UK Onshore Geophysical Library

UNIVERSITY of DERBY

Maps and map interpretation

An introduction for geoscientists

Produced by the University of Derby
in conjunction with UKOGL

Aims

- This teaching package provides an introduction to maps and how to identify landforms using contours and cross-sections

- It is designed primarily for A-Level and first year undergraduate geology and geography students who may have little experience of topographic maps, or for those who haven't worked with them recently

Contents

- Part 1 - Introduction to maps
  - Title
  - Key (sometimes called legend or explanation)
  - Scales
  - Contours

- Part 2 – Map interpretation
  - Contour patterns
  - Cross-sections

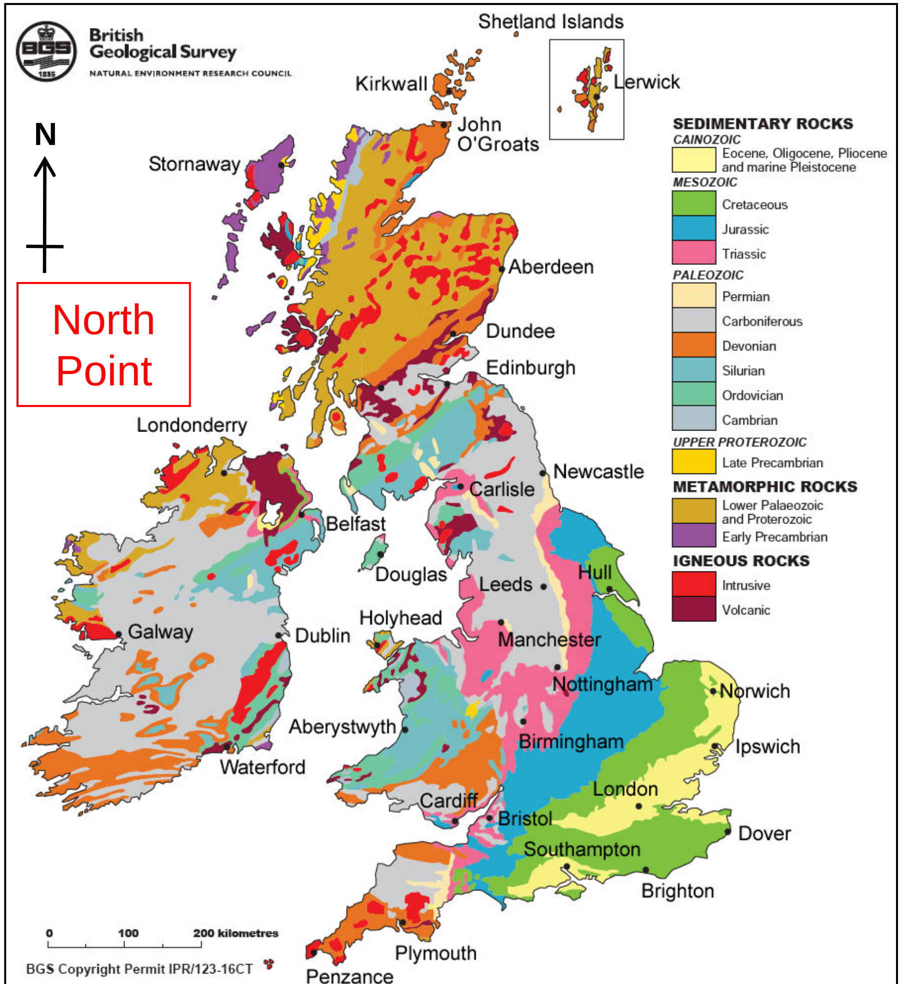
Part 1 - Introduction to maps

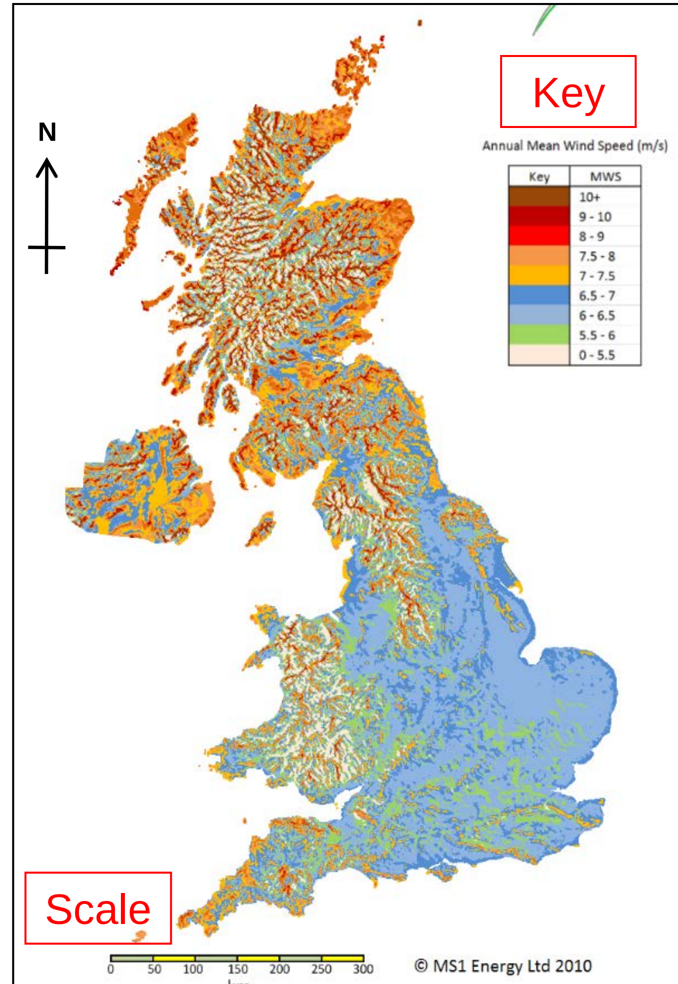
- Maps are a 2-D representation of a 3-D world. They are a ‘bird’s eye’ view – as if the viewer is ‘flying’ above the land surface and looking down on it

- They show how objects are distributed and their relative size

- Maps are a very useful way of visualizing all sorts of data and they are a key tool for geoscientists

The same map outline can be used to show different information, so it is important to identify the map title, key, scale and orientation



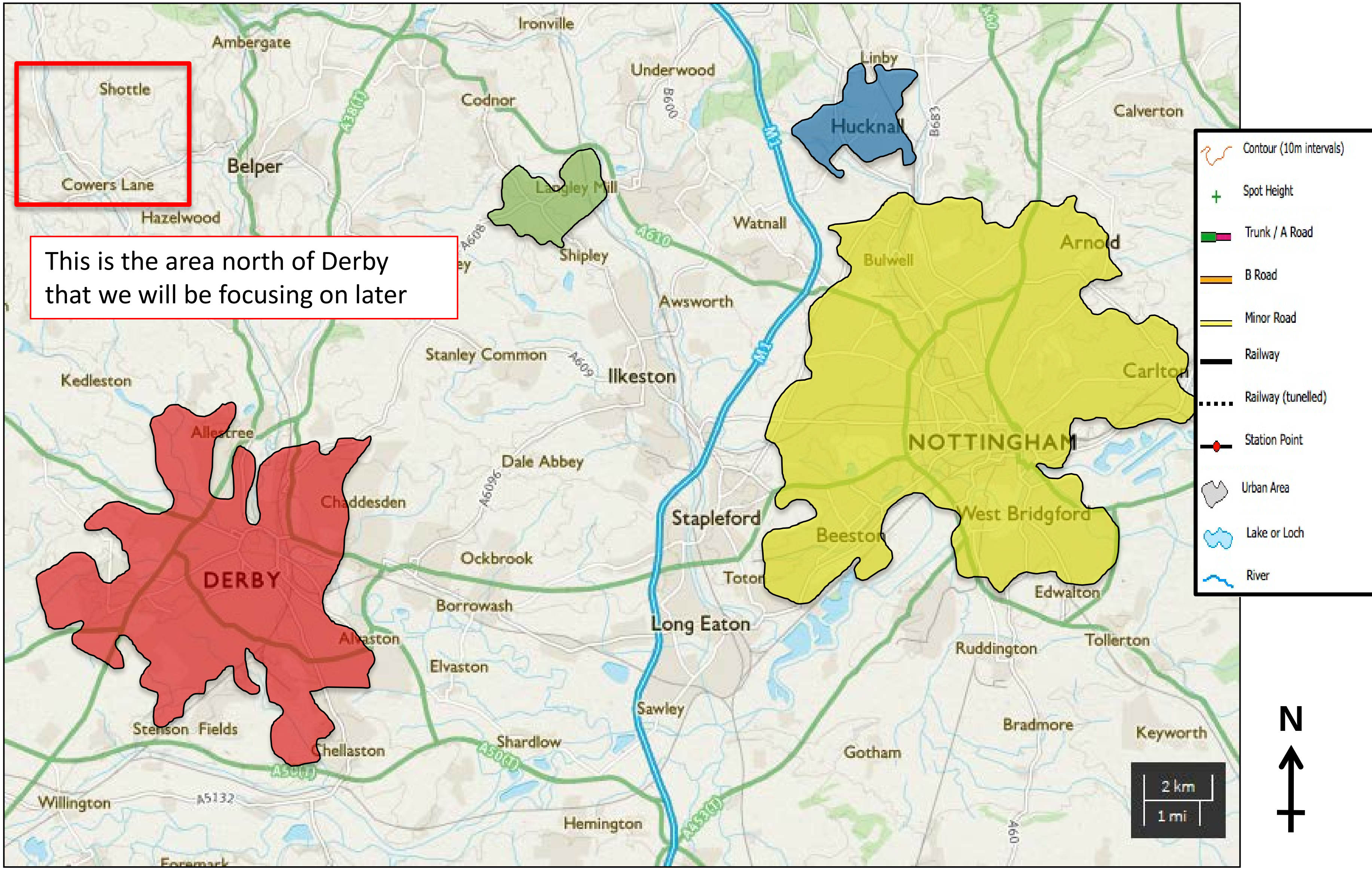


Title

UK Bedrock Geology

UK Annual Mean Wind Speed

Maps show how objects are distributed and their relative size



Scales

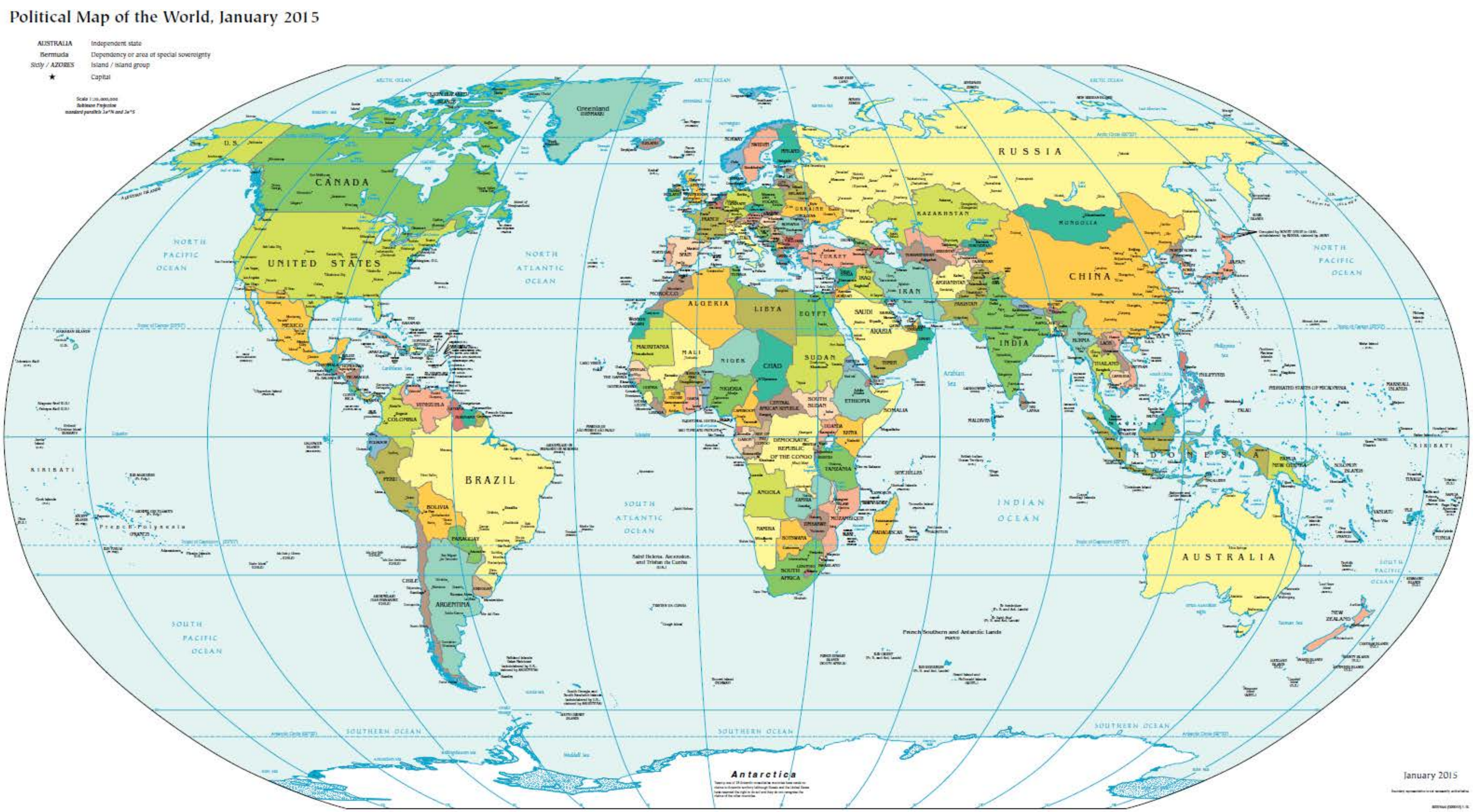
- Show the distance on the map compared to the distance on the ground
- It is important to choose an appropriate map scale for the task you are undertaking
- Common scales include:

  1:30 000 000 (e.g. world map or atlas)
  1:1 000 000 (e.g. country map)
  1:50 000 (e.g. regional map)
  1:10 000 (e.g. local map)

- A map scale of 1:50 000 means:

  1mm on the map represents 50 000mm or 50m or 0.05km on the ground

Scales with large numbers (e.g. 30 million) produce maps covering a large area in little detail



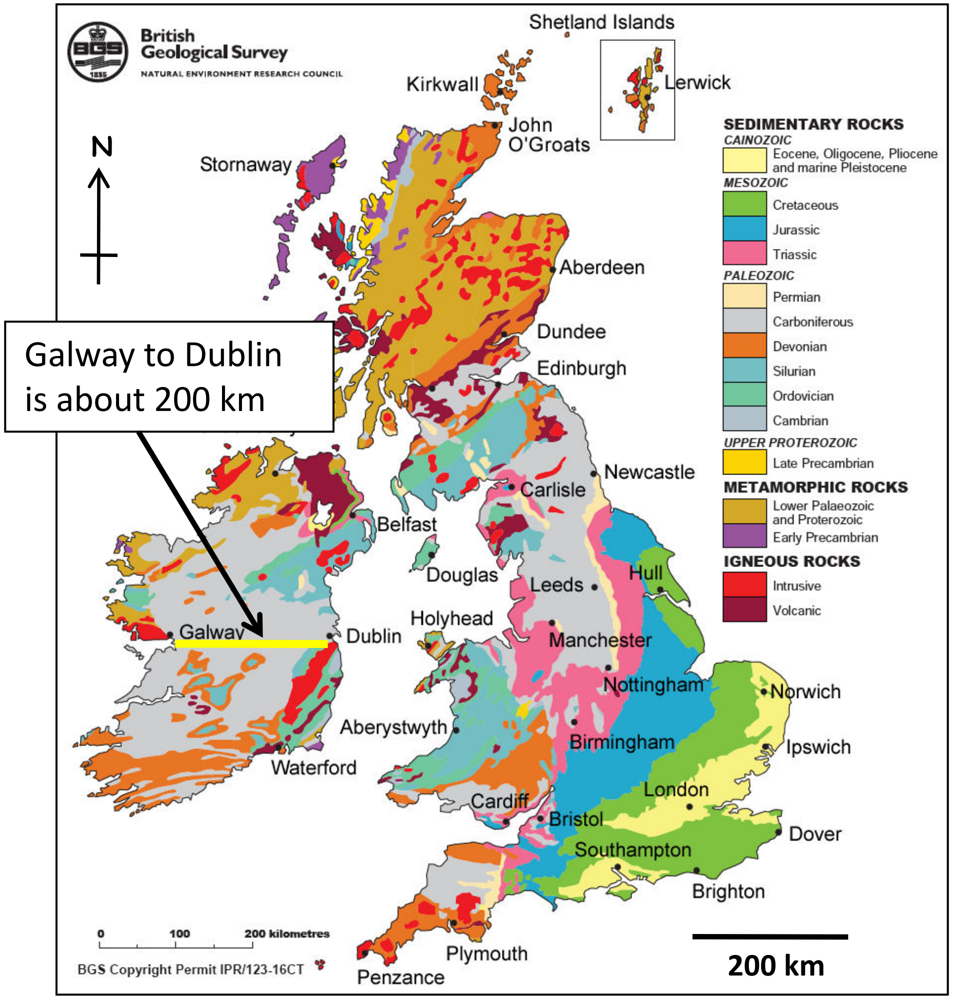
https://www.cia.gov/library/publications/the-world-factbook/docs/refmaps.html

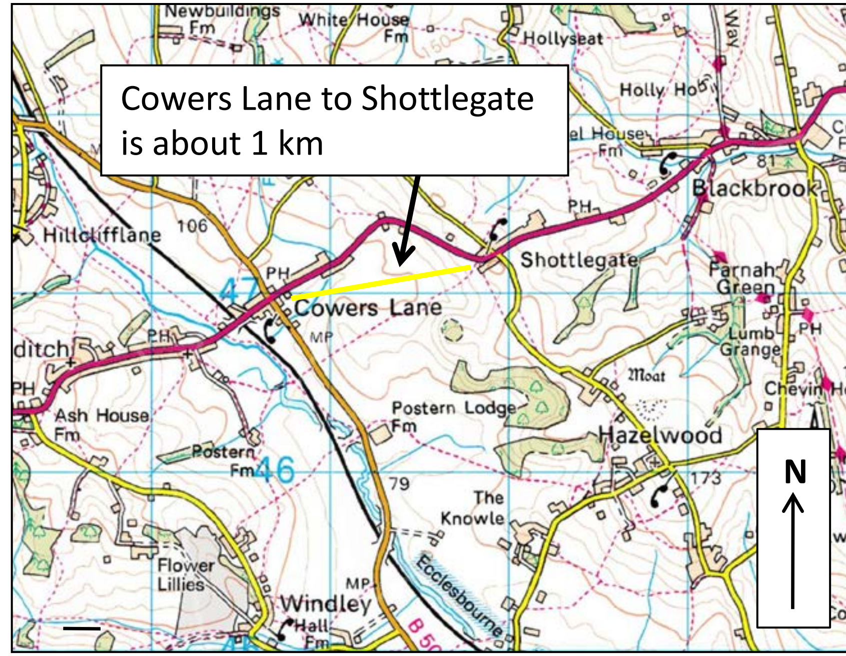
In contrast, on a 1:50 000 map, individual buildings, minor roads and contours are evident

1 km

N

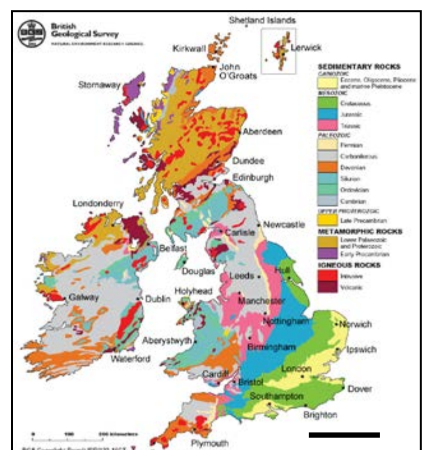
The scale bar shows a measurement on the map and the specific distance it represents on the ground





© Crown Copyright/database right 2014. An Ordnance Survey/EDINA supplied service.

