

## RIVER LANDFORMS: THE RIVER TEES

by Ann Bowen

**R**IVERS BEGIN AT THEIR SOURCE, high above sea level, and flow downhill towards their mouth, usually the sea. For ease of study we divide the river into three sections: the upper, middle and lower courses. In each of these sections typical landforms can be seen as a result of the processes at work. This unit investigates these landforms and processes along the River Tees in north-east England.

Figure 1 shows the drainage basin of the River Tees. The source lies high up in the Pennines close to Cross Fell (893 metres above sea level). The river flows east to its mouth in the North Sea. Along its way there are many tributaries. They join the river at a confluence and so the river gets wider and deeper downstream. Changes in the river downstream are also a result of changes in the processes at work – erosion, transport and deposition.

### The upper course of the River Tees

In the upper course the river flows over hard, impermeable rocks. The valley has steep sides forming a V-shape. The river channel is shallow and rocky and the river is turbulent and clear. In the upper course there is the famous High Force waterfall (Figure 2) and gorge as well as rapids and potholes. Erosion downwards is the main work of the river in the upper course.

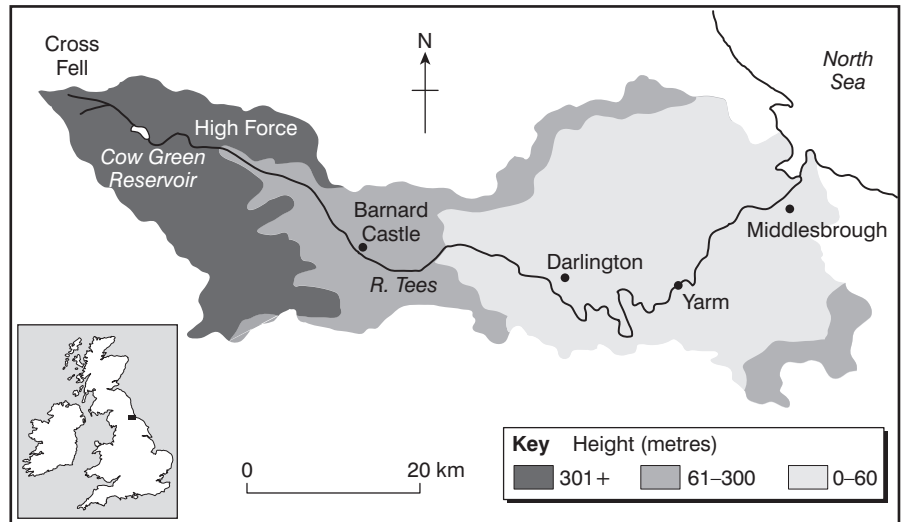


Figure 1: The drainage basin of the River Tees



Figure 2: The waterfall at High Force

There are four main processes of erosion in the upper course:

- **Hydraulic power** – the force of the water on the bed and banks of the river.
- **Corrasion** – the sand and gravel carried by the river grinds away at the bed and banks of the river.
- **Corrosion** – some soluble minerals such as calcium carbonate in limestone dissolve in the river water.
- **Attrition** – the stones, pebbles and other materials (**load**) carried by the river rub against each other making the particles smaller and more rounded as they move downstream.

### The waterfall and gorge at High Force

High Force is the tallest waterfall in England at 21 metres high, though this is pretty disappointing when you compare it with some of the world's greatest – Angel Falls in Venezuela are the world's tallest at 979 metres.

At High Force, the waterfall and its gorge of recession have been formed over millions of years. On Figure 2 notice the high head of water, the deep plunge pool at the base and how the rock type changes. At the top of the waterfall there is a very hard rock

