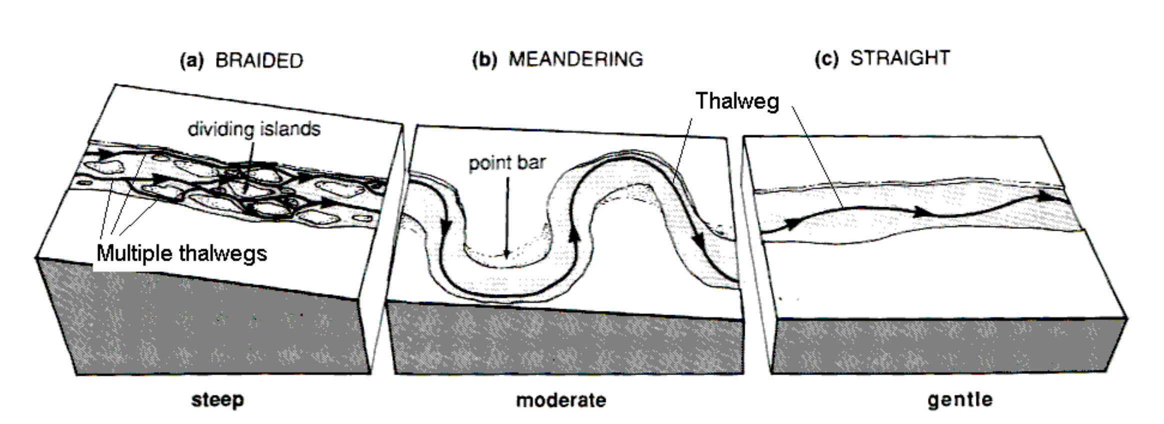
AS Geography 1.2 Fluvial Environments *Student Notes*

River Deposition

Deposition of sediments takes place when there is a decrease in energy (and hence water velocity). Larger particles will be deposited as the rivers competence decreases (often associated with an increase in capacity with increasing distance from the source).

Deposition takes place throughout a streams course. Large particles are often moved infrequently and remain deposited for long periods close to the source. Finer particles tend to be transported further downstream and deposited in low energy environments such as slow flowing parts of a channel, in lakes of as the river enters coastal waters in an estuary or delta. Very fine particles may be carried out to sea, beyond the fluvial environment.

Landforms that result from deposition include:



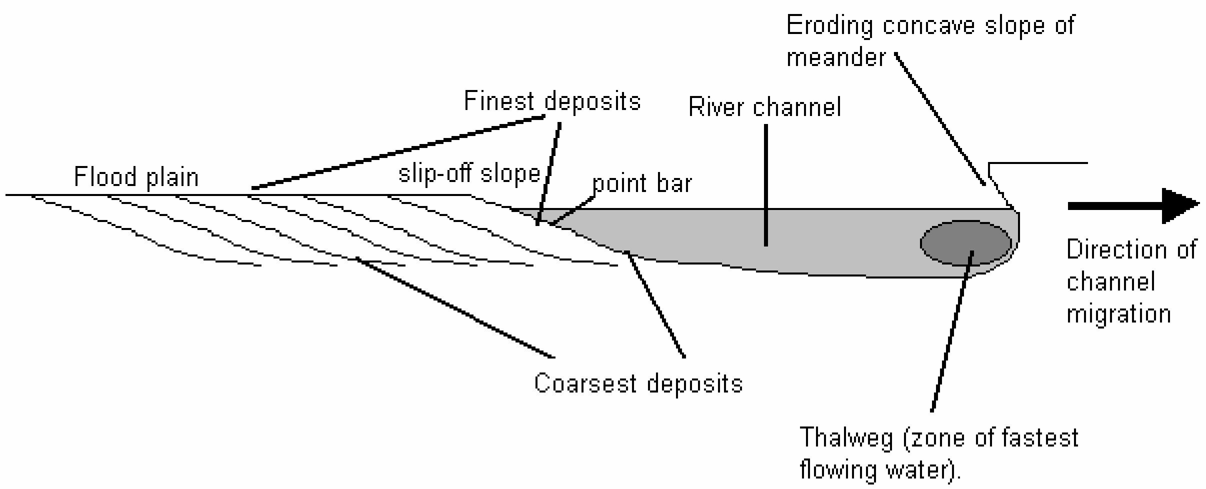
- **Braids.** Some rivers are supplied by large loads of sand and gravel which are transported as bedload. Such rivers usually experience extreme discharge regimes, such as rivers in arid areas, which experience flash floods, or rivers in cold climates, which as swollen by spring melting snow or glacial meltwater. In both environments, vegetation cover is thin allowing rapid erosion providing a large load. In such channels deposition occurs in the form of gravel of sand islands that divide the channel into smaller channels, or braids, in its attempt to find its way through its own disproportionately large bedload. Braided channels occur where the gradient is steep, the load is plentiful and coarse and the discharge fluctuates daily or annually. Compared with meanders, braids are very mobile and may shift their positions rapidly.