1 km



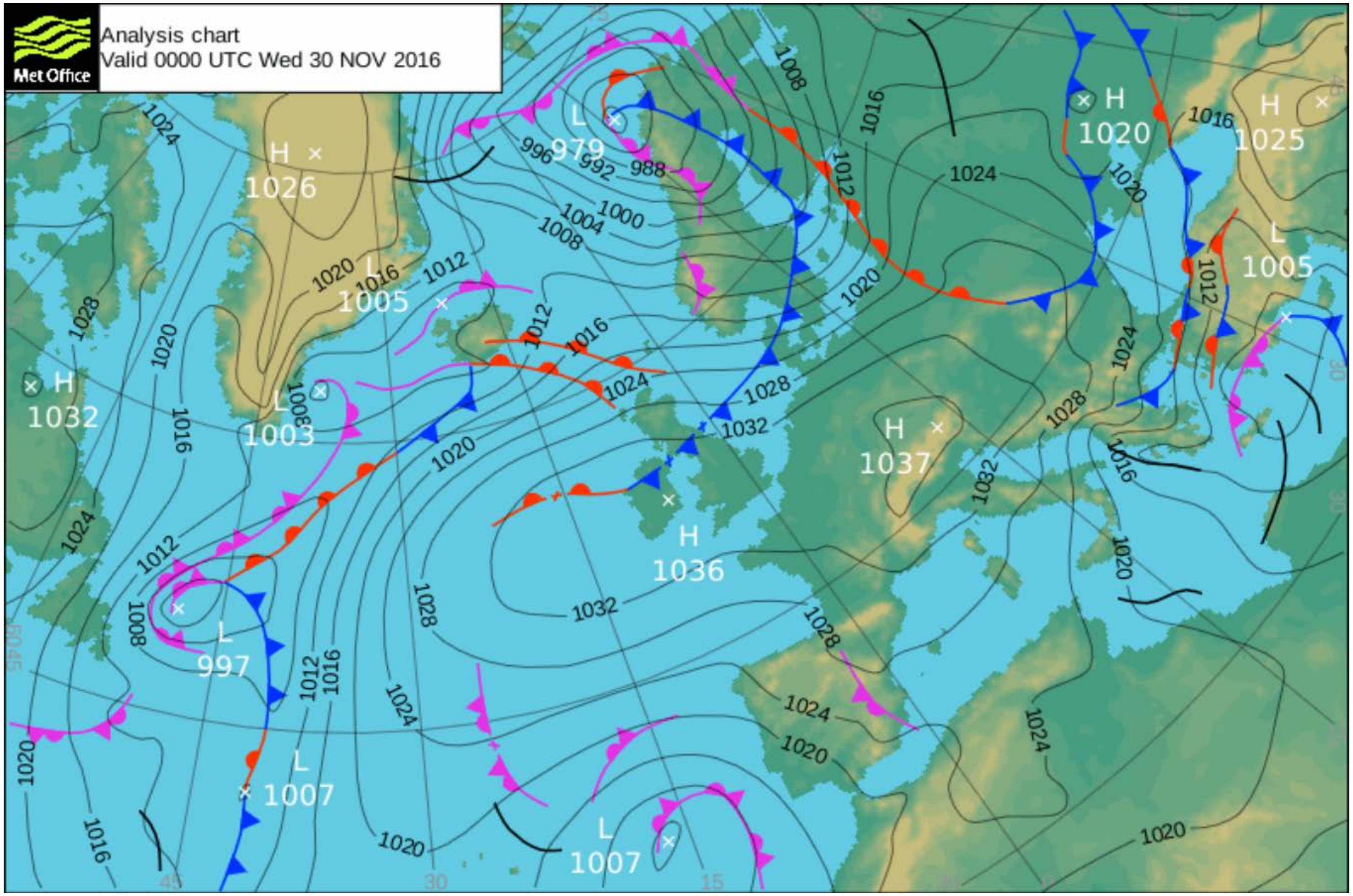
Contours

- Contours are lines joining points of equal value. This value on topographic maps is height (or elevation/altitude) above mean sea level (MSL)

- Each successive contour represents an increase or decrease in constant value. Often every 5th contour will be in bold to help identification

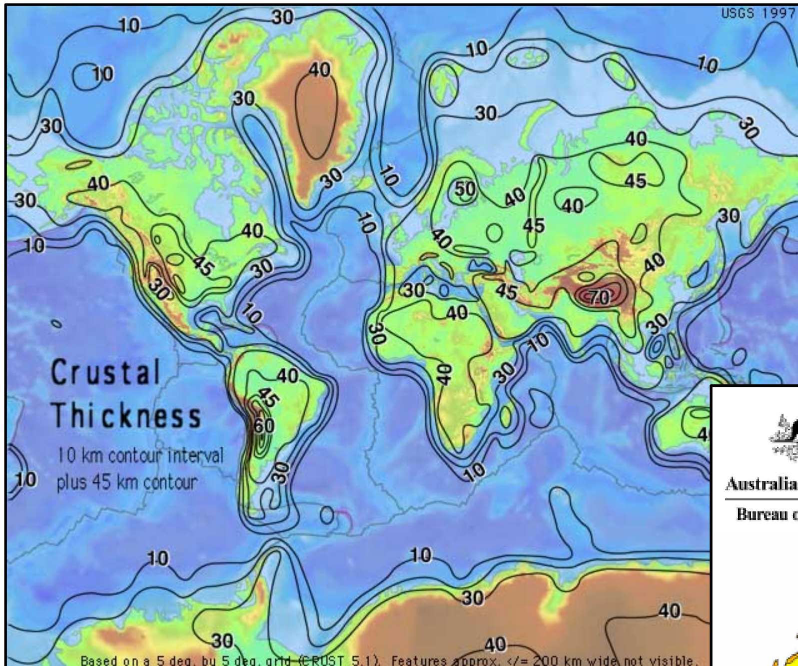
- Contours are normally associated with changes in height, but they can represent any parameter (e.g. thickness, pressure, rainfall). They can also be called iso-lines (e.g. isopachs, isobars, isohyets)

Contours show the distribution and relative size of any measured value

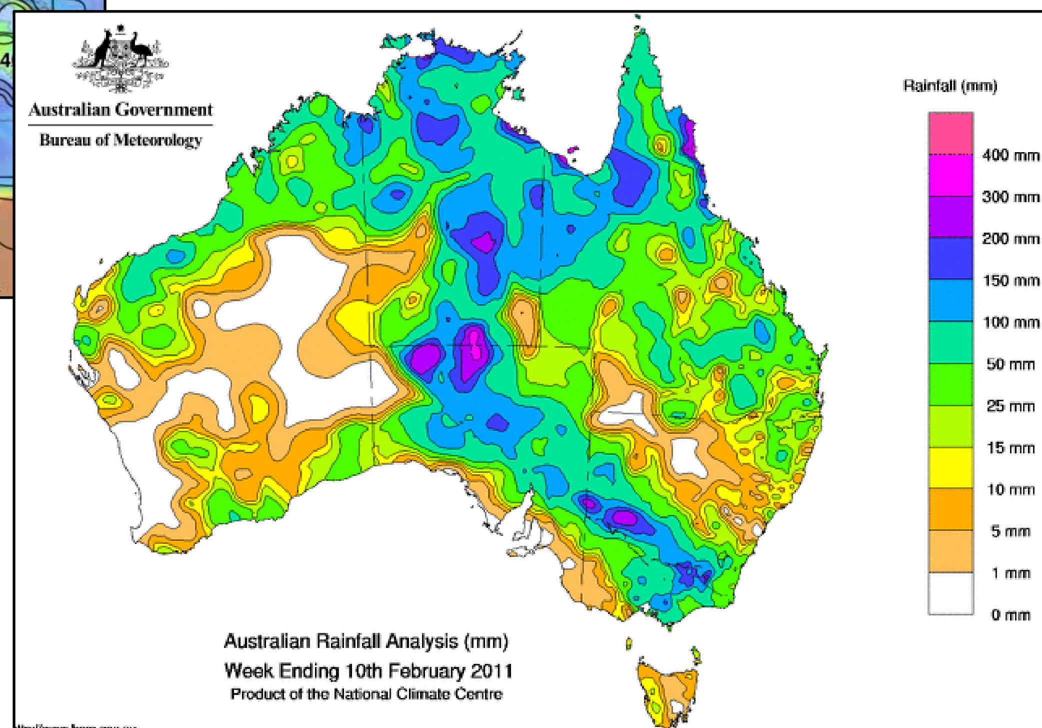


Surface air pressure is measured in millibars and is shown here as isobars

Contours can show the distribution and relative size of any measured value

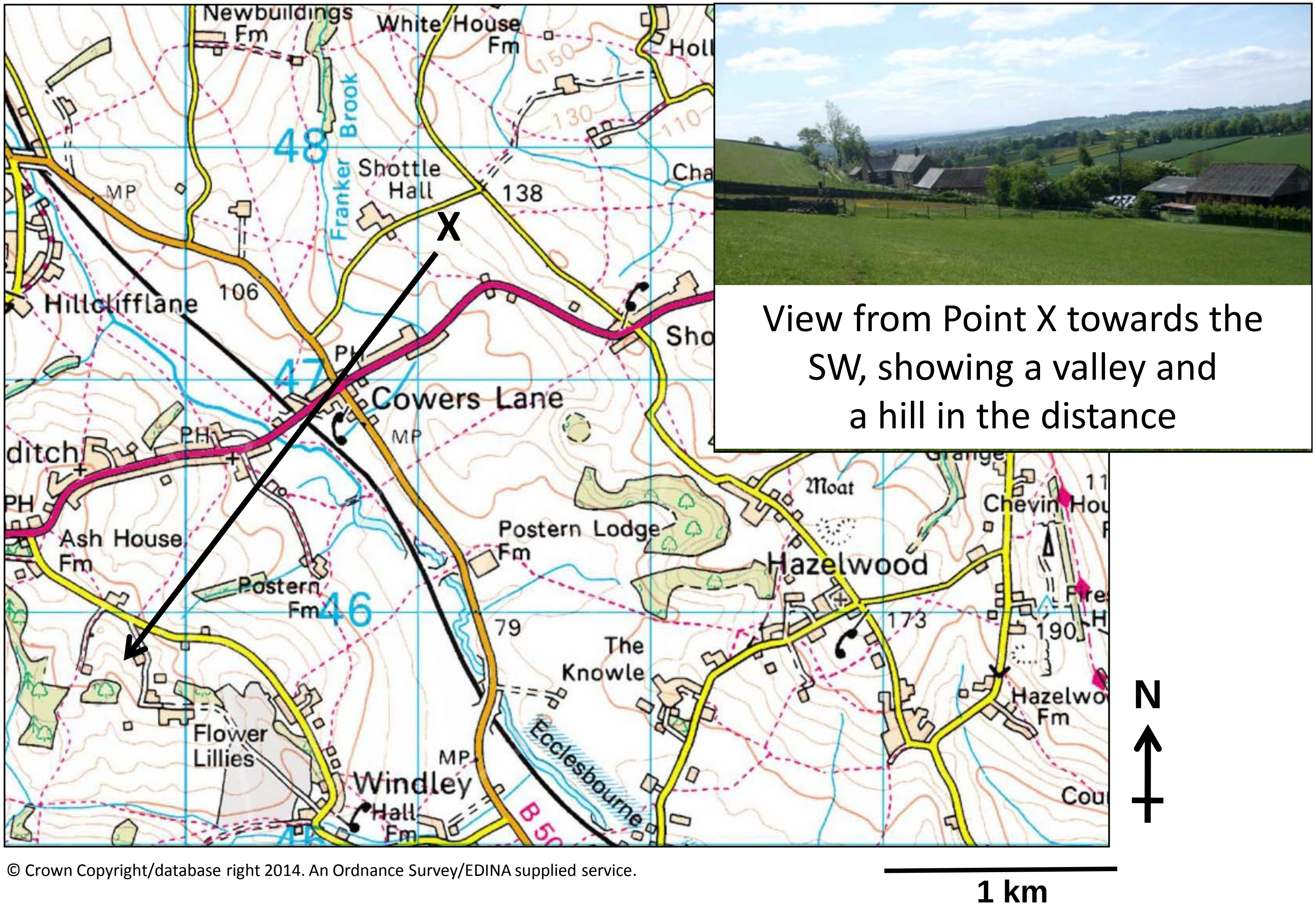


This map shows the thickness of the Earth's crust (in kms)



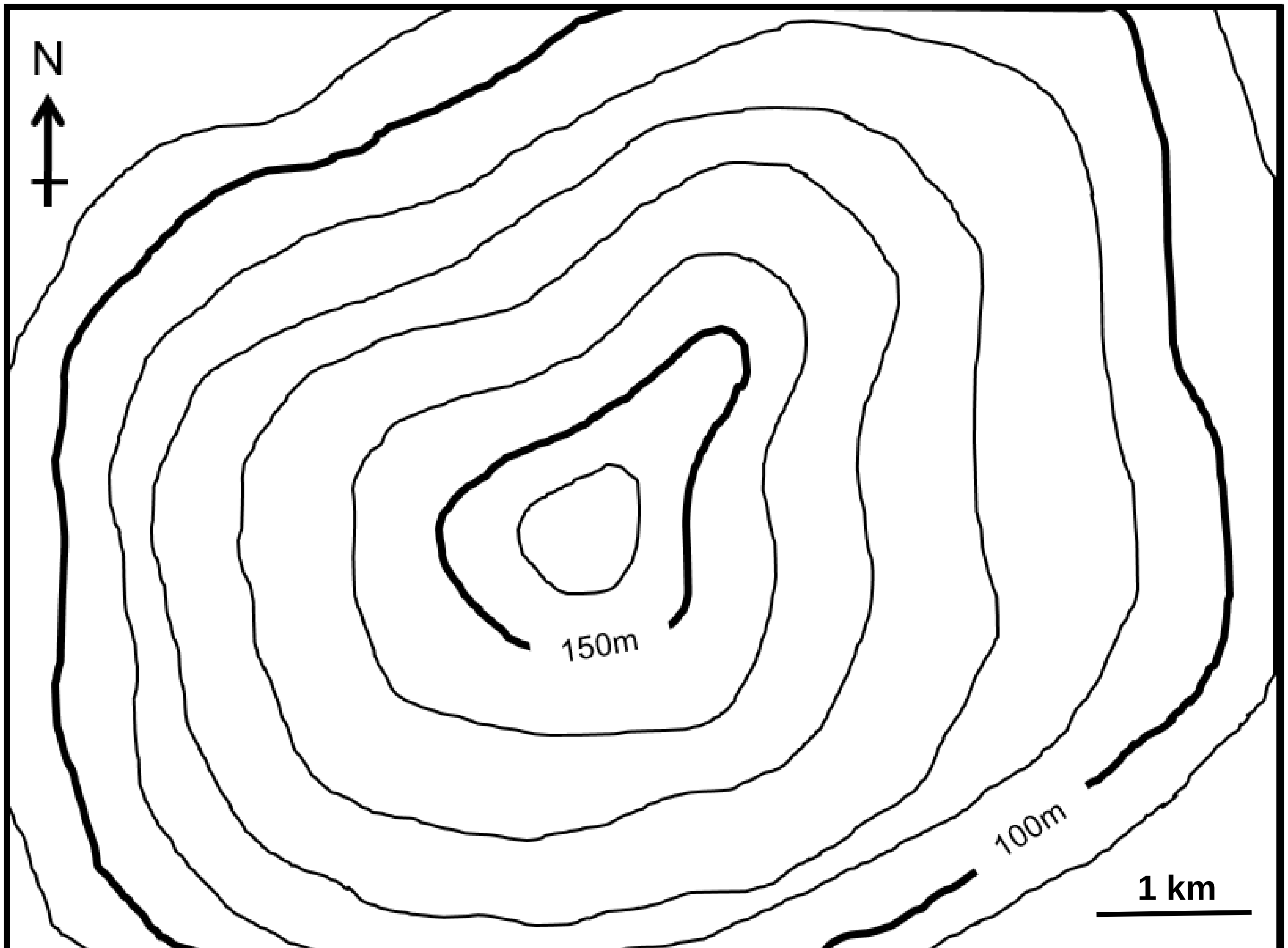
This map shows rainfall data for Australia (in mm)

Let's return to topographic maps - on the map the land surface looks flat, but the contours indicate otherwise