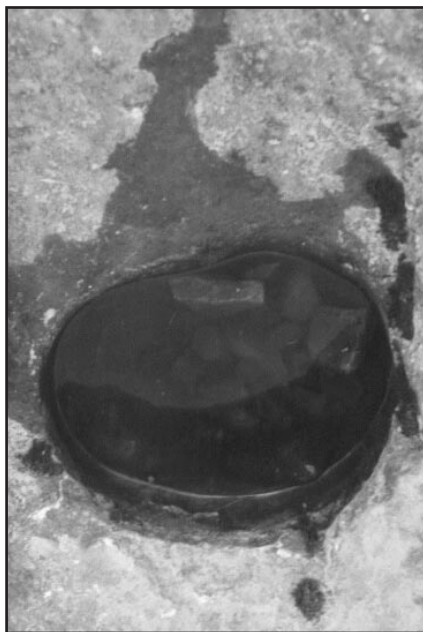


Figure 3: A pothole at Low Force in Upper Teesdale

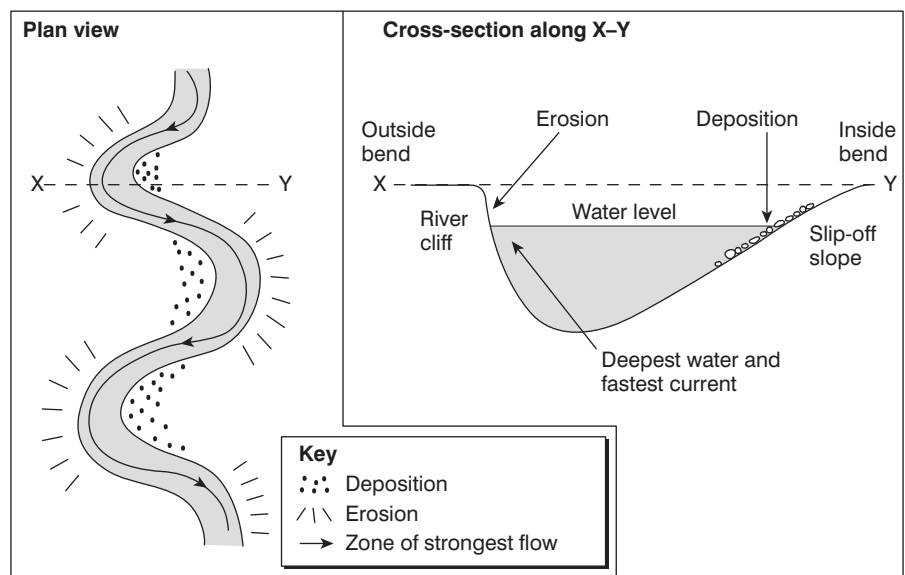


Figure 4: Plan view and cross-section of a meander

called Whinsill, which is the cap rock. Below this lie softer rocks such as limestone, sandstone and shale. At the edge of the plunge pool are large boulders and rocks. At High Force the hard Whinsill lies on top of softer limestone and sandstone. The river flows over the harder rocks and erodes the softer rocks below more quickly. Over a long time the softer rock is undercut and the hard cap rock overhangs. Eventually the hard rock collapses under the force of gravity. The great power of the water erodes the plunge pool. The rocks resulting from the collapse of the cap rock and from the erosion of the plunge pool are moved to the edge. As the cap rock collapses the waterfall retreats upstream. This is repeated again and again causing a steep-sided gorge of recession to be formed. Gradually chips of rock are also broken off the top of the waterfall and the waterfall reduces in height.

### Potholes and rapids at Low Force

Figure 3 shows a pothole in the river bed at Low Force. Here small pebbles have become trapped in hollows in the rock. The river's flow has caused the pebbles to swirl around in the hollow making it deeper and deeper. The pebbles grind and scrape at the bedrock, eroding the hollow by corrasion. At Low

Force there are also rapids formed by smaller outcrops of Whinsill. The less resistant limestone has been eroded away leaving the rapids.

### The middle course of the River Tees

As the River Tees flows downstream the gradient becomes less steep. The river begins to erode sideways (lateral erosion) rather than downwards and the river begins to deposit sand and gravel. The lateral erosion means the river gets wider, the river valley gets wider and meanders begin to form.

### Meanders

A meander is a bend in the river (Figure 4). On the outside bend of the river the water is deeper and flows more quickly. The force of the water (hydraulic power) and corrasion erode the outside bend to form a river cliff. On the inside bend the water is shallower and flows more slowly. Here there is deposition of sand and gravel forming a slip-off slope.

As the meanders get wider they erode away the valley floor, creating a wider valley in a broad U-shape. The meanders also migrate or move downstream. This too broadens the flood plain, creating a line of river bluffs at the edge of the flood plain.

