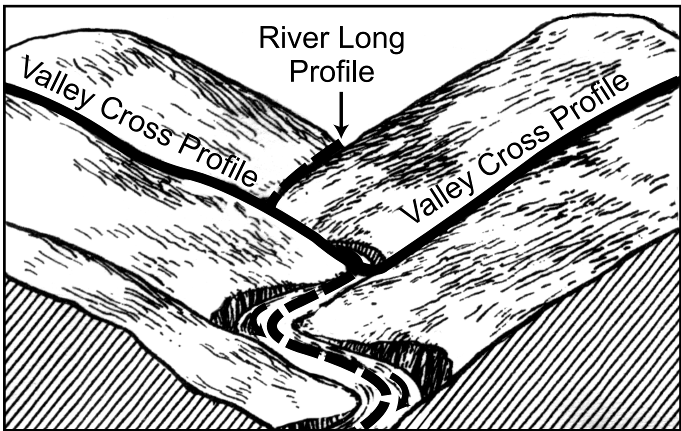
Geo Factsheet

www.curriculum-press.co.uk Number 215

RIVER LONG PROFILES & VALLEY CROSS PROFILES

Fig. 1 River long profiles and valley cross profiles.



Students get very confused when asked to describe or explain the formation of long and cross profiles.
The first stage is to understand the difference.

As you can see from *Fig. 1*:
- **the long profile is a section drawn along the river gradient from source to mouth**
- whereas a cross profile is a **cross section drawn across the river valley** at intervals along its course.

To understand the difference do the exercise at the end of this Factsheet.

River Long Profiles
A careful study of river long profiles reveals a variety of features:

- The general form of the profile is a **concave** upward curve *(see Fig. 2a)* but the degree of concavity varies considerably depending on the overall steepness of the gradient.
- The degree of **regularity** of the concave curve varies between different rivers. Some may show regular concave sections separated by even convex sections.
- Most long profiles show considerable **irregularities** as shown by the case study of the Afon Glaslyn, *Fig. 2b*. In this case there is evidence that overtime the river is establishing an equilibrium by eroding the knick points, and filling in the lakes be deposition which will 'iron out' the irregularities.

Factors which control the shape of long profile form, i.e. concavity, are:
- The **base level**, i.e. the lowest point of any stream – usually the sea, but lakes can cause local base levels to occur *(see Fig. 2b)*.
- The **increase in discharge** downstream which is **usually** greater than the load increase. Increasing discharge means that a given load, and in most a larger load, can be moved with the same velocity over a lower angle of slope.
- Decrease in the load **calibre** (size) downstream, so that a given mass of load can be transported over gentler slopes.
- Increasing discharge implies an increasing cross-sectional area which, assuming no channel x section change, means an increase in efficiency.
- **Greater depth and finer load** leading to a smoother channel bed downstream, so that energy transformation caused by turbulence will decrease.

All of this means that flow over gentler slopes is possible, hence the concavity associated with the decreasing gradient.

Fig. 2 Smooth and irregular curves in long profiles.

Fig. 2a* *Smooth concave profile known as a graded profile.

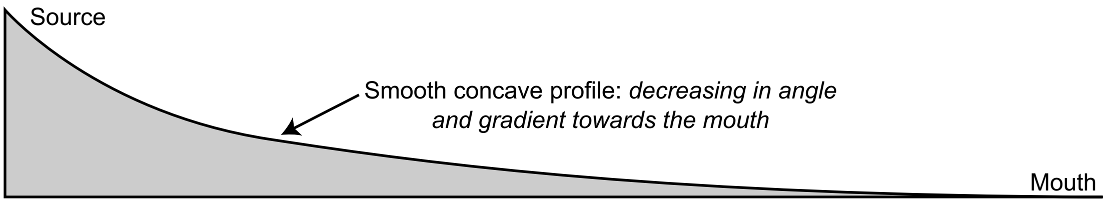
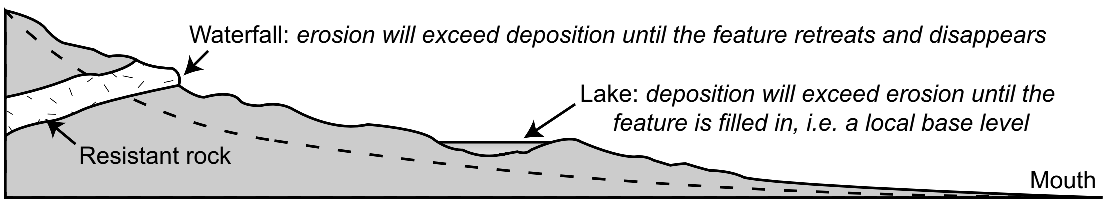