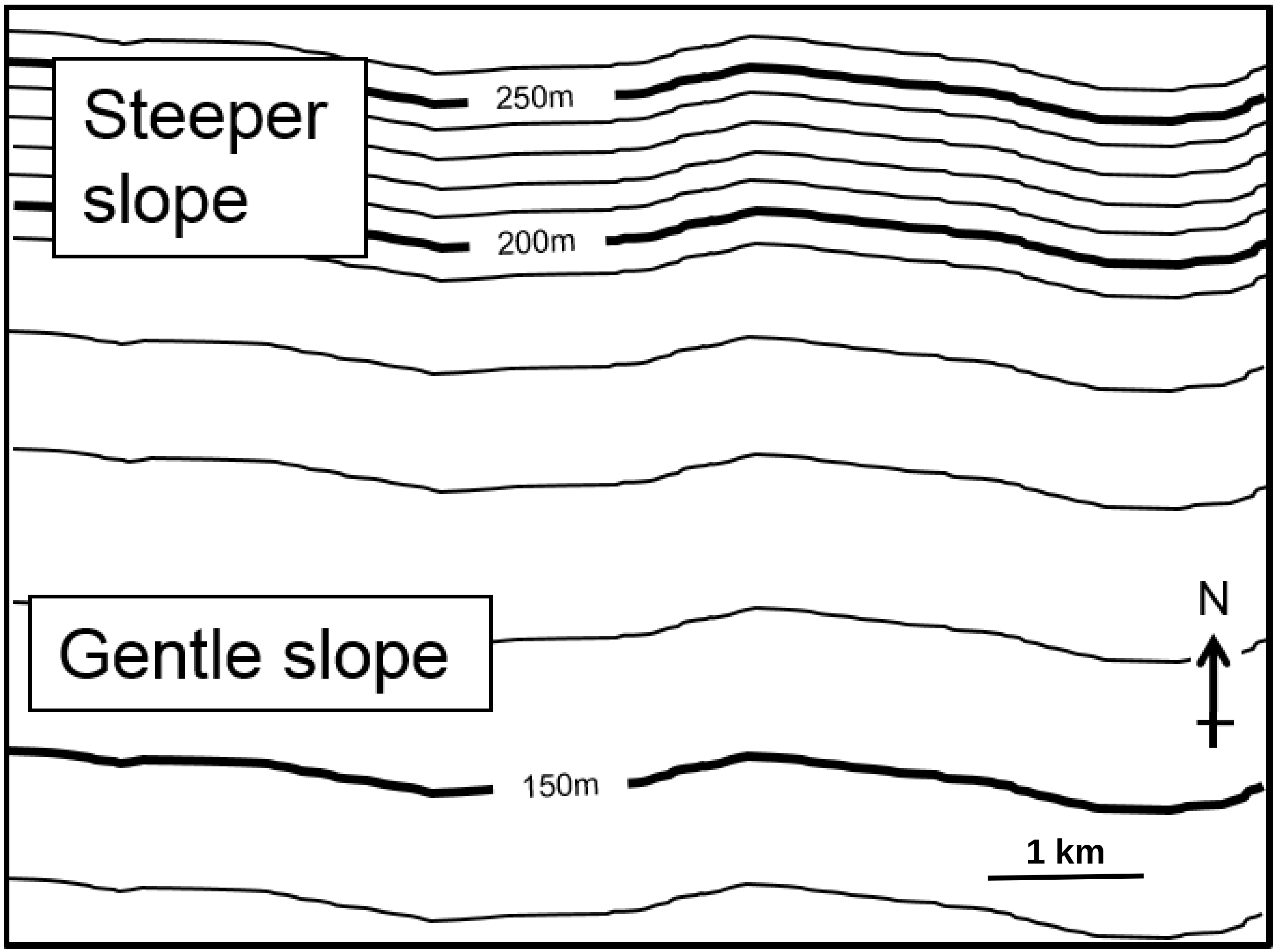


View from Point X towards the SW, showing a valley and a hill in the distance

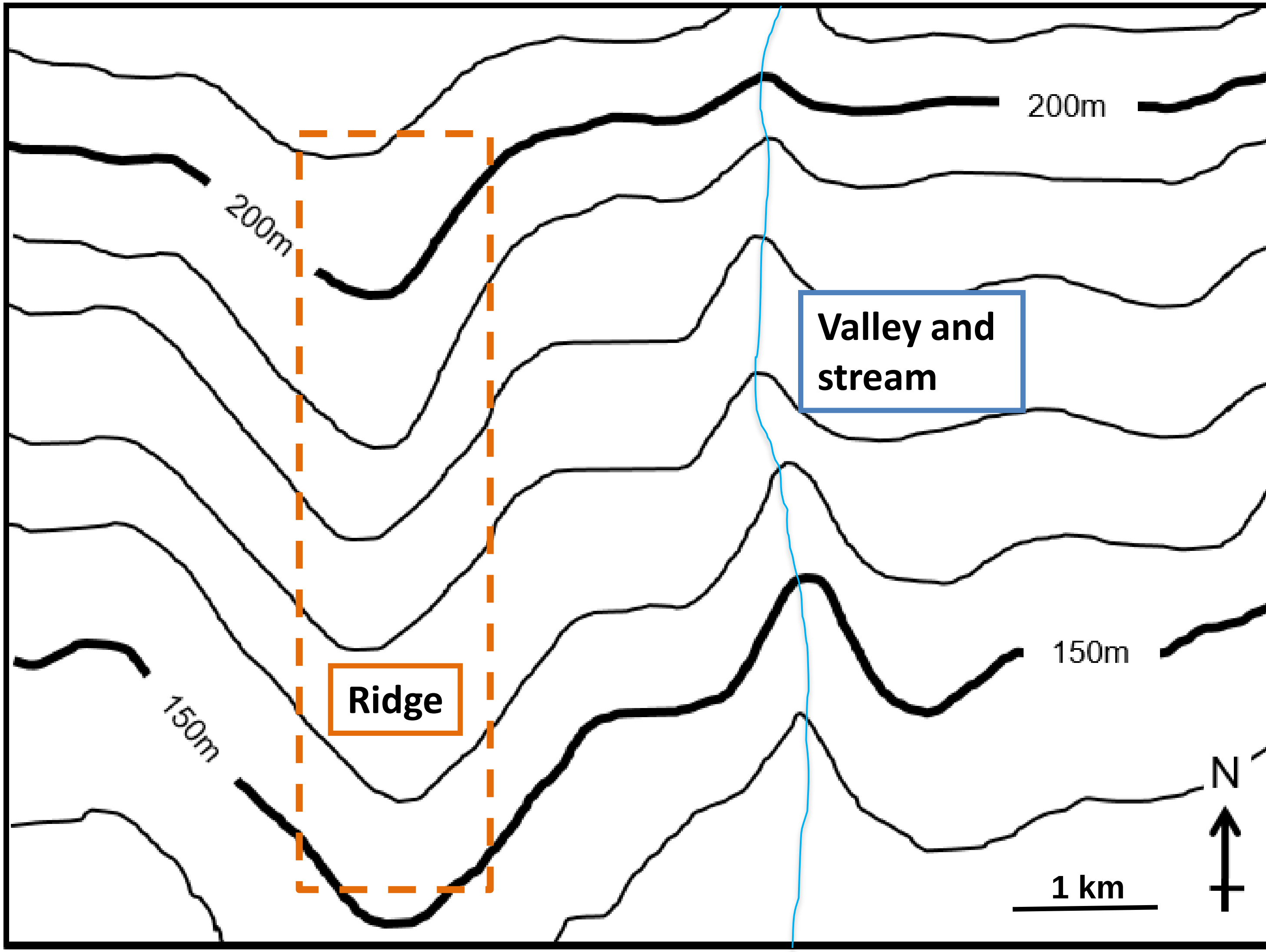
Contours never cross and will at some point close, although this may be off the map. Topographic contours that close in concentric patterns delineate hills or depressions



Contours are drawn perpendicular to the maximum slope, with the spacing between contours indicating the steepness of the slope



Based on the shape of contours, landforms such as valleys and ridges can be recognised



This image highlights the real shape of two hills and how they are shown on a contour map

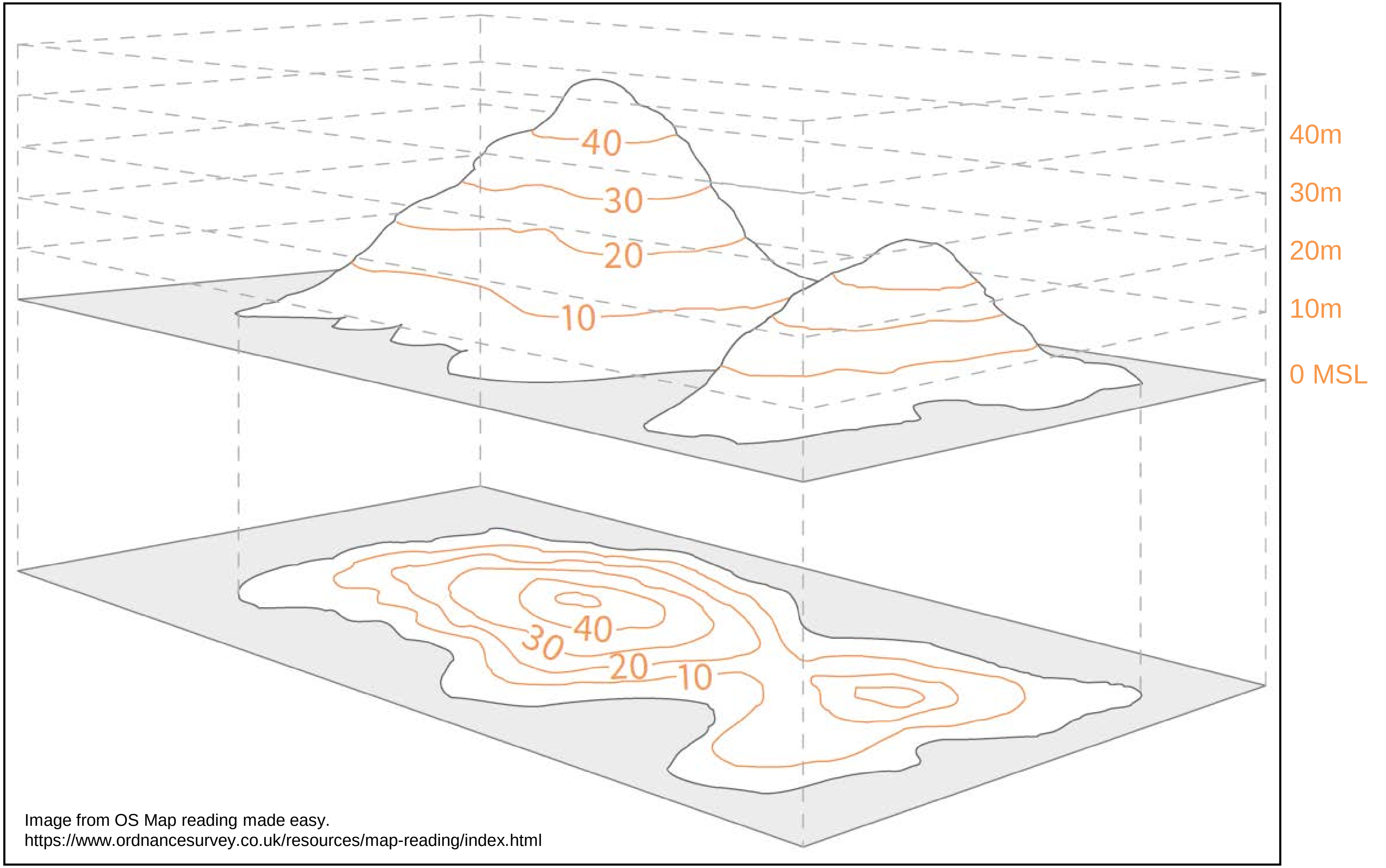


Image from OS Map reading made easy.
https://www.ordnancesurvey.co.uk/resources/map-reading/index.html

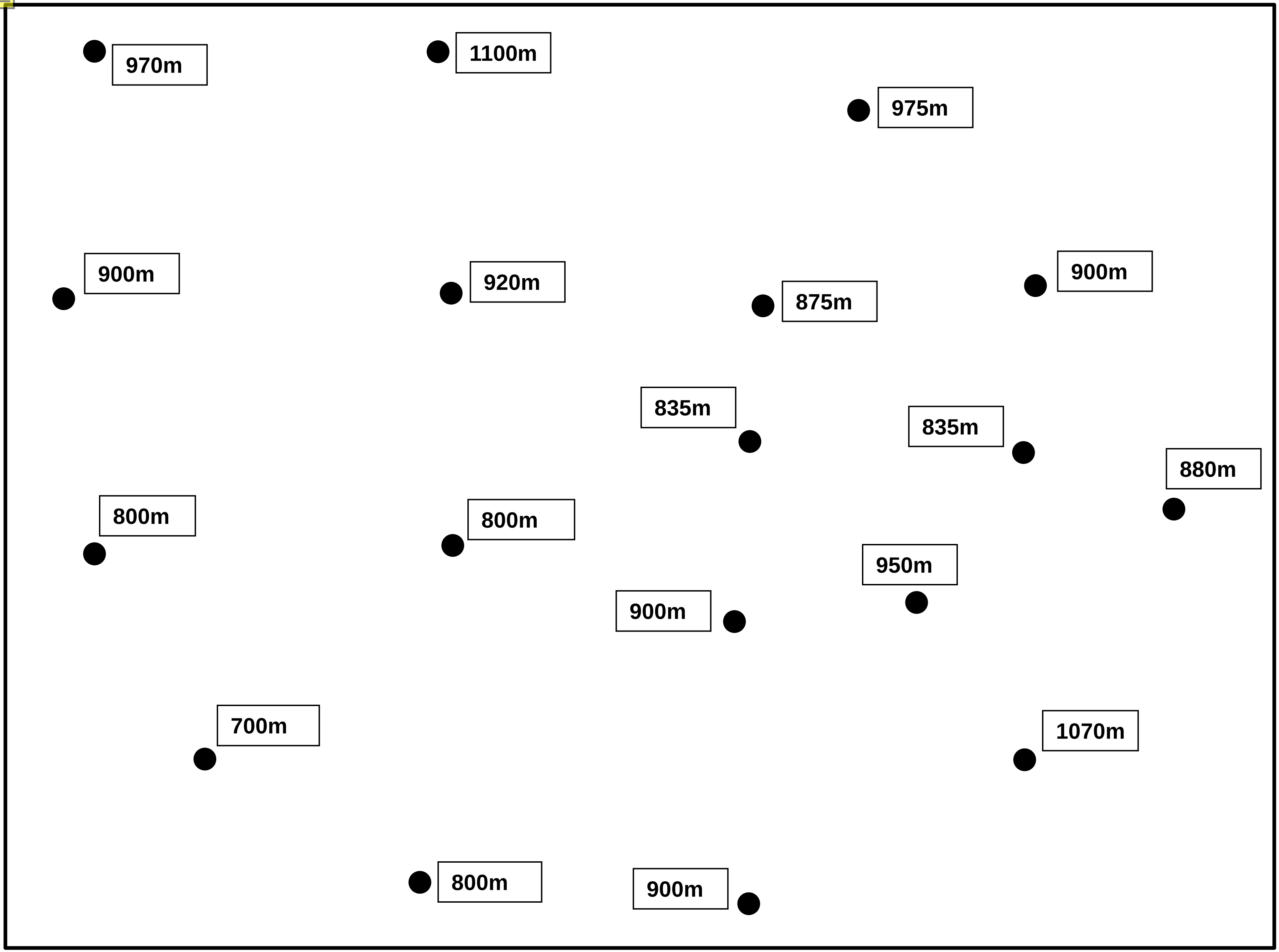
You can watch a video explaining how to read contour lines on an Ordnance Survey map

Click here to play…

The Ordnance Survey website has further information on all aspects of maps and map reading, including how to work out grid references and take compass bearings

https://www.ordnancesurvey.co.uk/resources/map-reading/index.html

Practical exercise 1
Drawing contours

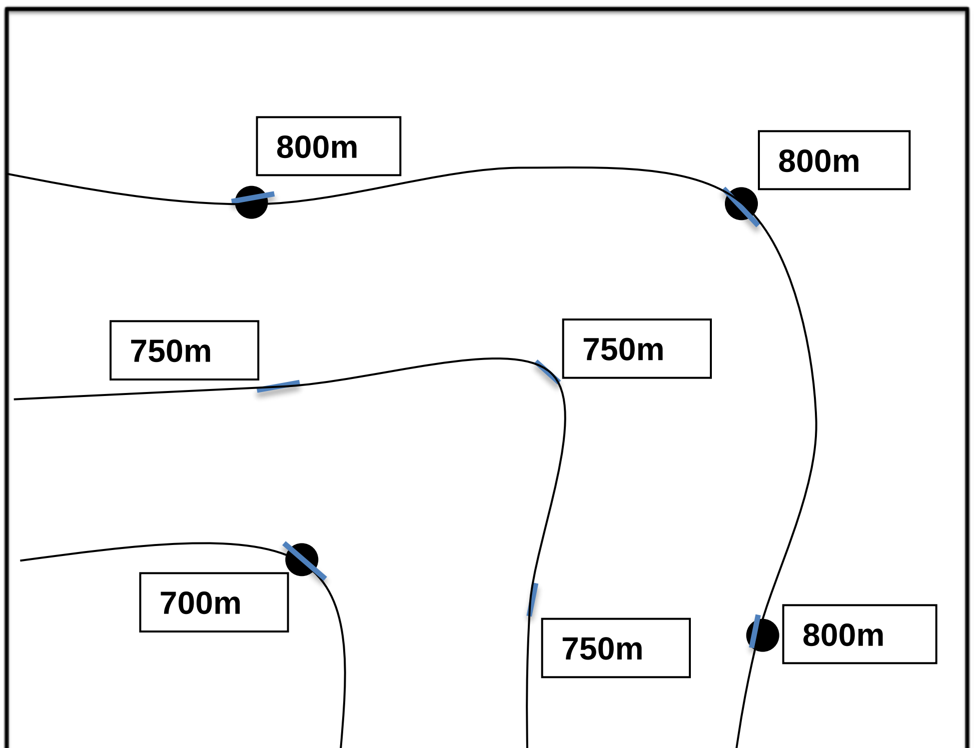


970m
1100m
975m
900m
920m
875m
900m
835m
835m
880m
800m
800m
950m
900m
700m
1070m
800m
900m

The easiest way to draw a contour map based on spot heights is to simply interpolate between the known values.

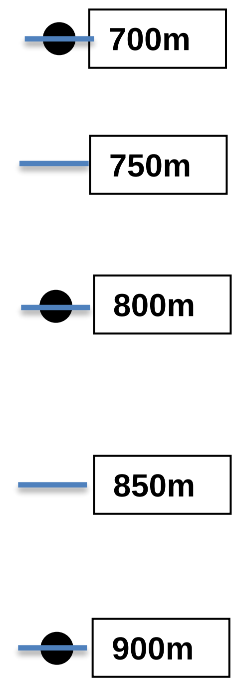
As you interpolate between points make sure you label the new values, as it quickly becomes very confusing if you don't!