- **Meanders.** Most river channels display a degree of sinuosity. In other words, they meander. Meanders occur where vertical erosion has virtually ceased (the river has reached its "graded state") and the available energy is used in lateral erosion (and deposition) producing meanders. Most meandering streams are associated with a range of sediments from fine clays to gravel and cobbles, gentle gradients ad organised flow patterns.

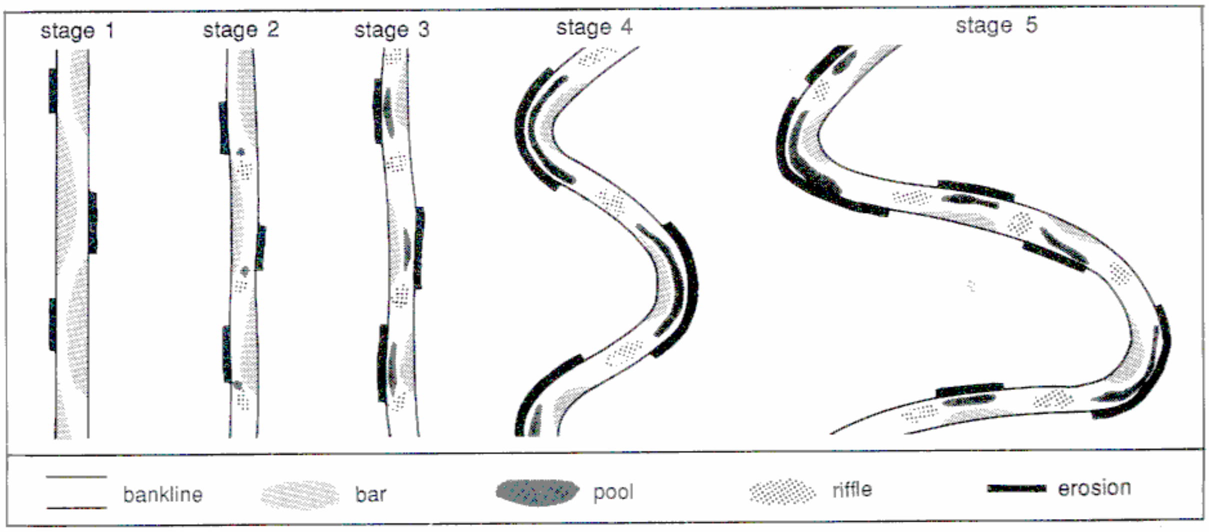
  The origin of meanders is problematic. In low flowing conditions, straight channels are seen to have alternating bars of sediments in the river bed so that the flow is forced to weave around them. These form shallow, faster flowing ***riffles*** and deeper, slower flowing ***pools.*** The swing of the flow, induced by the riffles, tends to direct the zone of maximum velocity, or ***thalweg*** to one side of the channel, leading to erosion. The resulting concave bank is eroded by undercutting of the alluvial materials of the river's floodplain.

  On the opposite convex bank, deposition occurs in the relatively slow flowing, low energy water. This creates a **point bar deposit.** With erosion on one side and deposition on the other, the whole channel migrates, keeping a relatively constant width. As it does so, it becomes more sinuous, acquiring a typical meander shape.