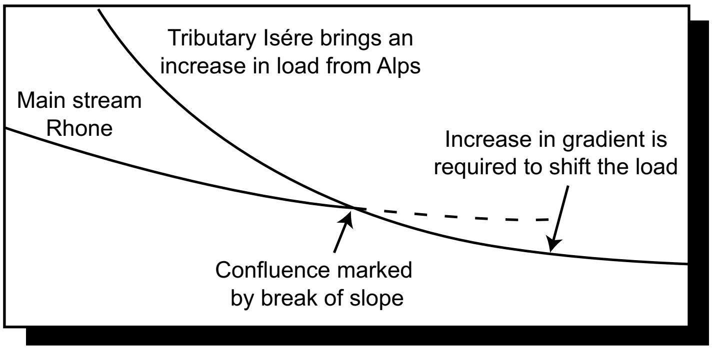
Fig. 2b* *Irregularities in the profile of the Aberglaslyn.



Factors resulting in irregularities in the long profile

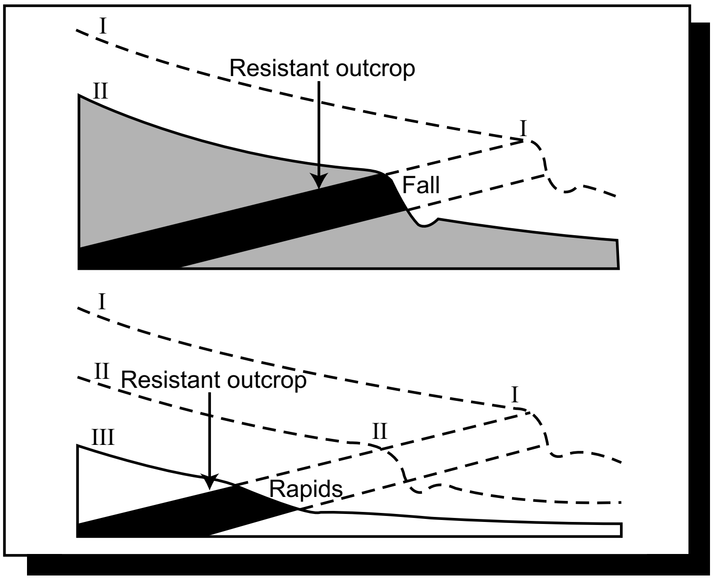
1. ***Occurrence of significant tributaries*** can lead to a break of slope *(Fig. 3)*.

Fig. 3



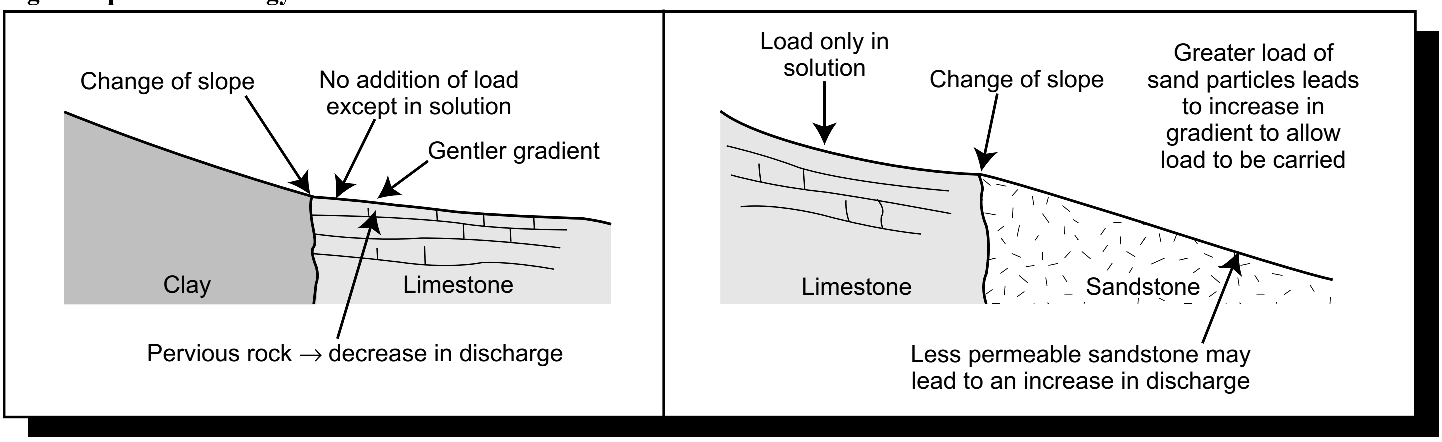
2. ***Changes in geology***
Lithological variations may also have an effect on the nature of a long profile. **Structural knick points**, usually marked by waterfalls, occur where bands of hard rock cross river beds, as shown in *Fig. 4*. This shows successive positions of the waterfalls as they retreat upstream and in some cases become less prominent.