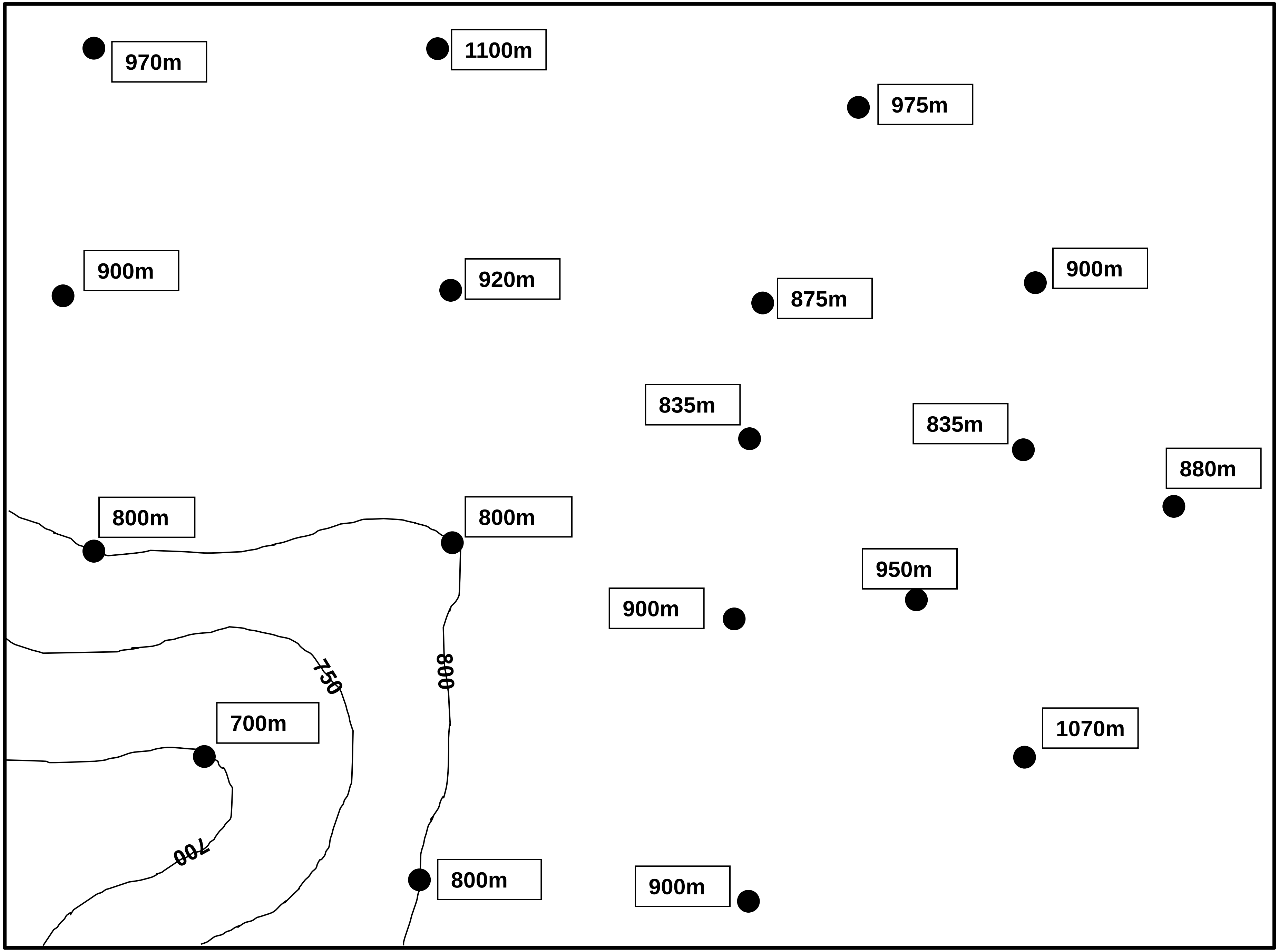
Then join identical values with smooth curves to create contours that simulate topography



Start by interpolating between individual points, labelling new values as you go.

Then join up all the original and interpolated points of equal value to form contours.

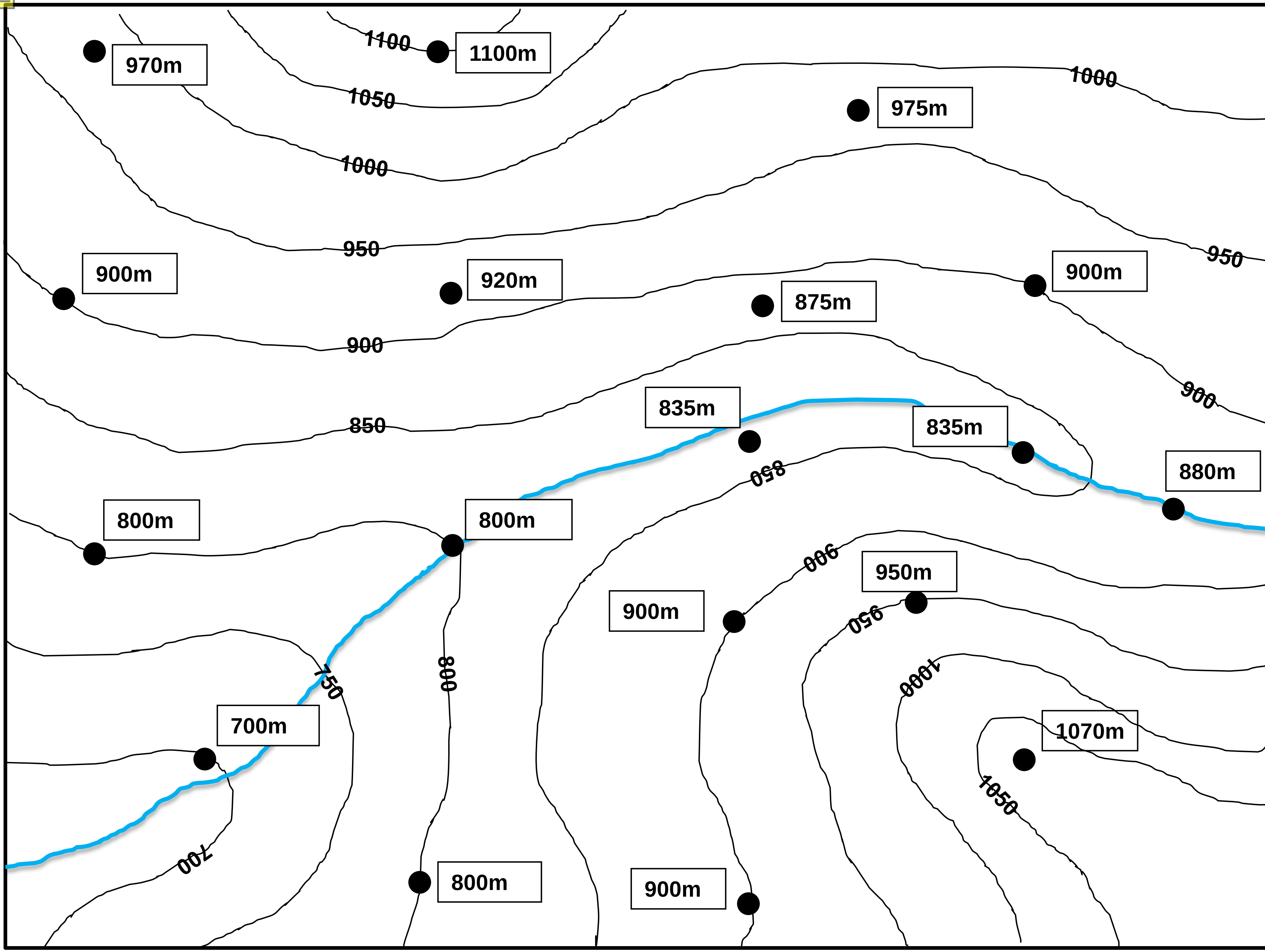




970m
1100m
975m
900m
920m
875m
900m
835m
835m
880m
800m
800m
950m
900m
750
800
700m
1070m
700
800m
900m

Completing the contouring exercise

- Based on the contour map you have created:
  - Where is the highest ground?
  - Where is the lowest area?
  - Describe the major landforms
  - Mark on the most likely course of a stream and determine in which direction it is flowing


970m
1100
1100m
1050
1000
975m
1000
950
950
900m
920m
875m
900m
900
900
900
850
835m
835m
850
880m
800m
800m
900
950m
900m
950
750
800
1000
700m
1070m
1050
700
800m
900m

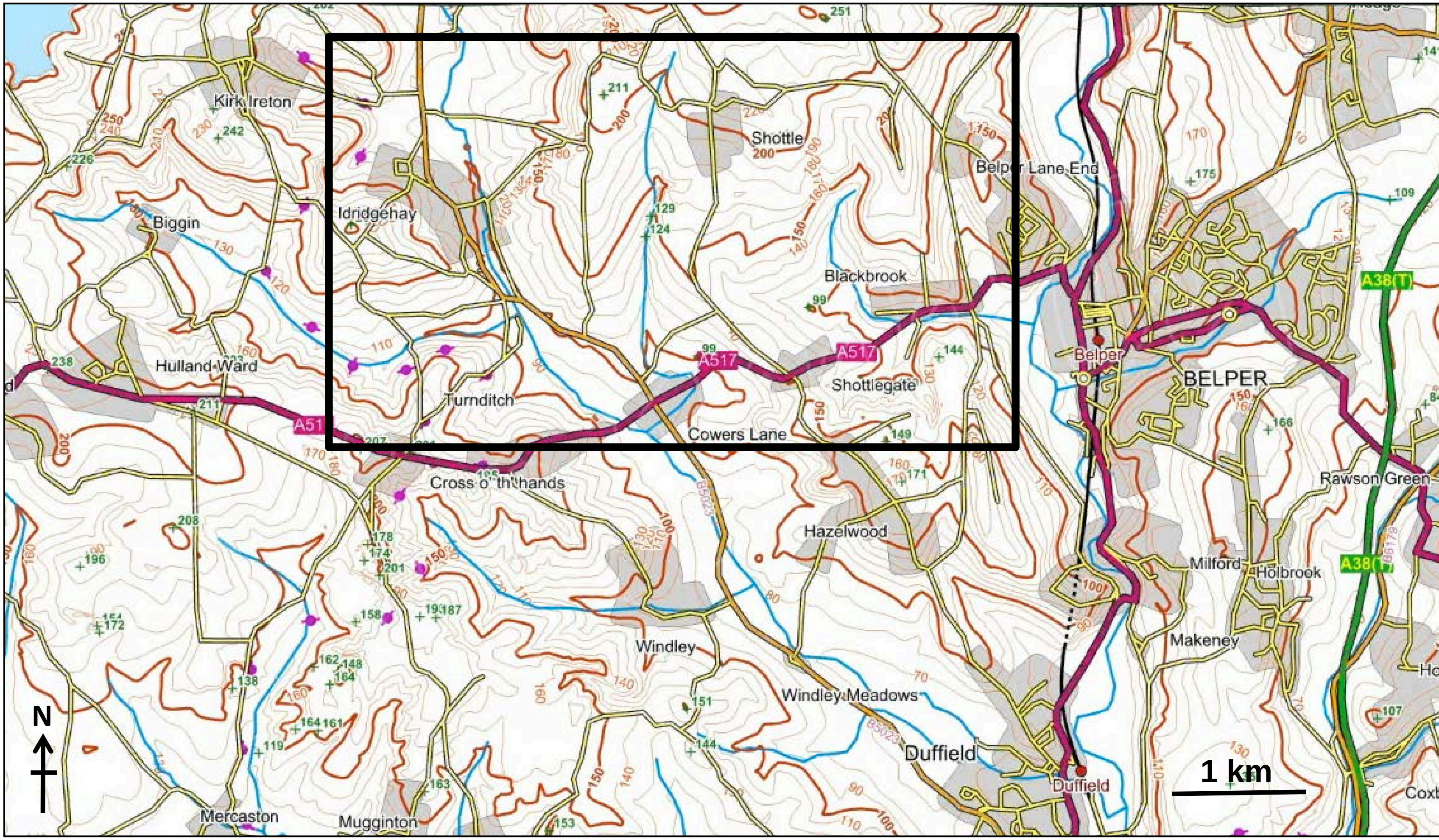
Part 2 – Map interpretation

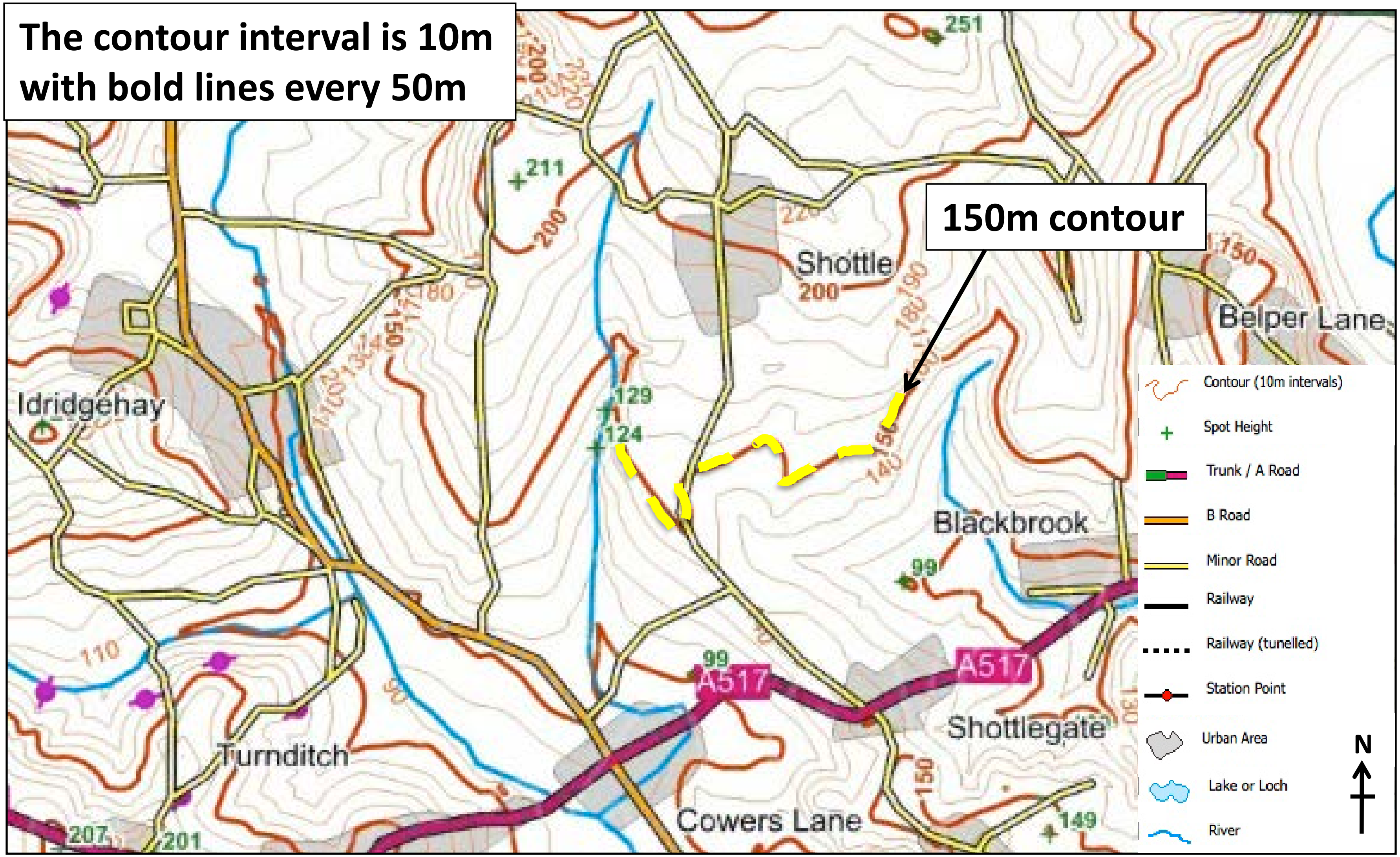
- Contour patterns can be used to recognise distinctive landforms such as ridges, valleys and hills

- Contours may appear as black or coloured lines on maps, and are often supported by colour shading to give an impression of relief

- Cross-sections provide a useful way of visualizing the shape of the land surface, but care needs to be taken in their construction, particularly in terms of vertical exaggeration

Previously we looked at the topography in this area – let's take a closer look at the contours