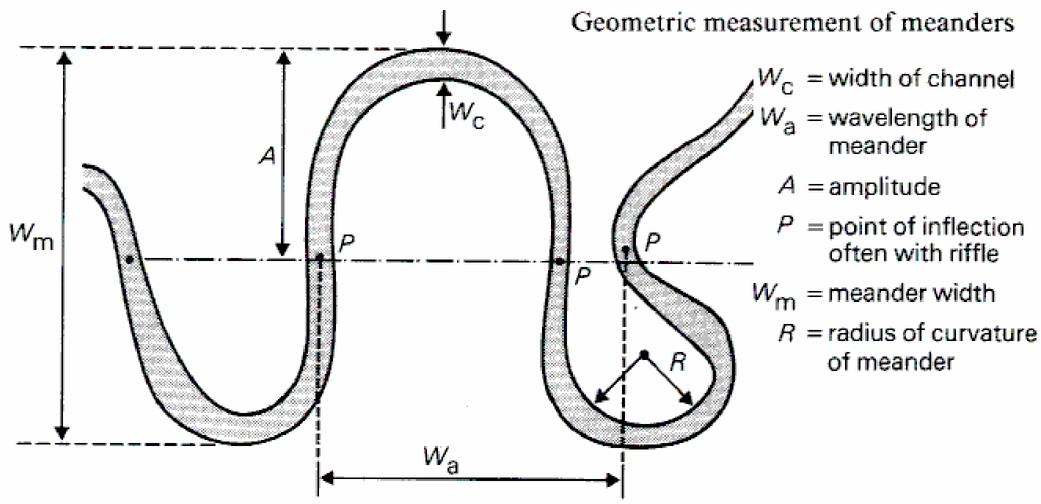
Some features of a meander



Stages in the formation of meanders



The Geometry of Meanders

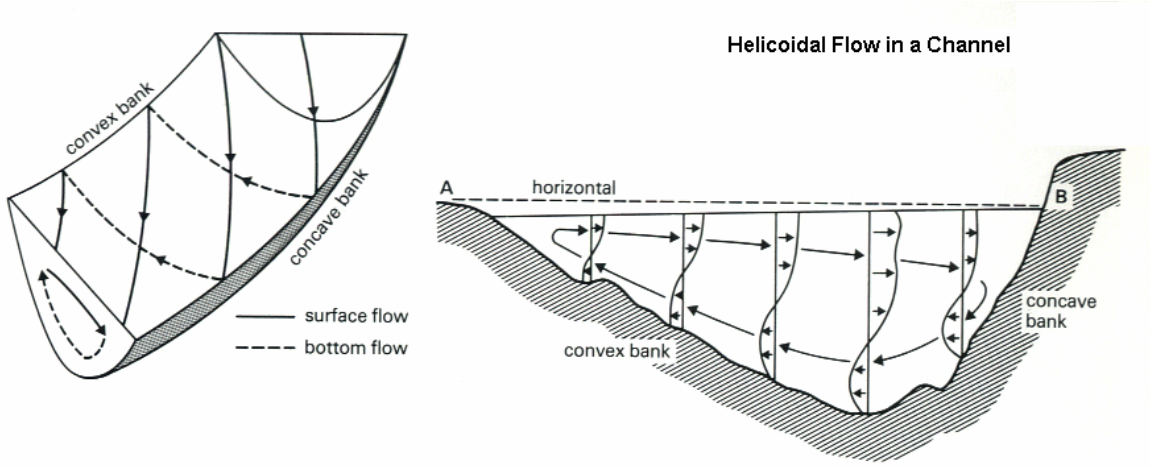


There seems to be a close relationship between most of these and other variables. The wavelength, for example increases with mean annual discharge and W_c: W_a is usually in the range of 1:10-14.