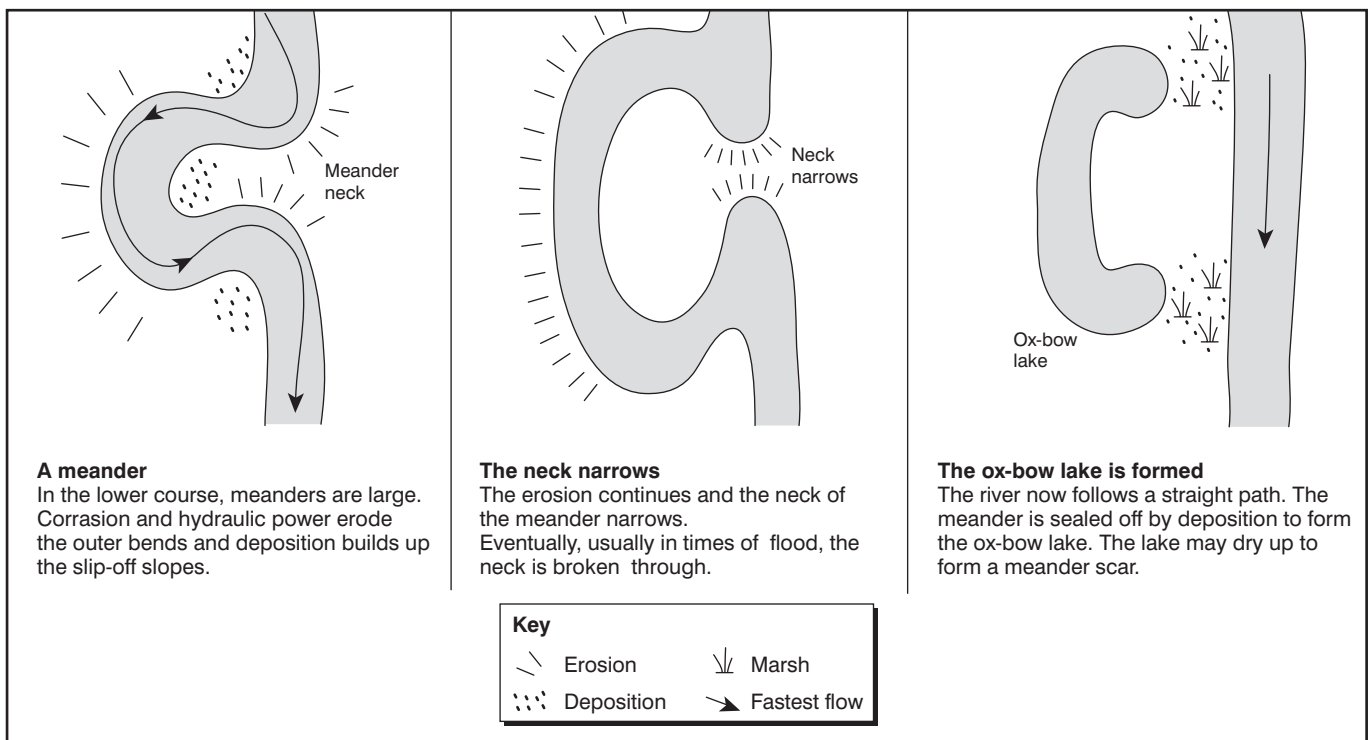


Figure 5: Formation of an ox-bow lake

## The lower course of the River Tees

Close to Yarm the River Tees has formed very large meanders. Some of these meanders have led to the formation of ox-bow lakes (Figure 5) and flooding has caused levées to form (Figure 6). Levées are high banks of silt along the banks of a river. They are formed where a river flows slowly, carries a large load of silt and floods on occasions. When the river floods the coarser material is deposited first close to the river channel. The finer material is deposited further away. Over many years this coarse material builds up to form the levées on the river bank. In times of low flow when the river has little water and is flowing slowly it deposits material on the river bed, building it up. Gradually the river bed increases until it is higher than the land around. Then flooding is disastrous as the water cannot flow back into the river. The lateral erosion by the meanders and the occasional floods build up a wide, flat flood plain on either side of the river. Here the valley is a broad U-shape with quite gentle sides.

## The mouth of the River Tees

The mouth of the River Tees is an estuary. An estuary is a river valley in a lowland area that has been flooded. During the Ice Age vast amounts of water were stored as snow and ice. This caused sea levels to be much lower than they are now. At the end of the Ice Age the melting of the snow and ice caused sea levels to rise and so the lower parts of river valleys were flooded to form these wide estuaries. The River Tees has a very wide estuary with mudflats and sandbanks. The estuary has been a magnet for industry with iron and steel, engineering and chemical works all along its length. However, parts of the estuary are very important sites for wildlife, such as seals, and migratory birds. Some areas are Sites of Special Scientific Interest (SSSIs), and are carefully managed for the unique ecosystems they support, eg Seal Sands.