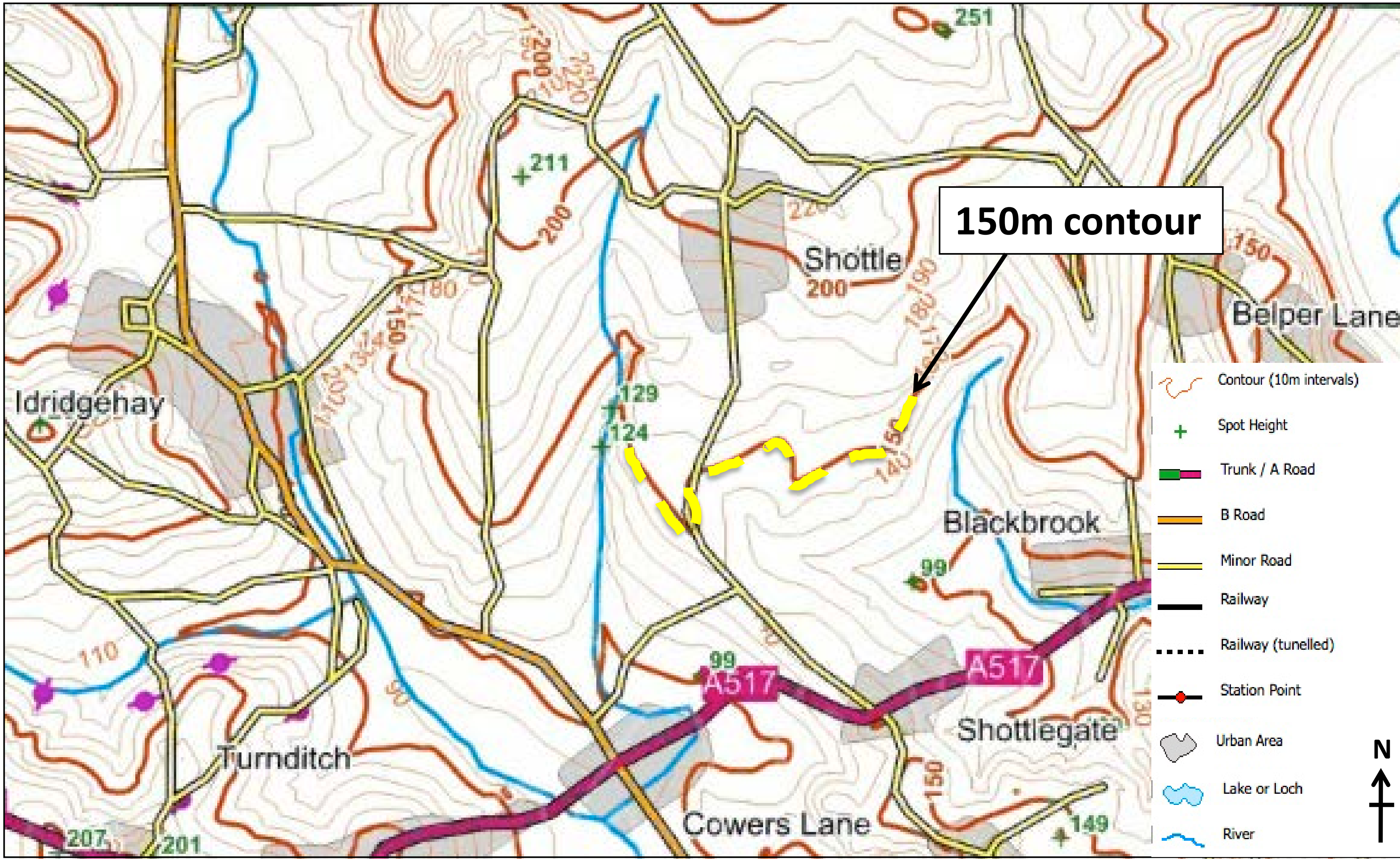




1 km

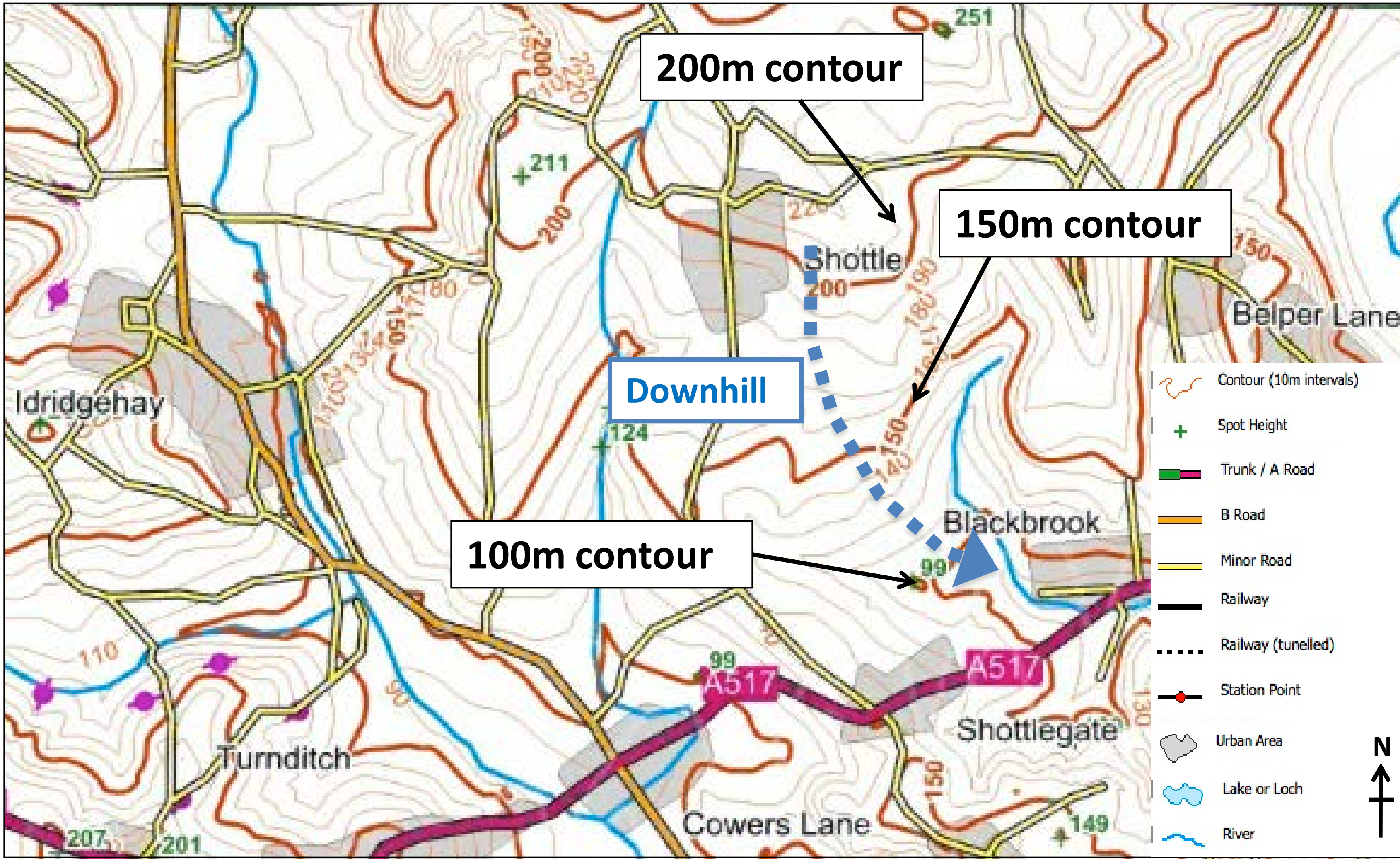
What is the contour interval?

Locate the 150m contour between Shottle and Blackbrook

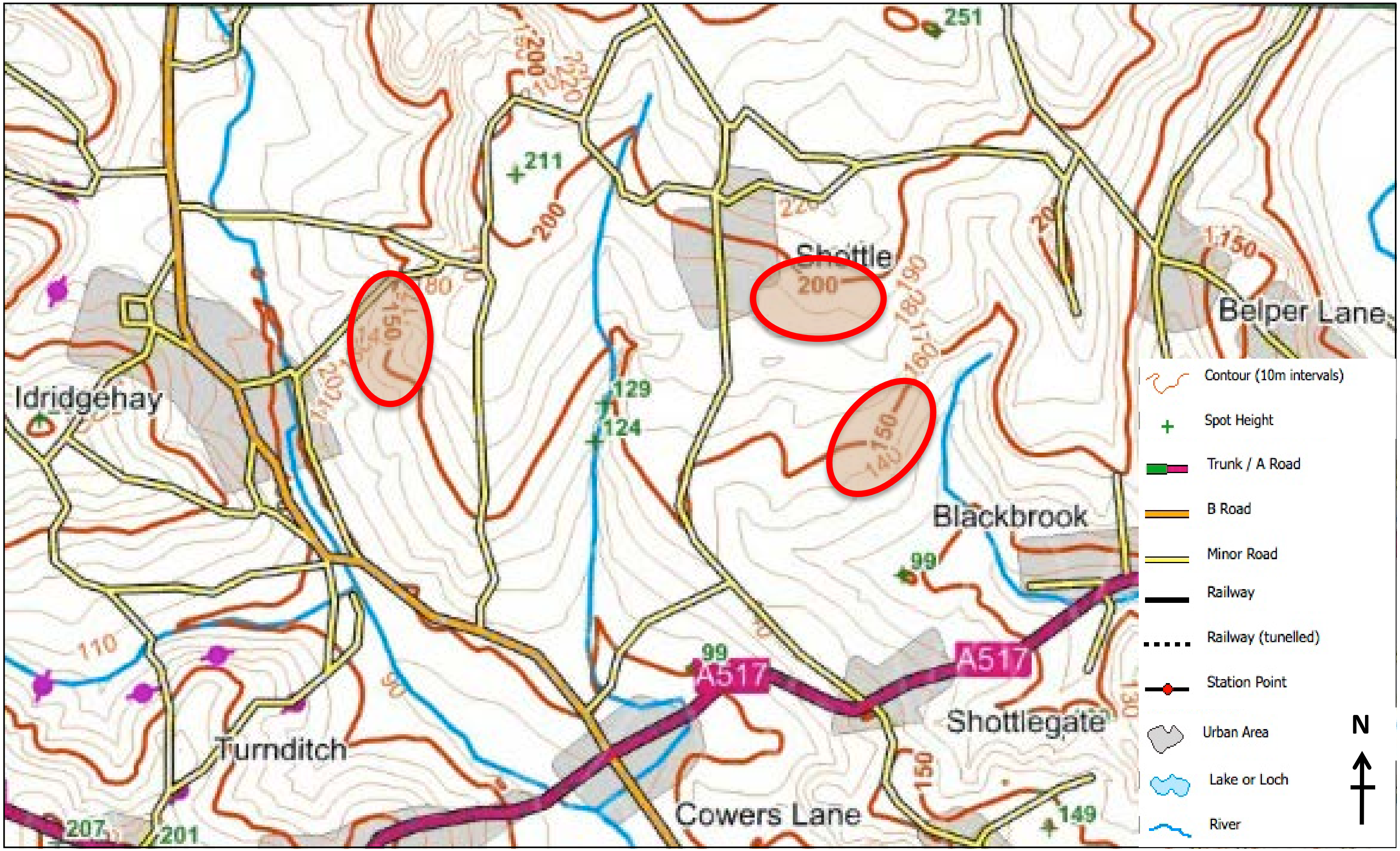


If you walked along this contour, what would your route be like?

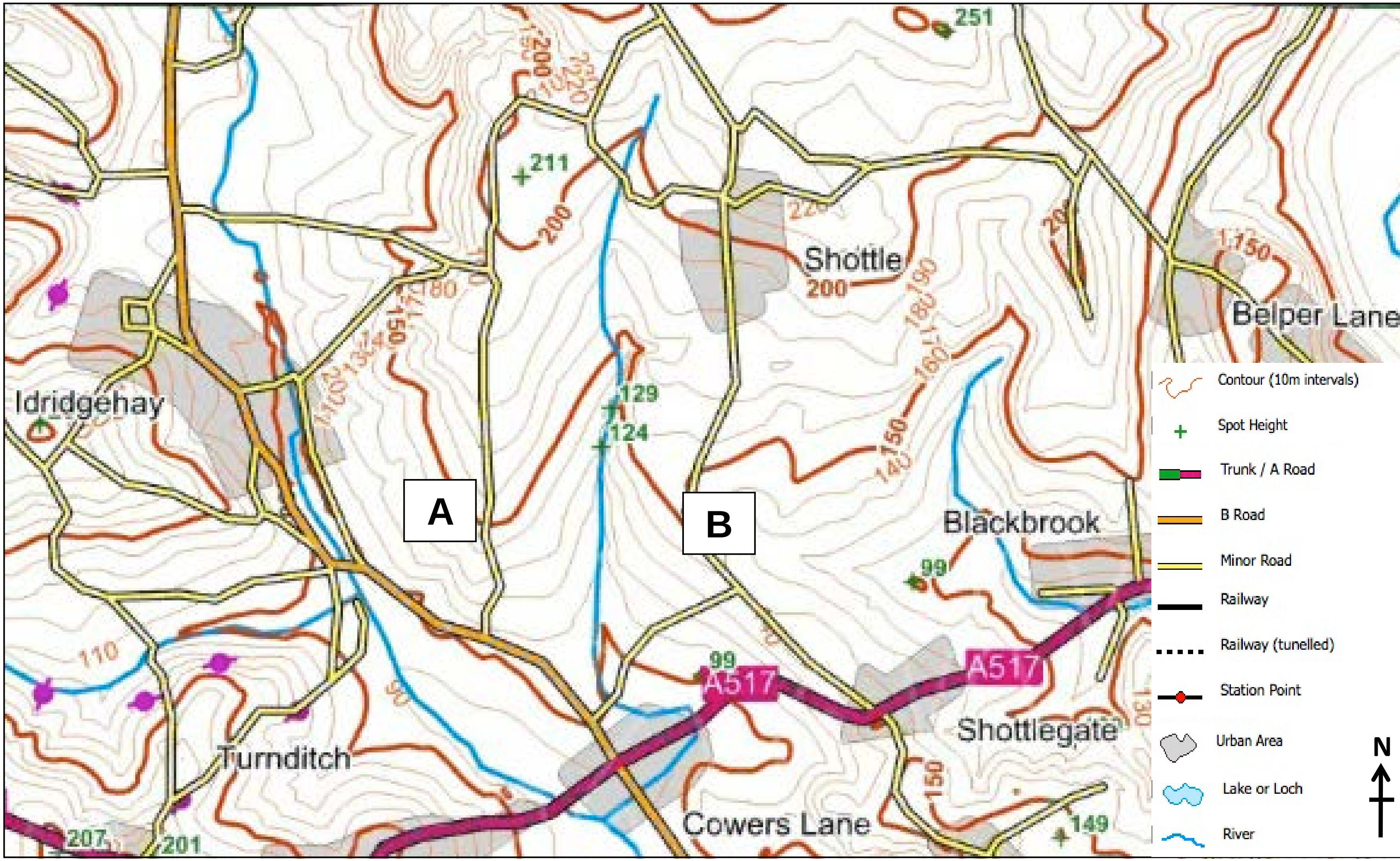
Flat, as long as you remain on the 150m contour



Which direction is downhill from the 150m contour?



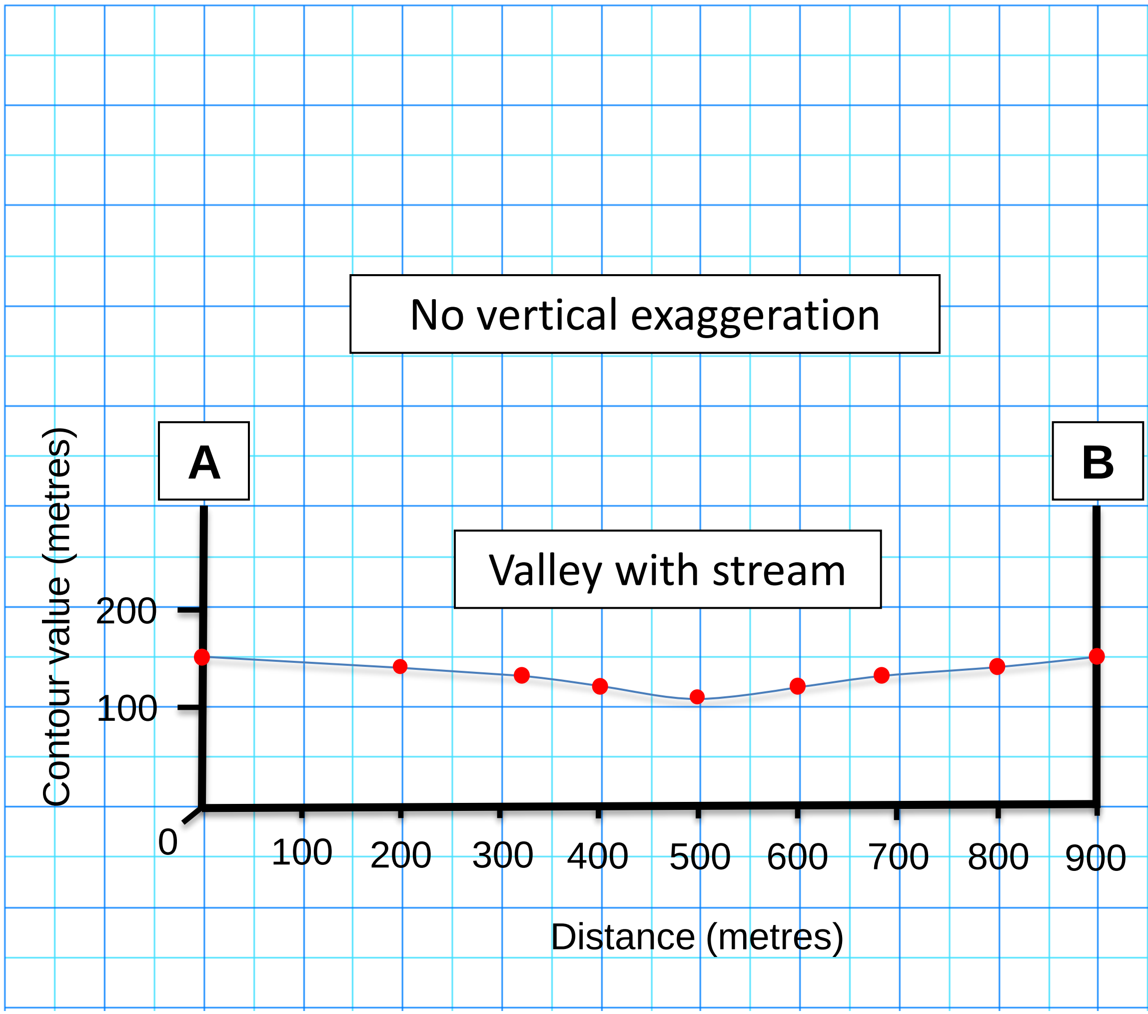
What else about the contours help to determine the direction of slope? The contour values are perpendicular to the slope, with the bottom of the number on the downhill side



1 km

What does the hillside look like if you stand at Point A and look towards Point B? It would go downhill to the stream and then uphill again to Point B

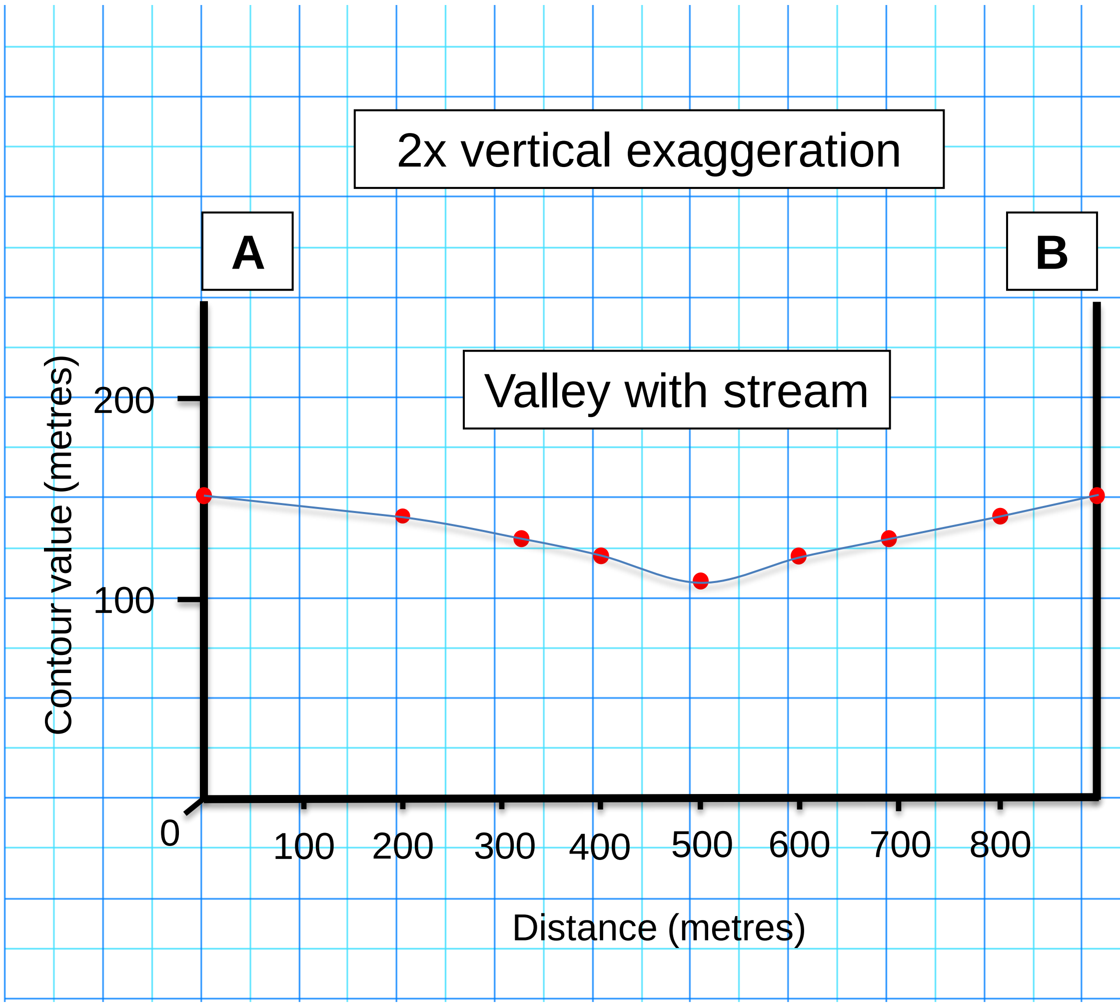
A useful technique to visualise landforms is to draw a cross-section. This one is between Points A and B on the previous map



This image shows a similar valley in the area, confirming the gentle slope angles