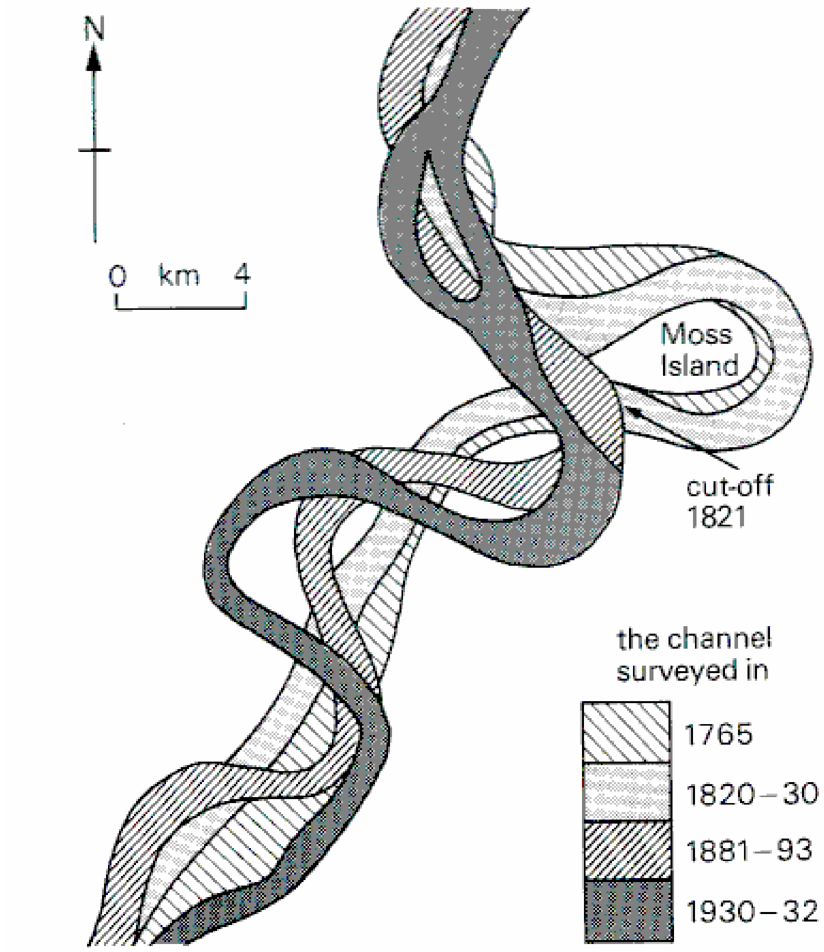
Sinuosity = $\frac{\text{channel length}}{\text{straight line distance}}$ $\frac{T}{L}$ = 1.5 to 4

In general, pools and riffles are spaced at intervals about 5-7 times the channel width.

Water flow in meanders is complex. In simplified analysis it seems to be **heliciodal**. The water flows fastest on the outside of the meandering channel in an attempt to maintain a straight course. It is deflected by the bend in the riverbank. The effect is to produce surface flow towards the outside of he bend and compensatory return flow across the bed, while the water moves down channel. The effect of heliciodal flow is to transport sediment eroded from the concave bank downstream to a convex bank to add to the point bar deposit.



The greatest erosion of the concave slope occurs just downstream of the axis of the meander bend. This causes the meander to migrate down valley. Rates of down-valley movement of up to 15m a year in some rivers. The section of the Mississippi shown below shows a typical shifting meander pattern. The cut-off or oxbow that occurred in 1821 considerably accelerated the rate of change.



- **Oxbow Lakes.** If the sinuosity becomes too great, a river flood may be able to break through a **meander neck** thereby straightening the channel, increasing its gradient and reducing energy loss. The abandoned channel, a **cut-off** may be used during floods but frequently they become blocked by alluvium and the channel becomes an **oxbow.** These are rapidly filled until only a marshy tract is left. These are sometimes called **meander scars** of **meander scrolls**. Oxbows are common on many rivers including the Mississippi, the Dee, the Thame and the Thames.

