TYPES OF SOFT SEDIMENT DEFORMATION STRUCTURES (SSDS):

- **Gravitational instability**

Load casts
Ball and pillow structures

Convolute lamination It is a structure showing marked crumpling or complicated folding of the laminae of a rather well defined sedimentation unit. Convolute folds tend to die out toward both top and bottom of the bed.

- **Downslope movement**

Slides
Slumps
Growth faults

- **Fluid flow**

Overturned cross bedding

- **Fluidisation**

Sand volcanoes
Diapers
Dish and pillar structures
Sedimentary dykes

BIOGENIC STRUCTURES:

Stromatolite

(To be continued)