The X axis represents distance and the Y axis height

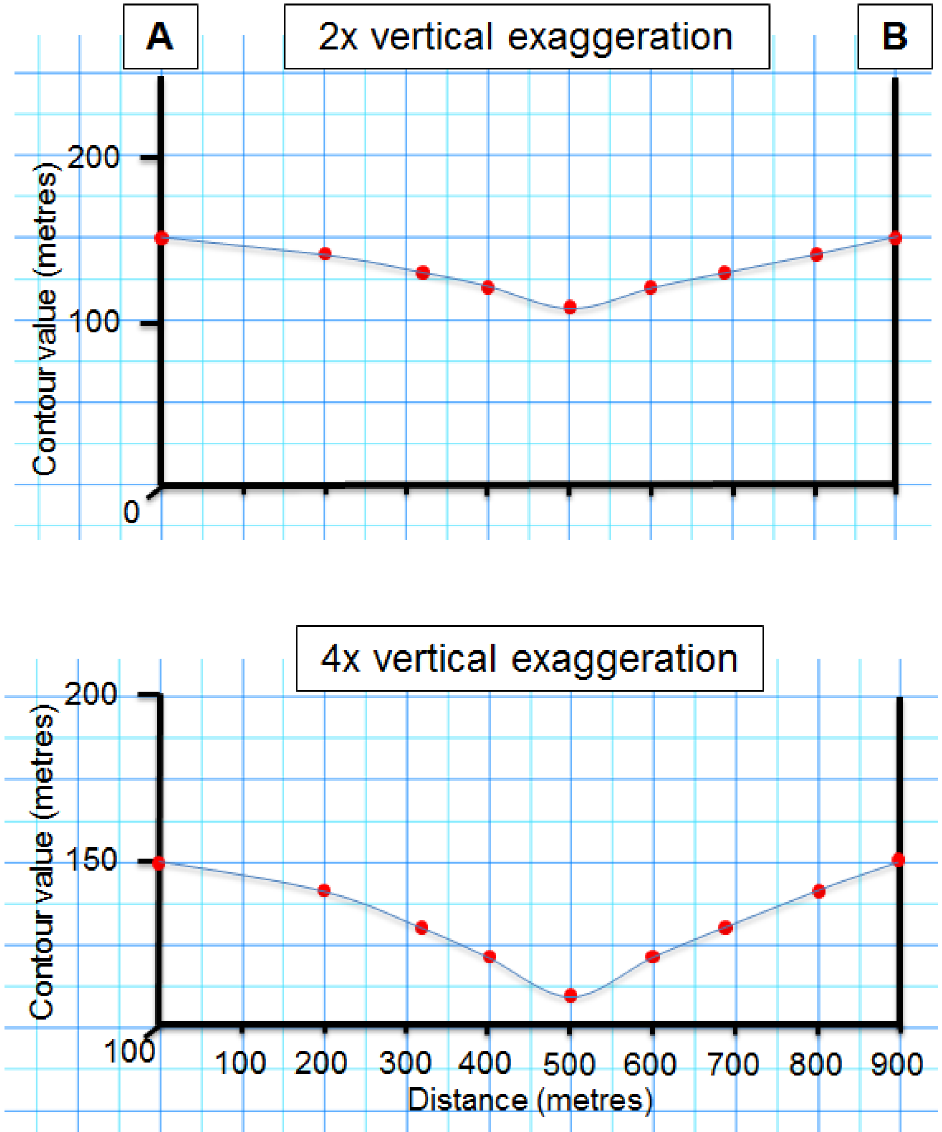
When drawing cross-sections it is important to be aware how the scales affect your perception of slope angle



The purpose will dictate the scales you use. If the cross-section is to highlight relative changes in topography then a vertical exaggeration is fine, despite the fact that it increases the angles of all sloping lines

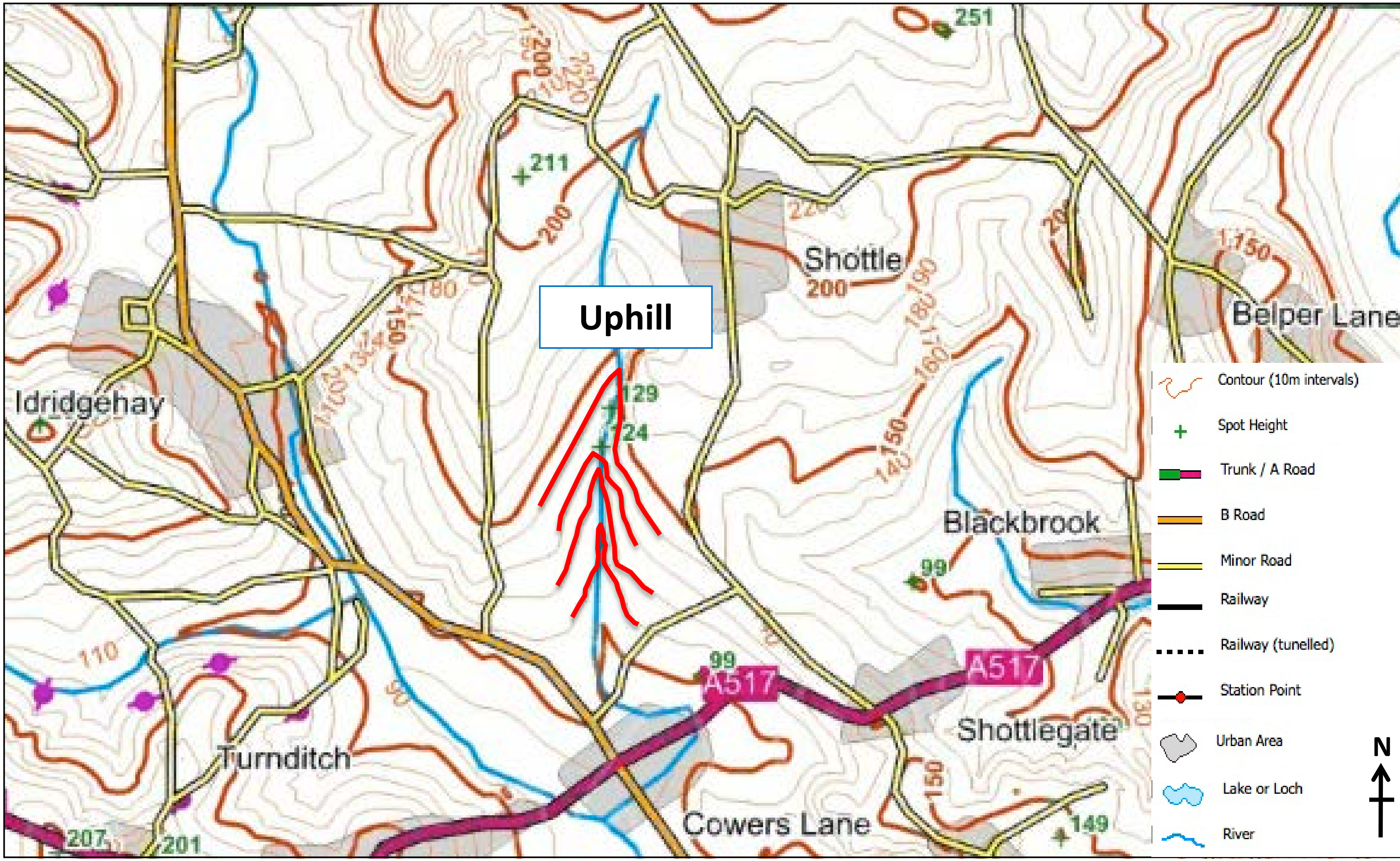
If there is a need to add sub-surface geology or calculate true slope angles, then there should be no vertical exaggeration

Compare the effects of vertical exaggeration on the same cross-section

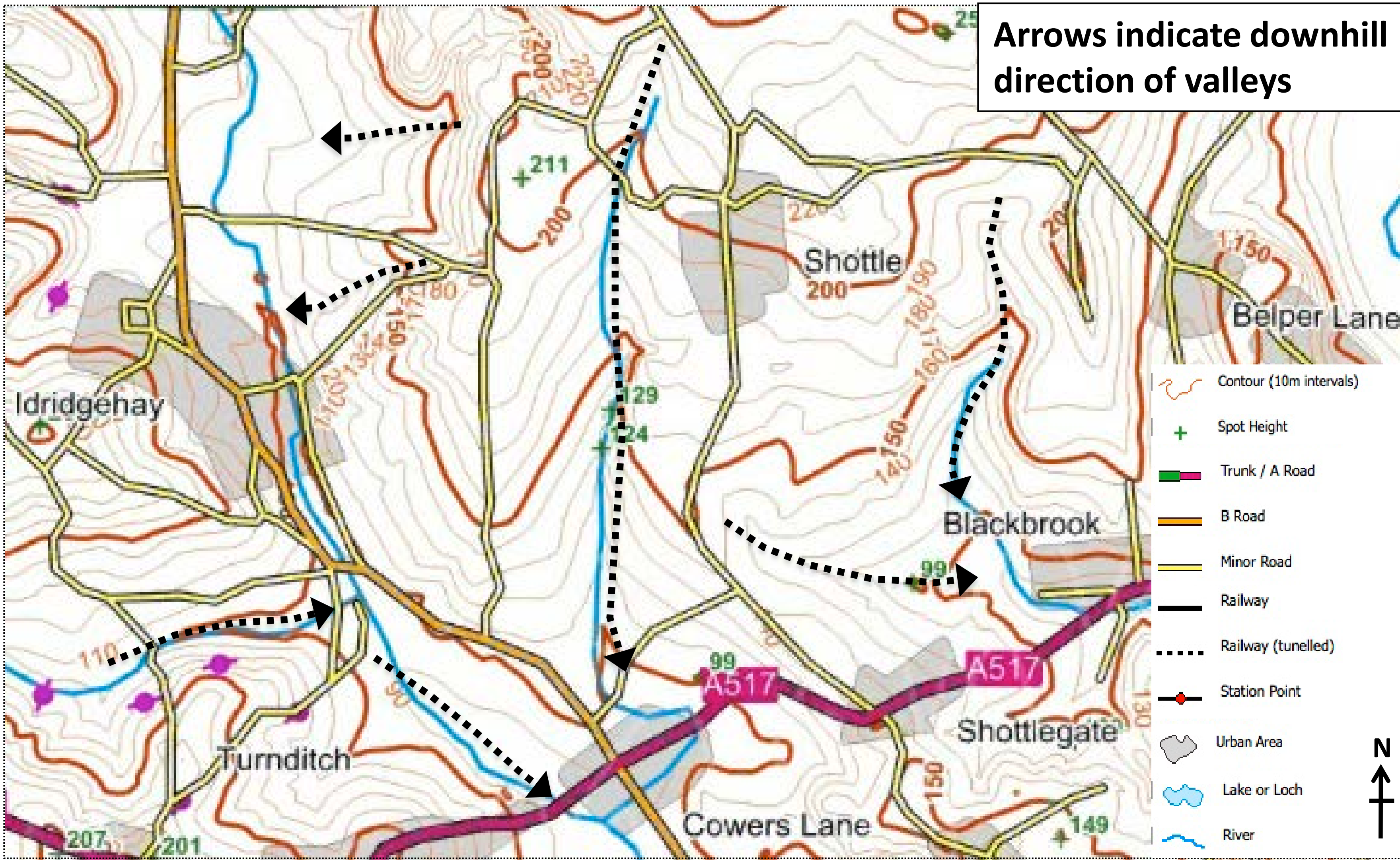


Notice how the change in vertical exaggeration affects the angles of slope

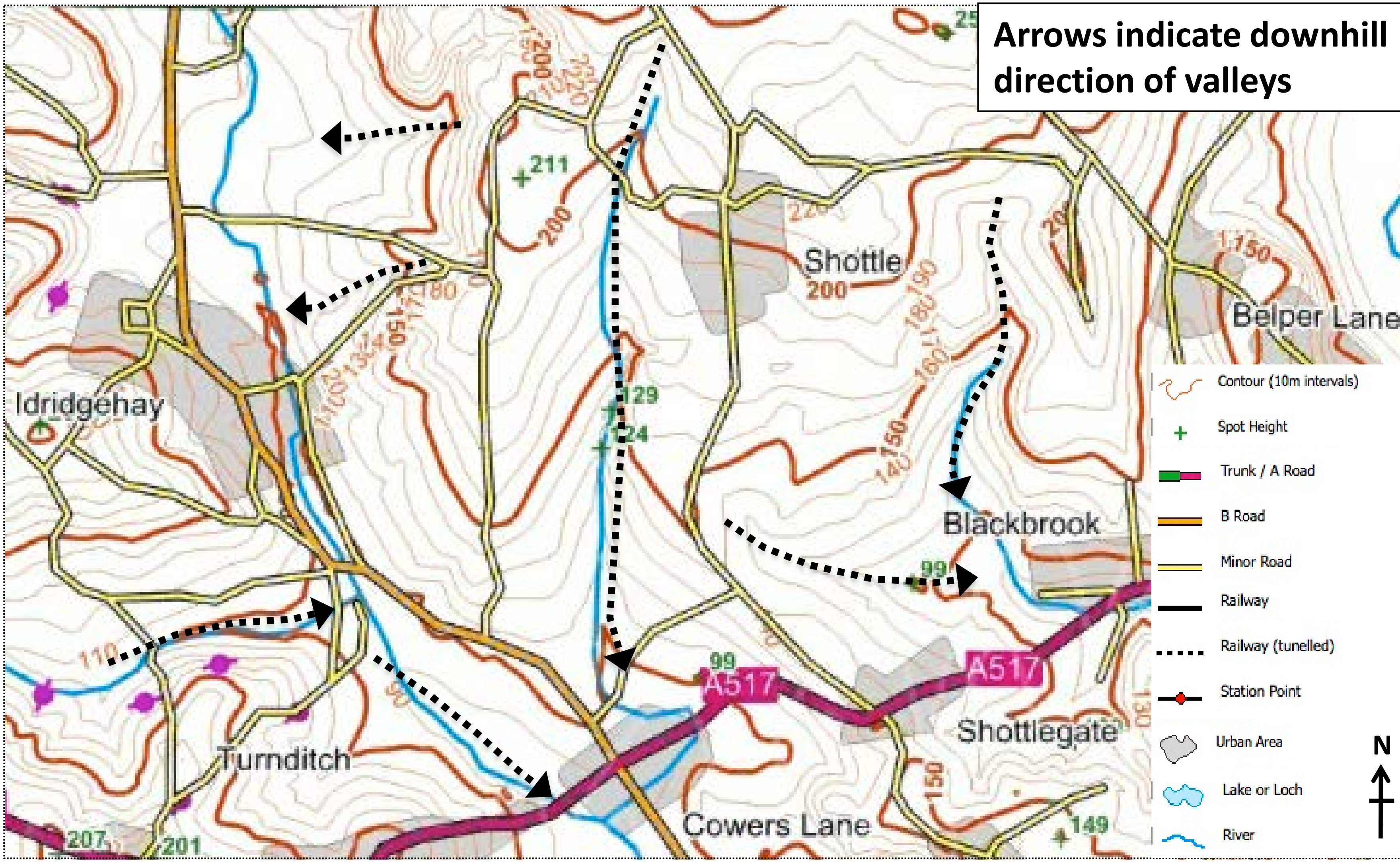
Bear this in mind when drawing your own cross-sections and decide how much (if any) vertical exaggeration is required



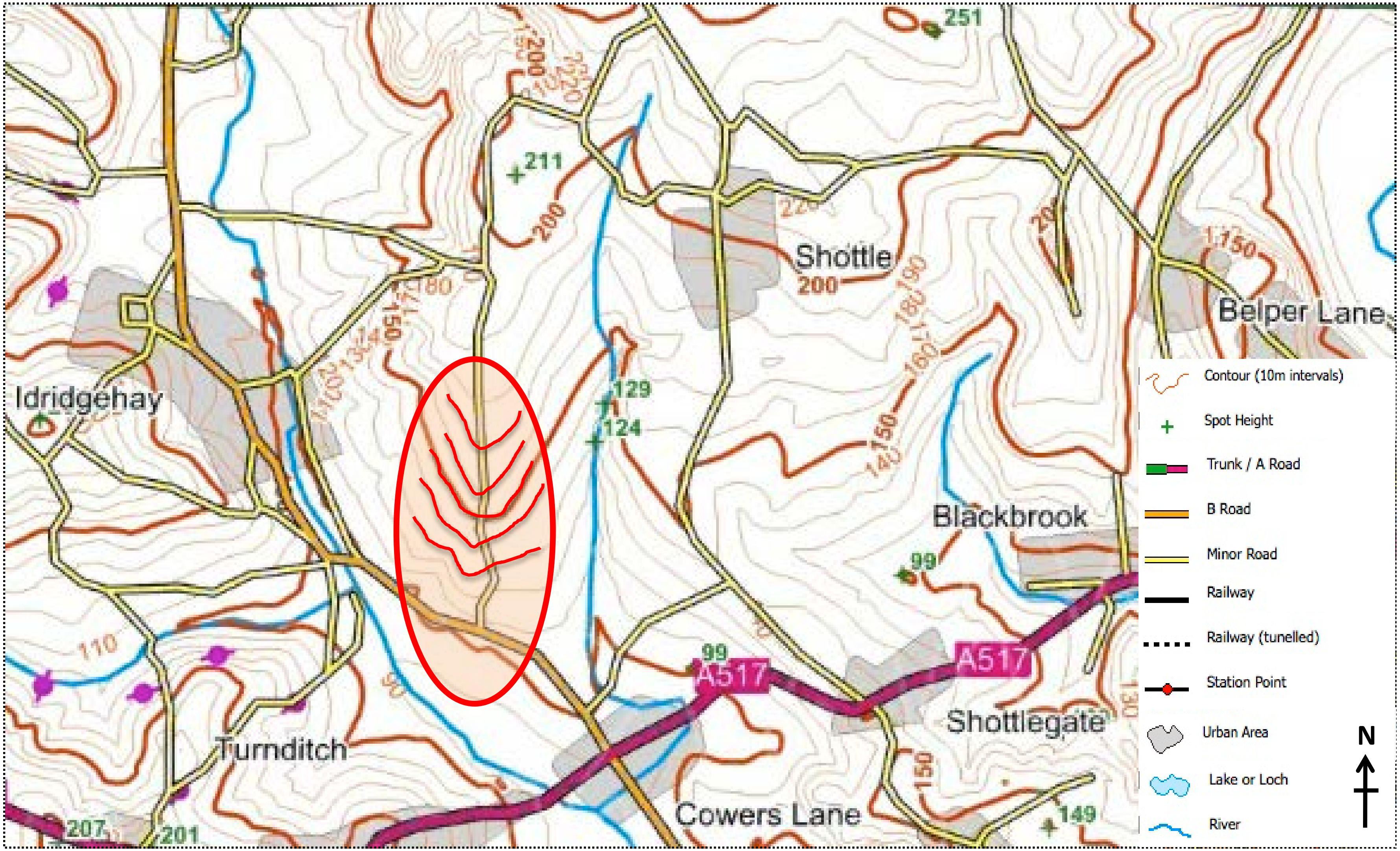
You now know how to identify a sloping valley by the shape of the contours. They form a V-shape that points uphill



There are lots of valleys on the map; mark them with an arrow pointing in the downhill direction