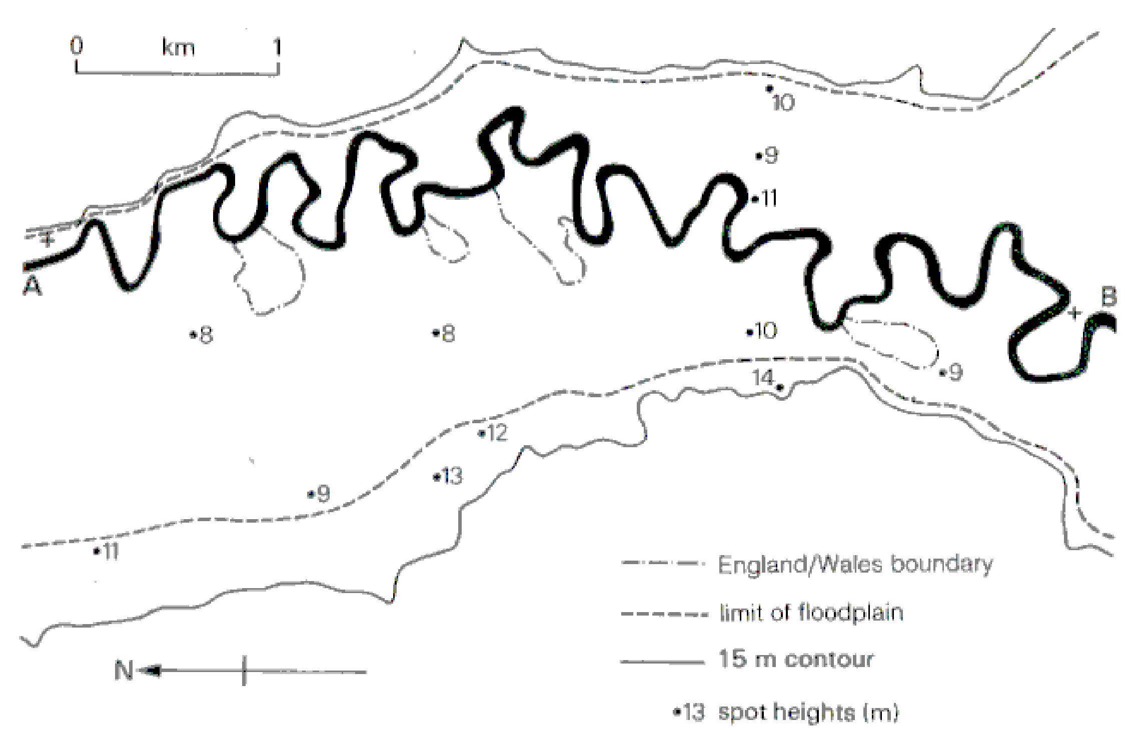
- **Floodplains.** The **alluvium** that forms the floodplain of a river has two main origins.

  1. From **overbank deposition**, which occurs at the time of a flood. These are usually fine clays, silts and sands.
  2. From channel deposits, mainly **point bar deposition** in migrating meanders. These are usually coarser gravels and sands.

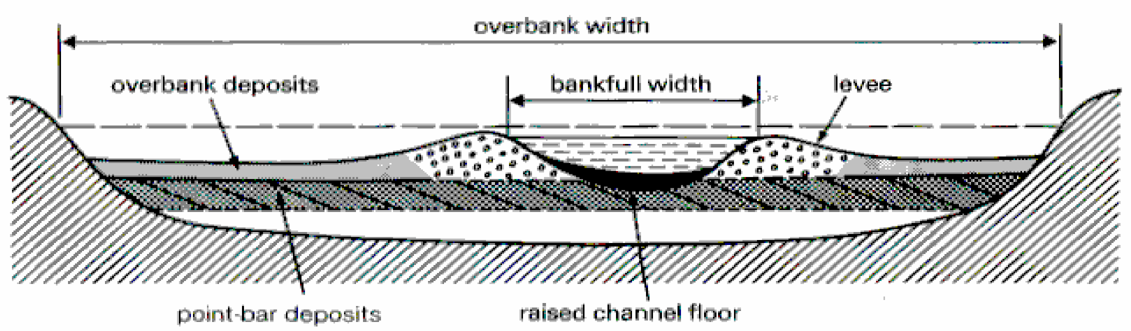
  When the river overtops its banks, the channel suddenly expands to the full width of its floodplain and the velocity of the water outside the channel falls considerably. Under these conditions, even very fine sediments can be deposited, particularly as he water becomes static in isolated pools in the flood plain, such as in old cut-offs.

  In rivers where rejuvenation has occurred, remnants of former floodplains become river terraces. These are particularly ell documented on the River Thames (see Waugh for further reading on rejuvenation, knick points and terrace formation).

  The map below shows the flood plain of the River Dee near Holt in Cheshire. In this case, the flood plain is wider than its meander belt although the position of the meander belt may change over time.



The diagram below shows the structure of a typical flood plain composed of a mixture of point bar deposits, overbank deposits and river channel sediments.



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  vees. The floodplain immediately adjacent to the channel often consists of slightly coarser

sediments and it is raised in comparison to the rest of the flood plain. These natural levees mark the zone where there I the greatest reduction in velocity during a flood. The coarsest, and the greatest volume of load are deposited to form an embankment, which, after many floods, effectively raises the height of the bank. In periods of low flow, sediments may accumulate in the channel. The combined processes can lead to a natural raising of the channel above the level of its flood plain between the two levees. It also prevents floodwater from returning to the channel.