## River basin management

The drainage basin of the River Tees has been managed for over a century. The management has had several aims:

- to reduce flooding
- to improve water supply

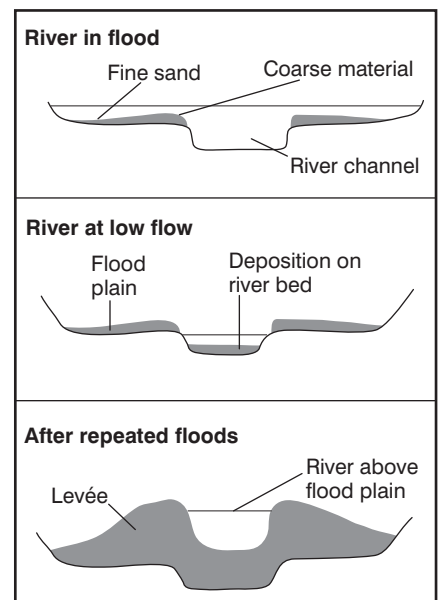


Figure 6: Formation of levées

- to improve water quality
- to improve navigation
- to provide more opportunities for recreation.

A variety of strategies have been used, including the building of reservoirs such as Cow Green and Grassholme. In the 19th century, 'cut-offs' were built near Stockton to straighten the river for navigation, and recent flood protection schemes have been built at Yarm. Today there is a huge watersports complex at the Tees barrage.

# Activities

1 Tops and tails – match the word or term with the correct definition:

Confluence	Diagram of a river from its source to its mouth
Cross-section	Where a river starts
Drainage basin	Where a river flows into the sea
Long profile	Diagram of a river from bank to bank
Mouth	Where two rivers meet
Source	The imaginary line around a drainage basin
Tributary	The area of land that a river drains
Watershed	A smaller river flowing into a large river

2 Complete a table like the one begun in Figure 7 to show the main landforms and processes along the River Tees. Try to include actual names of places and landforms.

### 3 Waterfalls and gorges

- Make a copy of Figure 2.
- Label your sketch with the main characteristics of High Force. Add a title.
- Match the numbers on Figure 8 with the following sentences. Rewrite the sentences in the correct order to explain how waterfalls and gorges are formed.

- The overhang collapses under gravity.
- The waterfall retreats upstream.
- Splashback from the waterfall erodes by hydraulic power.

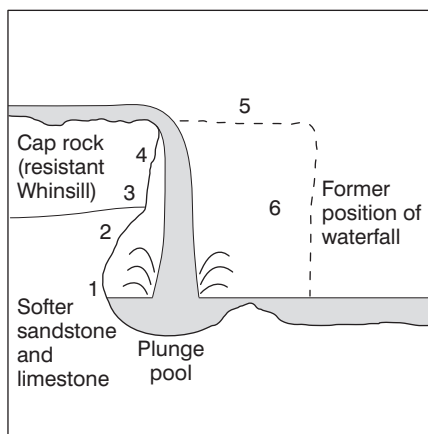


Figure 8: The formation of High Force and its gorge

	Upper course	Middle course	Lower course
Long profile			
Cross-section			
Valley features			
Gradient			
River and channel features/landforms			
Processes at work			

Figure 7: Landforms and processes along the River Tees

- A steep-sided gorge of recession is formed.
- The softer rocks are undercut.
- The hard cap rock overhangs.

### 4 Meanders and levées

Access the Ordnance Survey Get-a-Map website (<http://getamap.ordnancesurvey.co.uk>). Search for the extract for Yarm and download and print a copy of the map.

(a) On your map add the following labels in the most appropriate places:

- |             |                |
|-------------|----------------|
| Meander     | Slip-off slope |
| River cliff | Levées         |
| Flood plain |                |

(b) Add an arrow to show the river's direction of flow.

You could repeat this for maps of Upper Teesdale and the river mouth – practise recognising the landforms and other features of the river and its valley.

- At what height above sea level is the river at Yarm?
- Approximately how wide is the valley floor?
- Copy and complete the following sentences to explain the formation of ox-bow lakes:

In a meander, erosion by hydraulic power and c\_\_\_\_\_ on the outside bend leads to the formation of a \_\_\_\_\_. On the inside bend deposition builds up a \_\_\_\_\_. Over time the erosion on the outside bend causes the \_\_\_\_\_ of the meander to narrow. Eventually, usually in times of \_\_\_\_\_, the neck is broken through. The river follows a straight path. The old meander is sealed off by \_\_\_\_\_ to form an ox-bow lake. Eventually the ox-bow lake dries up and a meander scar is formed.

(f) Copy the diagrams in Figure 6 to show the formation of levées. Add notes alongside each one to explain how levées are formed.

5 (a) What is an estuary? In which part of the river is it found?

(b) Explain how an estuary is formed.

(c) Why are estuaries good sites for settlement and industry?

6 Produce an A4 leaflet explaining the journey of a river from source to mouth suitable for a pupil in Year 6 at primary school.