Fig. 4



In some cases lithological variations of a major character in a drainage basin cause irregularities in profile, as shown in *Fig. 5*.

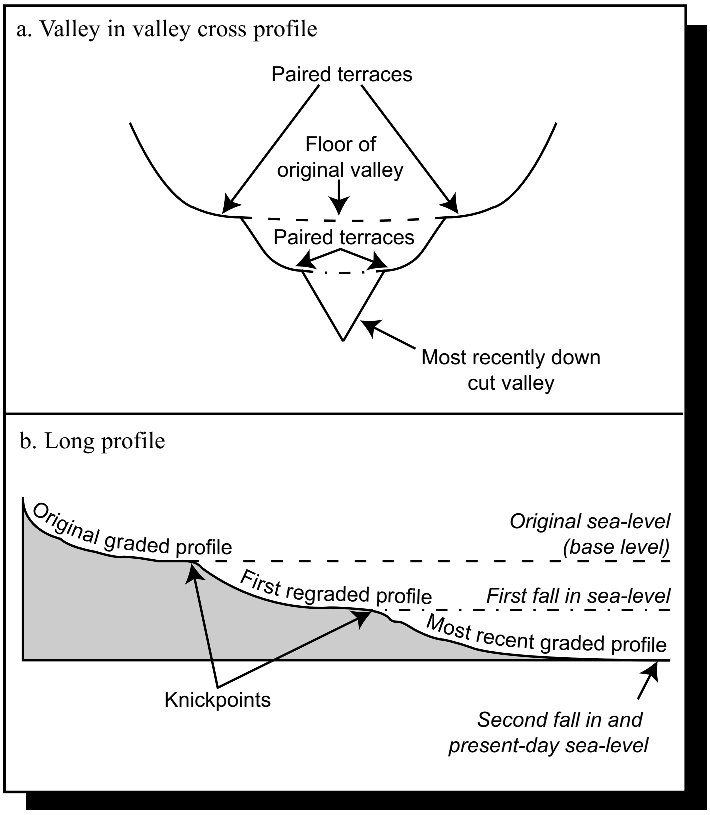
Fig. 5 Impact of lithology.



3. ***The impact of rejuvenation***
When there is a relative **fall** in sea level as a result of a negative change, the river has to work to a new lower base level and thus the gradient of the river steepens from the sea as this increases the potential energy of the river.

A marked break of slope occurs at the **knick point**, often marked by rapids or a small waterfall and thus tends to work its way back stream. Often a series of knick points along a river profile indicates several successive lowerings of the base level. These knick points are not **structural** and can be linked to paired terraces which will lead to a valley in valley cross profile *(see Fig. 6)*.

Fig 6



Exam hint: *Many students do fieldwork along rivers to test Bradshaw's or Schumm's models. Why not draw long and cross profiles of your river and identify key factors and processes that influence their form and shape?*

Valley Cross Profiles

Fig. 7 summarises the range of factors which are responsible for influencing the shape of valley cross profiles. The factors can be grouped into (1) those associated with the river, (2) those influencing the nature of the valley sides, (3) other factors such as the past history of the valley such as tectonic activity or glaciation. The particular cross profile results from the interaction of process and factors such as geology, vegetation etc.

The impact of river processes in relation to valley side processes:
Fig. 8 shows the usual progression of valley cross profiles from source to mouth and how these valley side processes operate in detail – a combination of surface wash weathering and mass movement. The diagram show the major processes responsible for their shape.

As with long profiles, rejuvenation has a major **impact** as renewed downcutting leads to a valley in valley profile with paired terraces *(Fig. 6)*.

Fig. 7 Factors influencing the shape of valley cross profiles.