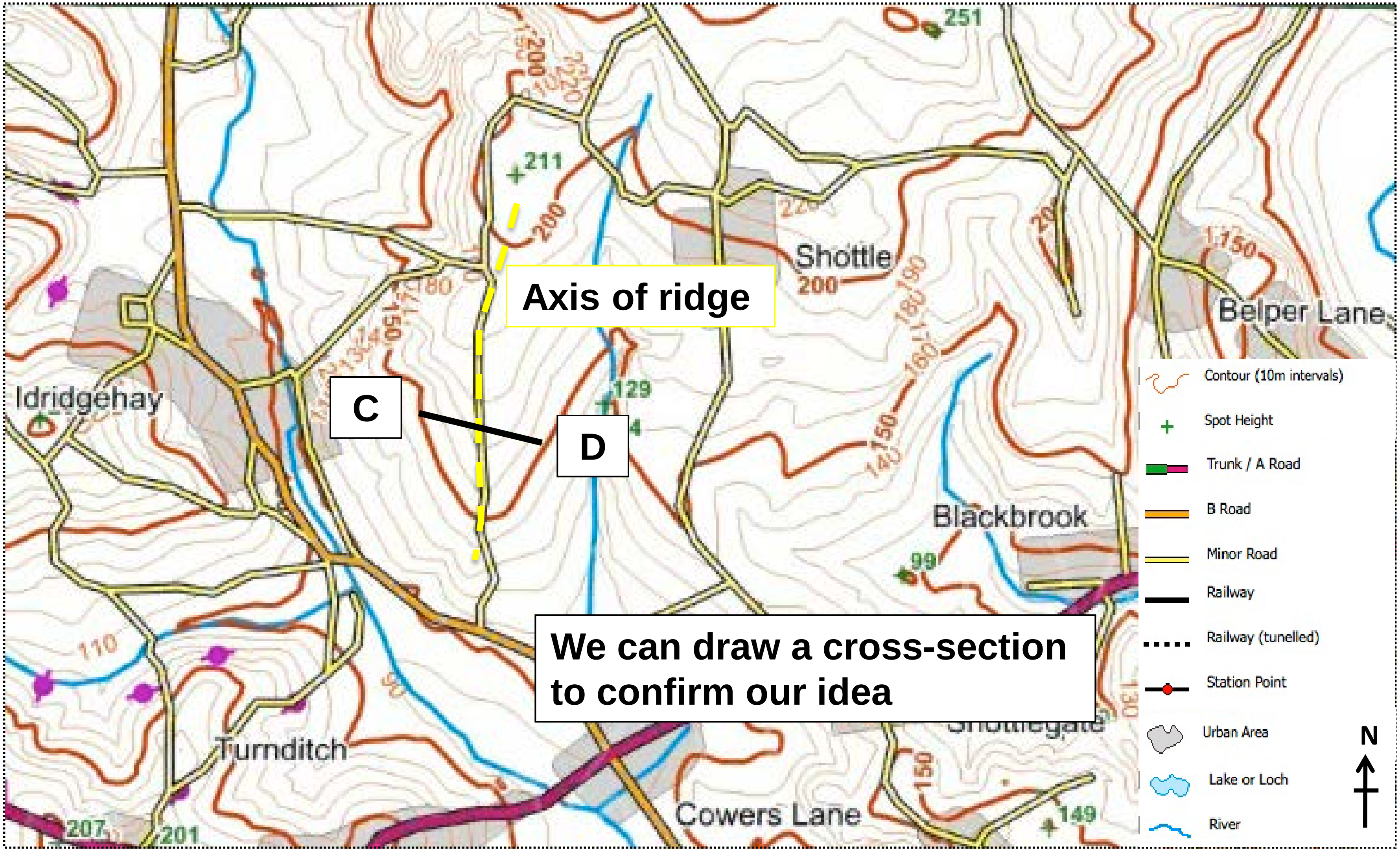


Notice that all the rivers are in valleys, but not all the valleys have a river. Why is this the case?



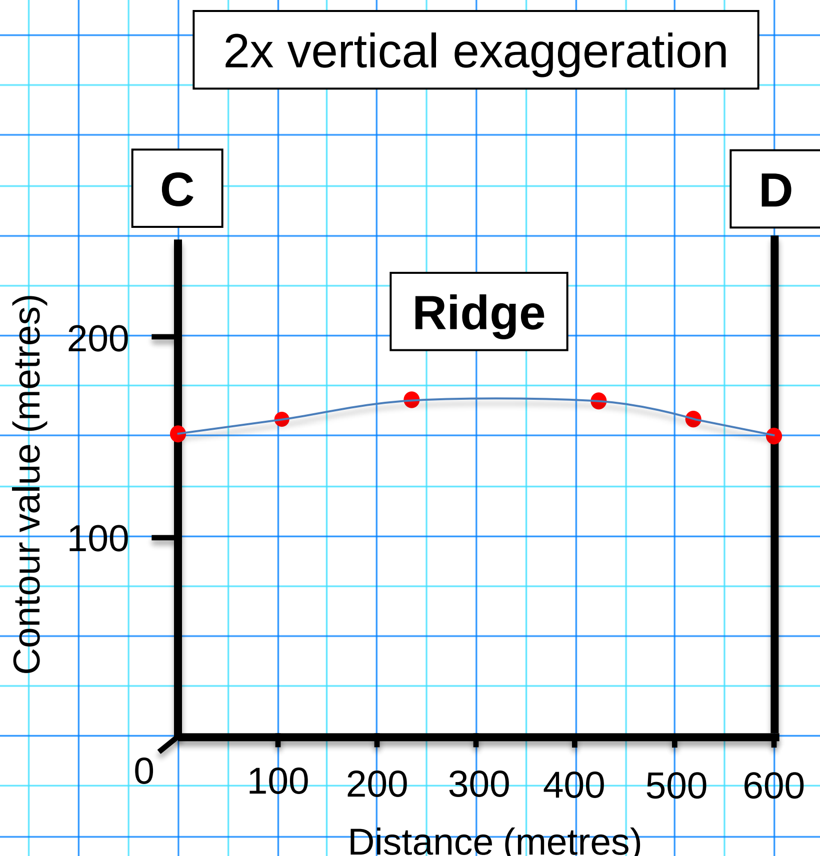
What feature do the contours in the red area represent?

A broad, N-S trending ridge



It may help if you imagine you are standing at Point C on the 150m contour, looking towards Point D. Would you be able to see Point D?

Cross-section showing the broad, gentle ridge between Points C and D



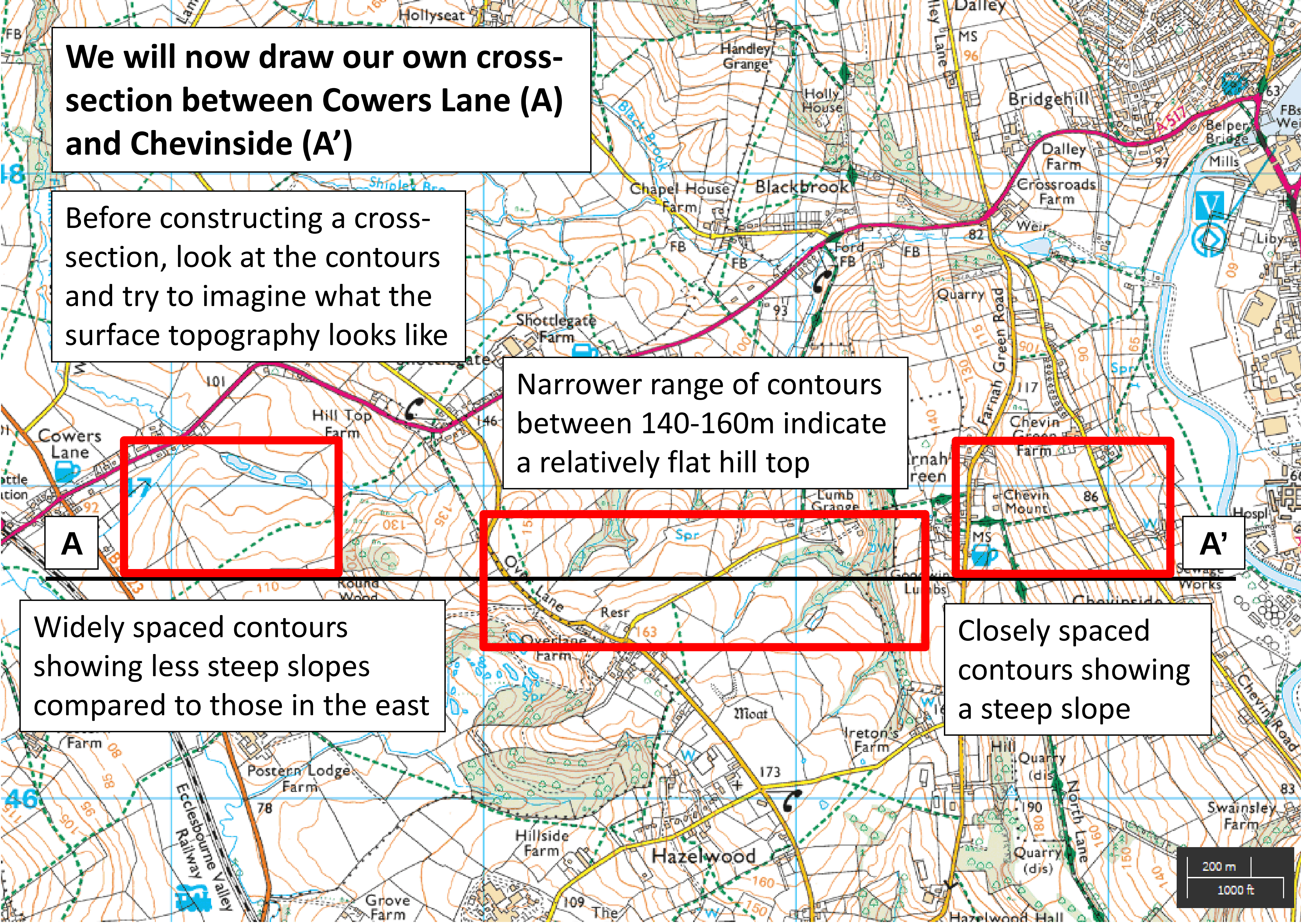
Standing at Point C you would be unable to see Point D because the crest of the ridge is higher than Point D

Here some vertical exaggeration is appropriate because the relief is very subtle

Practical exercise 2
Constructing cross-sections

We will now draw our own cross-section between Cowers Lane (A) and Chevinside (A')

Before constructing a cross-section, look at the contours and try to imagine what the surface topography looks like



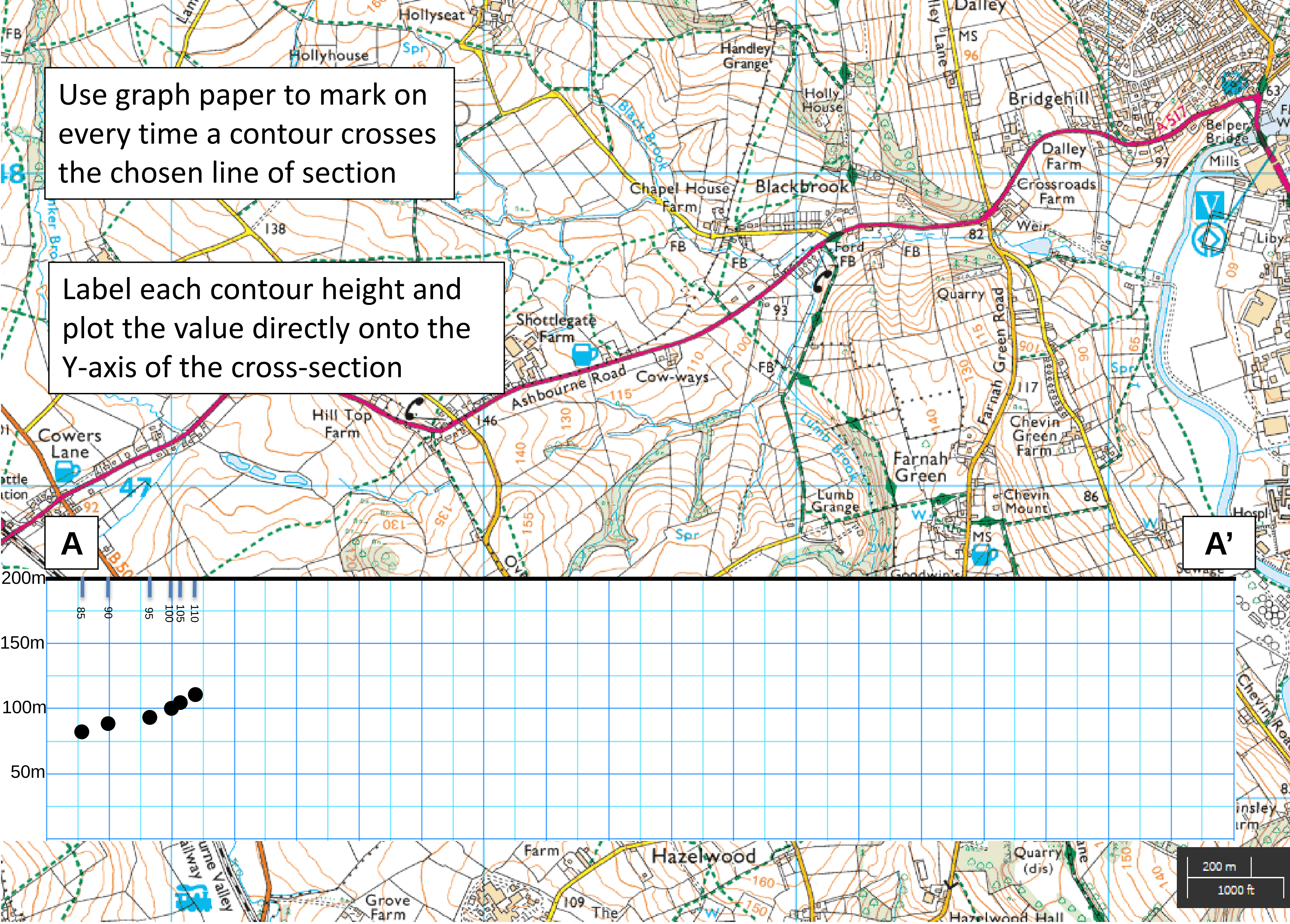
Narrower range of contours between 140-160m indicate a relatively flat hill top

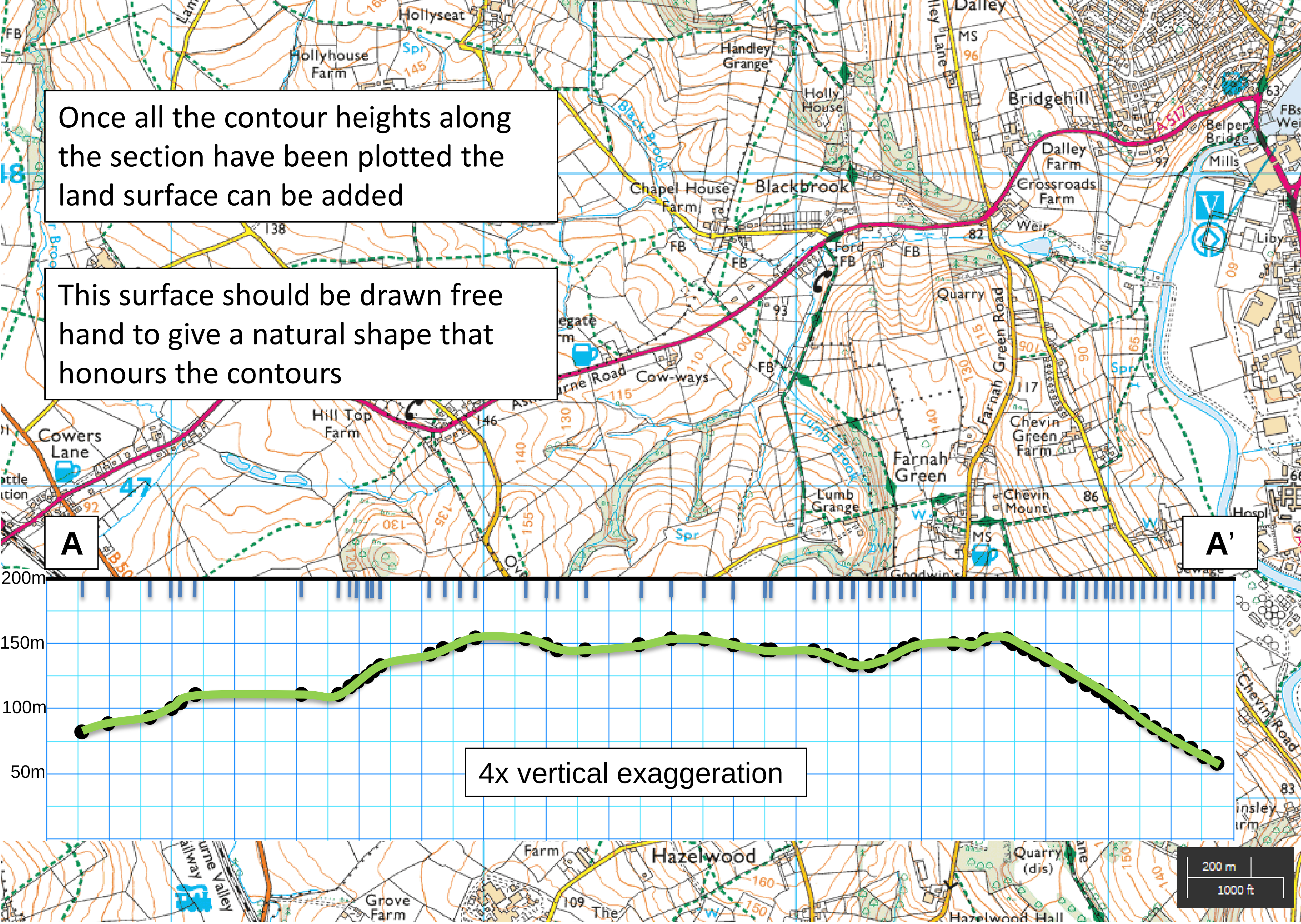
Widely spaced contours showing less steep slopes compared to those in the east

Closely spaced contours showing a steep slope

Use graph paper to mark on every time a contour crosses the chosen line of section

Label each contour height and plot the value directly onto the Y-axis of the cross-section