On rivers such as the Mississippi, the natural levees are often artificially raised as a flood protection measure.

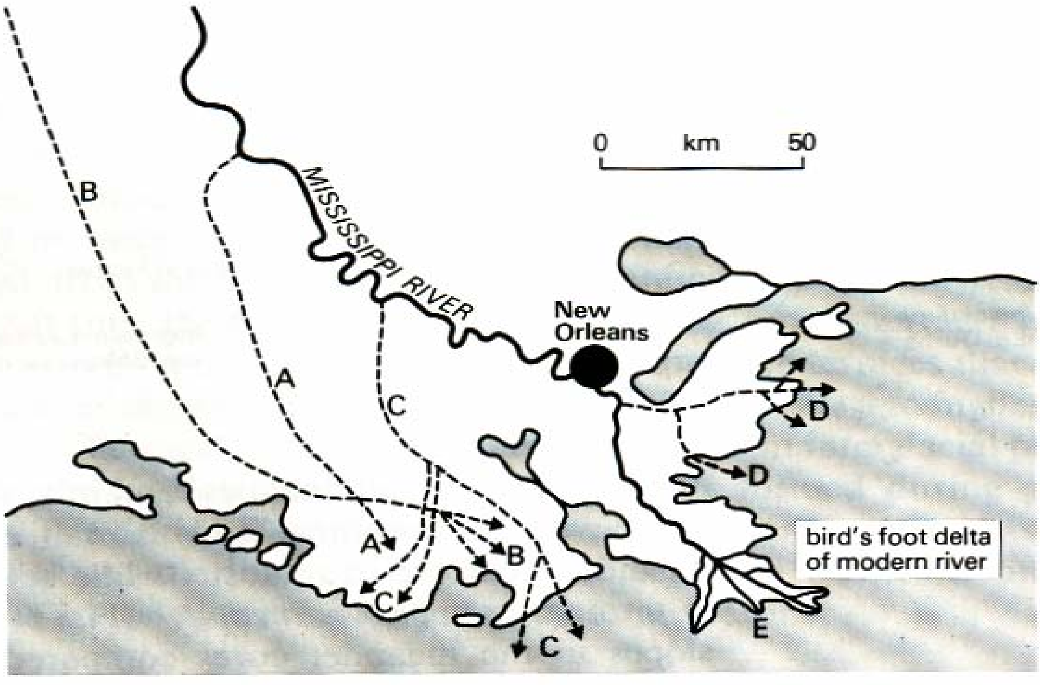
- **Deltas.** As a river enters the sea or a lake, its velocity decreases and its competence is reduced. Deposition occurs in the river estuary or out to sea. Around Britain's coast, tidal currents in estuaries are generally strong so the alluvial accumulations are often moved further out to sea.

  If the river discharges into a tideless (or low tide) sea the alluvium may build into a delta. This is more likely if the rate of wave erosion is lower than the rate of river deposition and if there is a broad, gently sloping continental shelf or shallow sea. Under these conditions, the build-up of alluvium causes the channel to divide into a number of distributaries. Deltas are classified according to their shape:

  - **Birds foot** (or digitate) e.g. the Mississippi Delta
  - **Arcuate** e.g. the Nile Delta and
  - **Cuspate** e.g. the Tiber

  The formation of the Mississippi Delta has occurred where the river has continued to build levees out into the sea. The less dense river water flows out across the surface of the more dense seawater, slowly spreading out. Alluvial material is deposited at the edges of the flow. A process of flocculation enhances the deposition of fine clay. In fresh water clay particles repel ach other, however, the electrolyte action of salt-water charges the particles and they form clots or **floccules**. These are larger and settle out of suspension ore easily.

  The map below shows the changing position of the distributaries of the Mississippi Delta. Channel A was used 3000 years ago, B, 1500 years ago, C, 1000 years ago and D, 700 years ago. The river has followed its modern channel for about 400 years.



  The deposits of a delta fall into three broad categories.

  Those that are carried furthest out to sea are called **bottom-set deposits**. These fine deposits underlie the rest. On top of these are angled **fore-set deposits**, which are sometimes deposited over each other in turbidity currents. On top of these the coarser **top-set deposits** are laid down. This coarse material is carried the least distance from the river mouth.