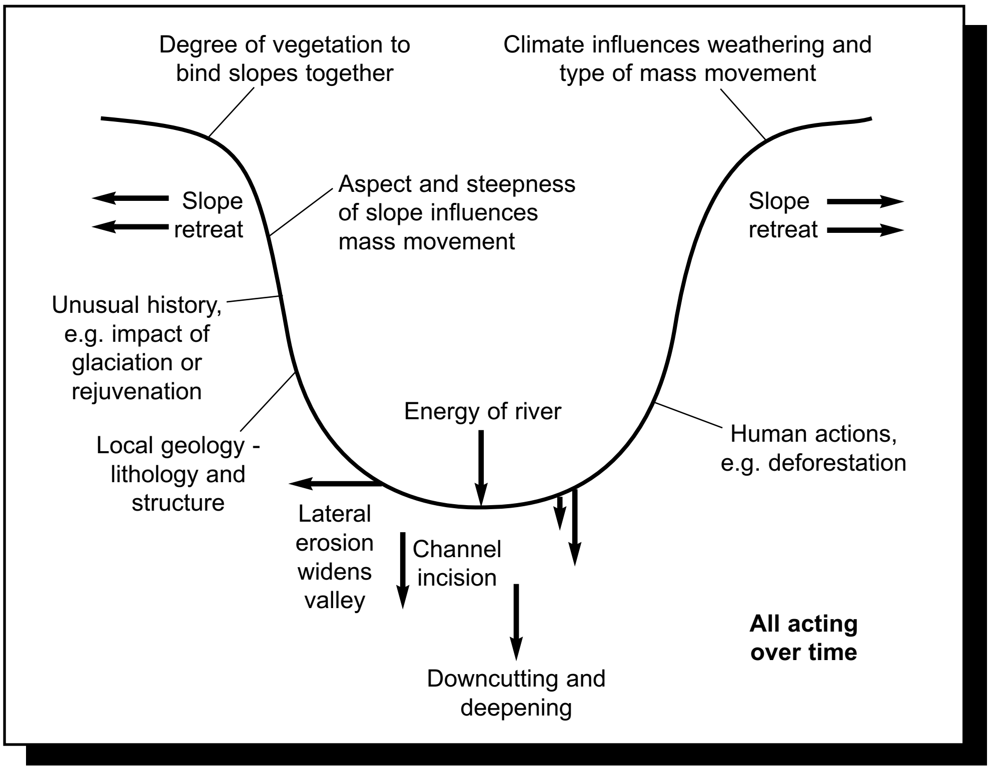


Fig. 8 Valley side processes.