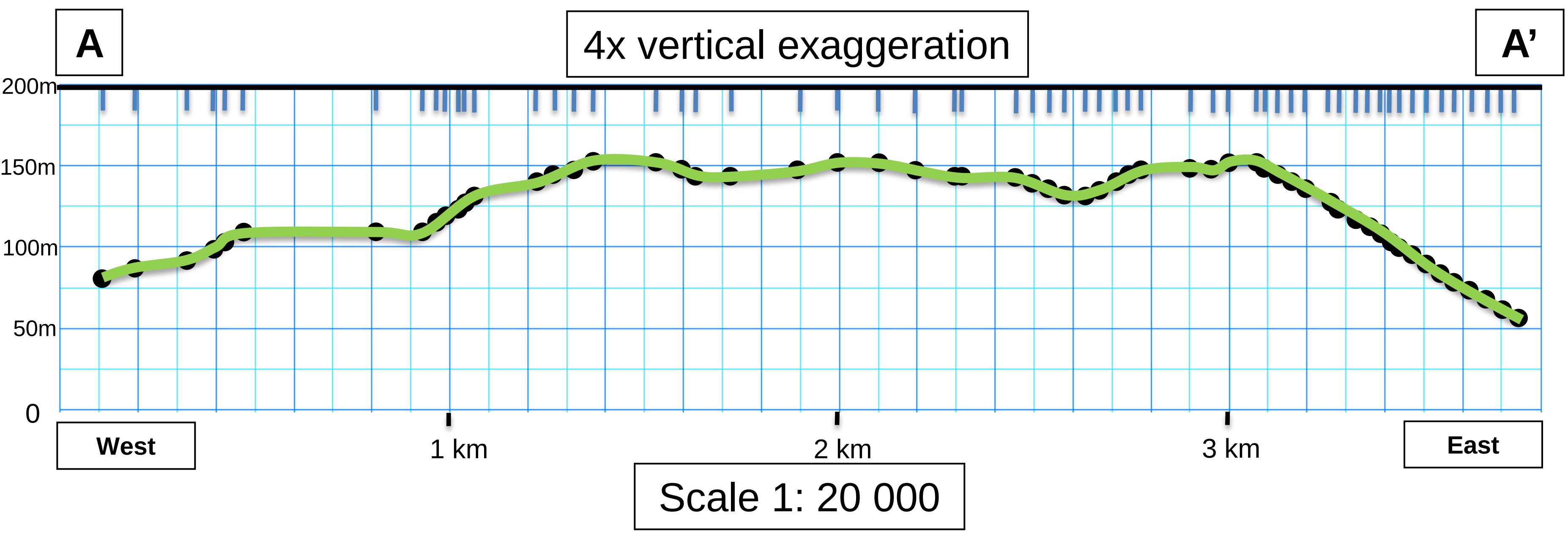



Once all the contour heights along the section have been plotted the land surface can be added
This surface should be drawn free hand to give a natural shape that honours the contours
A
A'
200m
150m
100m
50m
4x vertical exaggeration
200 m
1000 ft

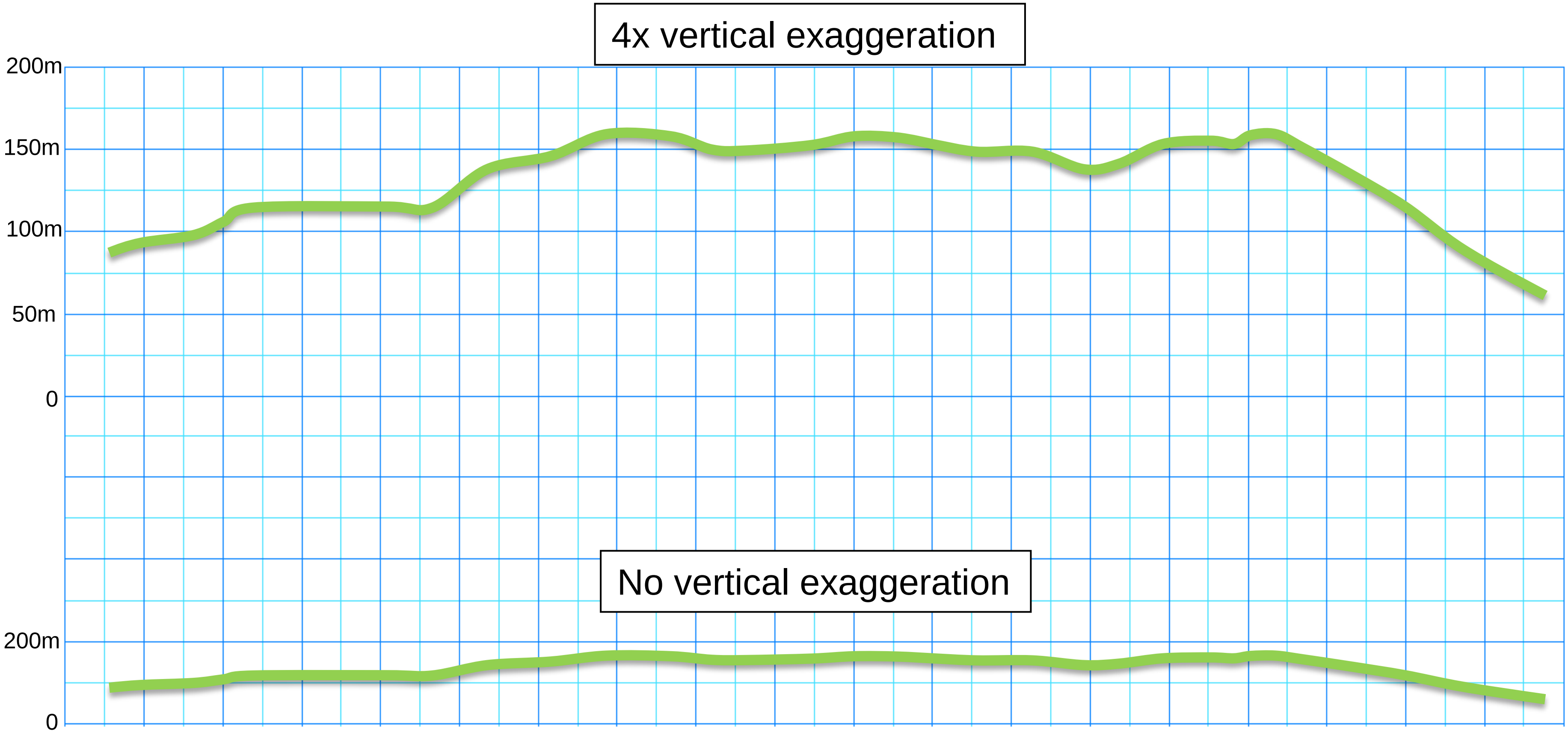
A completed cross-section between A-A’

The vertical scale has been exaggerated in order to show the subtle relief. To calculate the vertical exaggeration, divide the horizontal scale (1cm to 200m) by the vertical scale (1cm to 50m)

So, 200/50 = 4x vertical exaggeration



Comparison between a vertically exaggerated section and a true scale cross-section



The vertically exaggerated section provides a clearer representation of subtle landforms, the other a true representation of slope angles

Learning outcomes

You have now been introduced to the basic elements of topographic maps

You have used contours to identify common landforms and begun to visualise them in 3-D

You can now construct cross-sections and understand the concept of vertical exaggeration

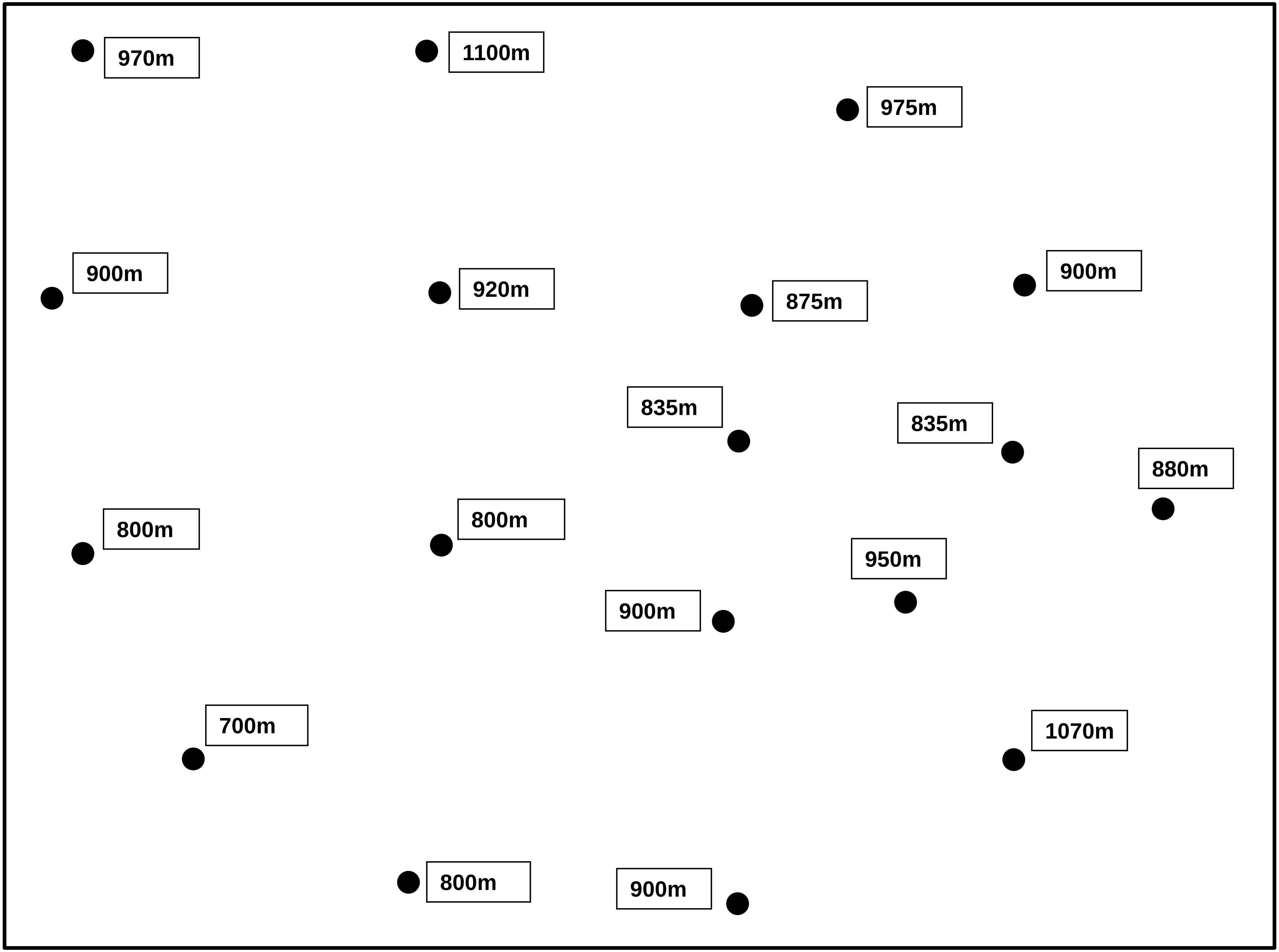
Handouts required for the practicals

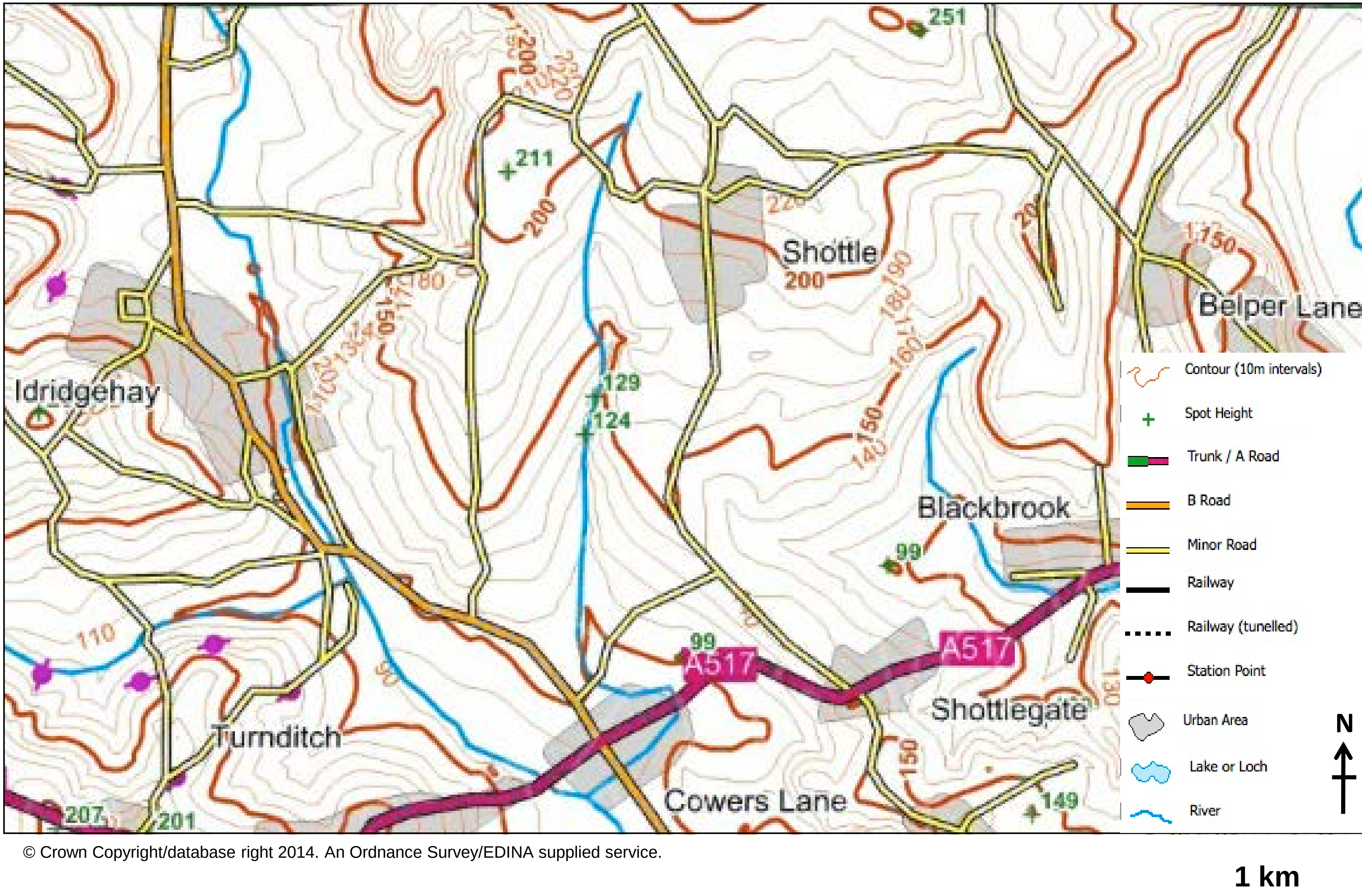
Slide 50: print out at A4, in B/W, portrait format

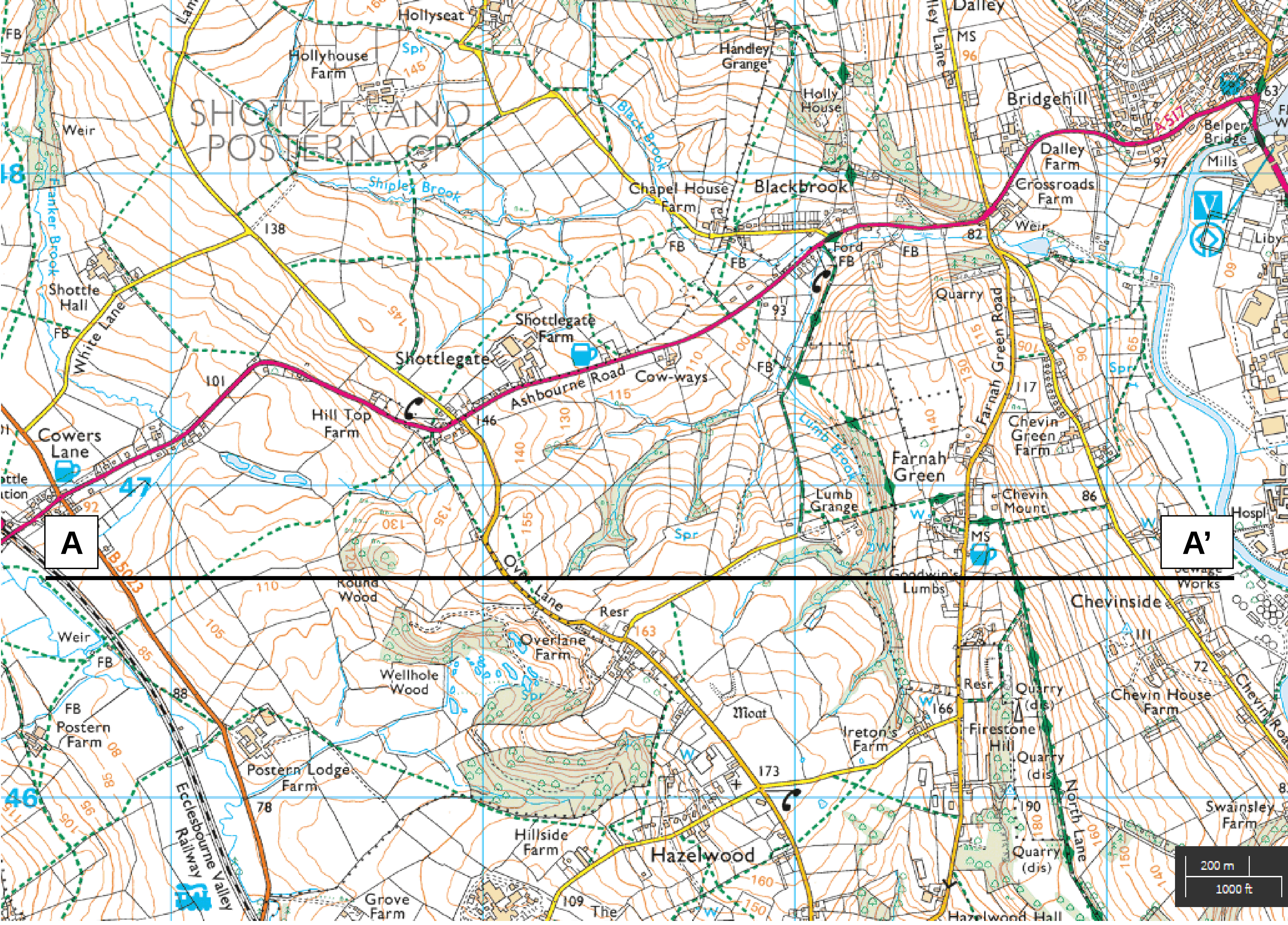
Slide 51: print out at A4, in colour, portrait format

Slide 52: print out at A4, in colour, portrait format

Graph paper for constructing the cross-section


970m
1100m
975m
900m
920m
875m
900m
835m
835m
880m
800m
800m
950m
900m
700m
1070m
800m
900m


Idridgehay
Shottle
Belper Lane
Blackbrook
Shottlegate
Turnditch
Cowers Lane
A517
A517
251
211
129
124
99
99
149
207
201
Contour (10m intervals)
Spot Height
Trunk / A Road
B Road
Minor Road
Railway
Railway (tunelled)
Station Point
Urban Area
Lake or Loch
River
N
1 km



A
A'
Hollyseat
Dalley
Hollyhouse Farm
Handley Grange
SHOTTLE AND POSTERN CP
Holly House
Bridgehill
Weir
Black Brook
Shipley Brook
Franker Brook
Chapel House Farm
Blackbrook
Dalley Farm
Crossroads Farm
Belper Bridge
Mills
A 517
Shottle Hall
White Lane
Shottlegate Farm
Shottlegate
Ashbourne Road
Cow-ways
Hill Top Farm
Cowers Lane
Quarry
Farnah Green Road
Farnah Green
Chevin Green Farm
Lumb Brook
Lumb Grange
Chevin Mount
Hospl
Goodwin's Lumbs
Sewage Works
Chevinside
B5023
Round Wood
Overlane Farm
Wellhole Wood
Resr
Moat
Ireton's Farm
Firestone Hill
Quarry (dis)
Chevin House Farm
Chevin Road
Postern Farm
Postern Lodge Farm
Ecclesbourne Valley Railway
Hillside Farm
Hazelwood
North Lane
Swainsley Farm
Grove Farm
Hazelwood Hall
Liby
200 m
1000 ft