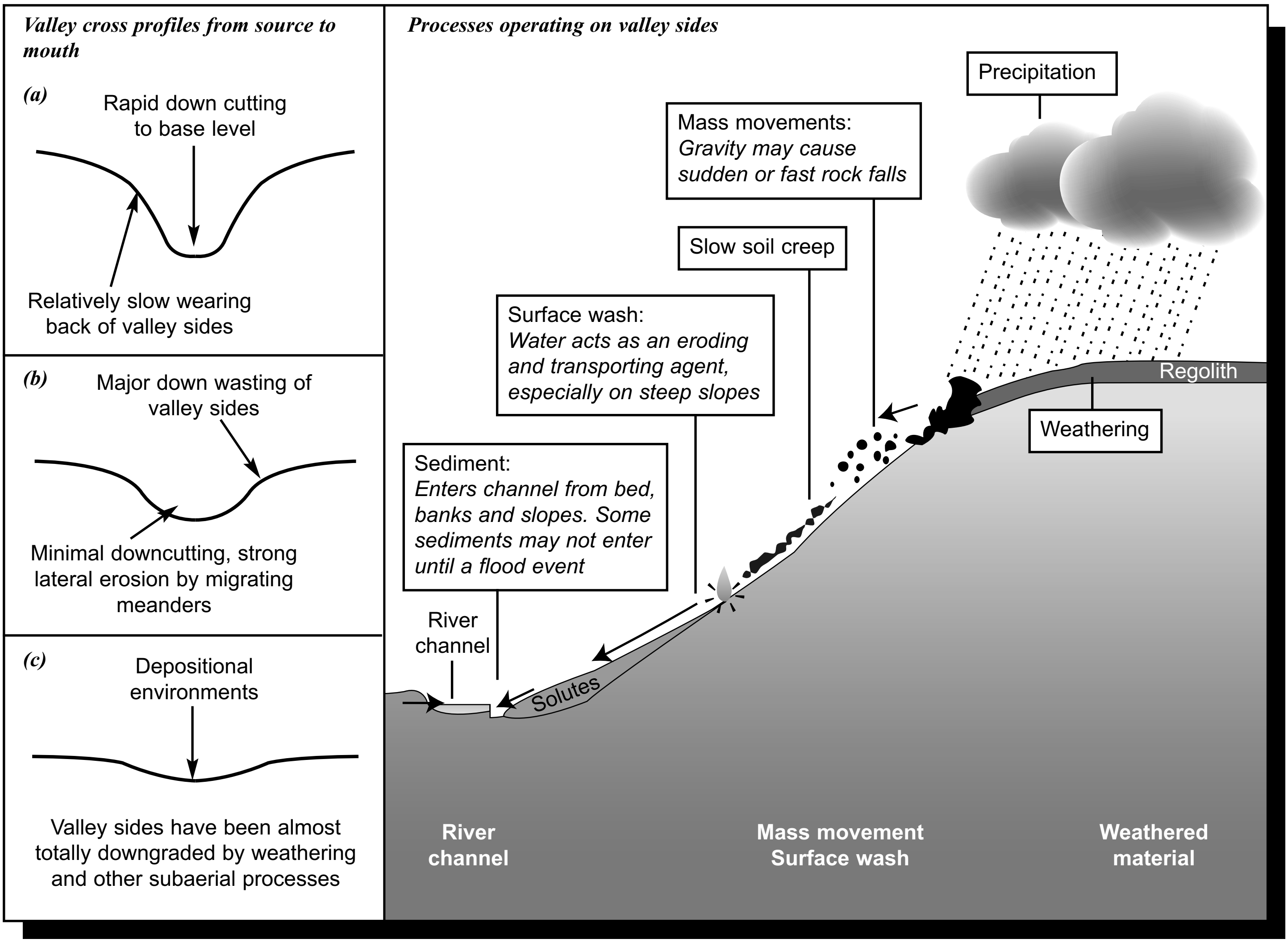
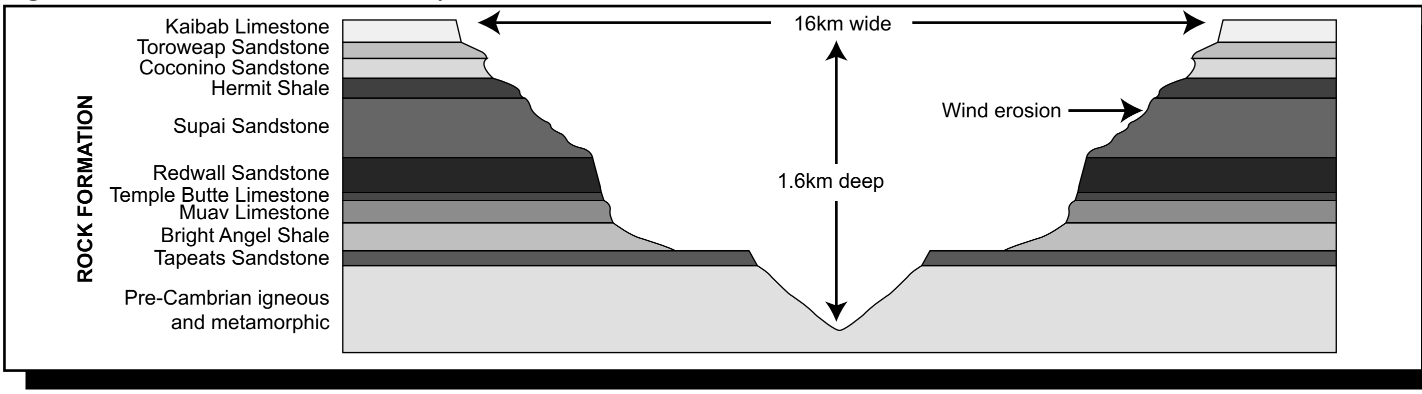


Fig. 9 Cross-section of the Grand Canyon

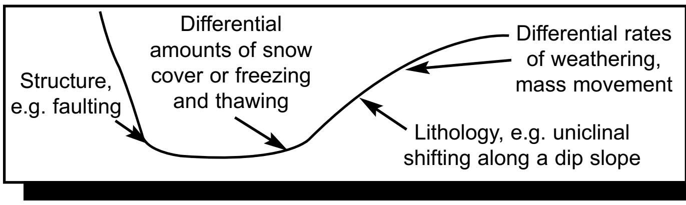


Geology also has a really major impact on valley cross profiles. *Fig. 9* shows a cross-section of Grand Canyon. The stepped profile results from the **differential erosion** of horizontal bedded largely sedimentary rocks. Tectonic uplift of the land in the Grand Canyon region of southwest USA has caused the Colorado River to erode down through 1,600 metres of rocks. The Canyon is 16km wide from rim to rim. Rock formations that are most resistant to weathering, such as Kaibab Limestone, form cliffs. Rocks that are less resistant, such as Hermit Shale, form gentler slopes. It has taken the river approximately 30 million years to erode the Canyon.

Many other valley cross profiles show the impact of **lithology**. Uniclinal shifting can even lead to **asymmetric valleys**. Rock structure, for example faulting, can also influence valley cross profiles as a result of the formation of fault scarps. Equally the fault can be a zone of weakness and **fault guided** valleys are often deep.

Aspect of the valley can also lead to **asymmetric valleys**. *Fig. 10* outlines some possible reasons why the valley side processes act **differentially**.

Fig. 10 An asymmetric valley.



Exam hint: *It is always worth including examples of valley cross profiles which owe their form to other factors such as the U-shaped troughs, e.g. Nant Francon, which were shaped by* ***glaciation*** *and are now experiencing subsequent modification.*

Further reading

Rivers & Coasts, Hordern, R. Philip Allan Updates - for a useful case study of the profile of the River Greta and River Lune.

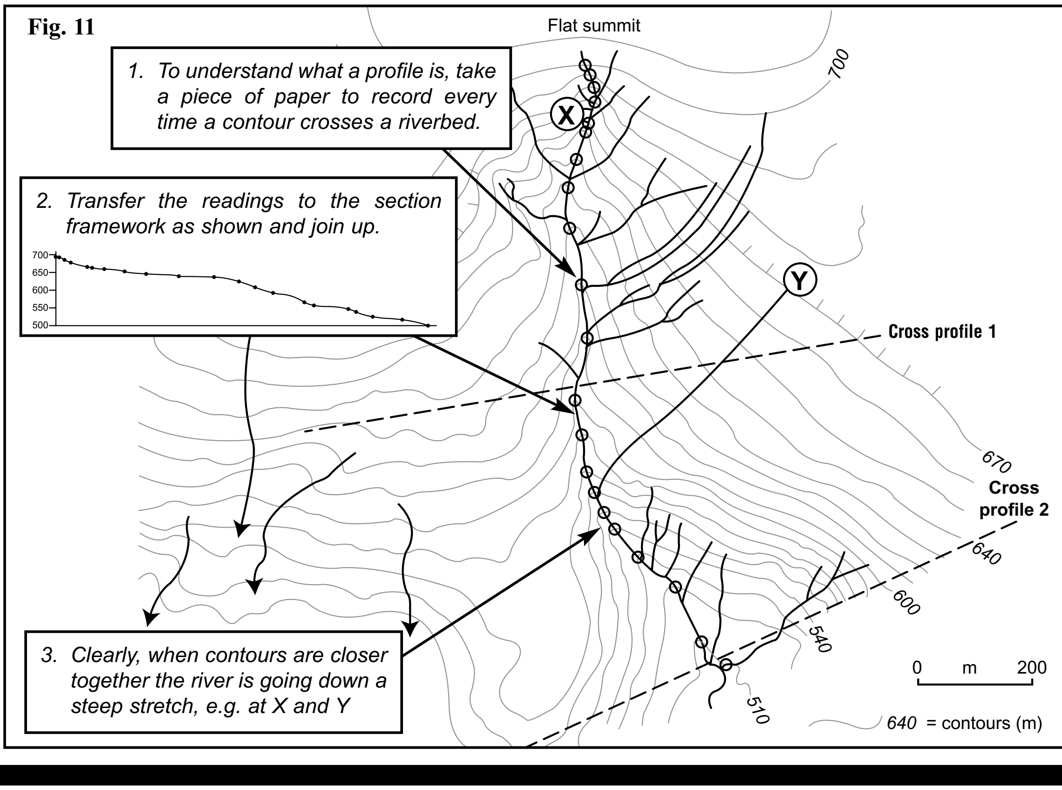
Exercise

1. Draw a long profile and river cross profiles as shown *(Fig. 11)*.
2. Describe and suggest reasons for the shape of the profiles you have drawn.

Answer Guidelines

- **Long profile** – try to explain knick points.
- **Cross profile** – try to explain how river processes are significant.

Fig. 11



Acknowledgements
This Factsheet was researched and written by Sue Warn. ***Curriculum Press, Bank House, 105 King Street, Wellington, TF1 1NU. Tel. 01952 271318.***
 ISSN 1351-5136