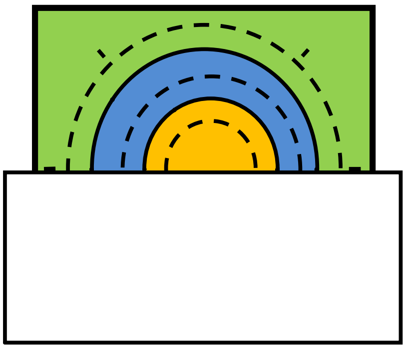
Geological mapwork from scratch 1: a conical hill
Draw your own cross sections – of increasing difficulty

A conical hill or knoll looks like this:

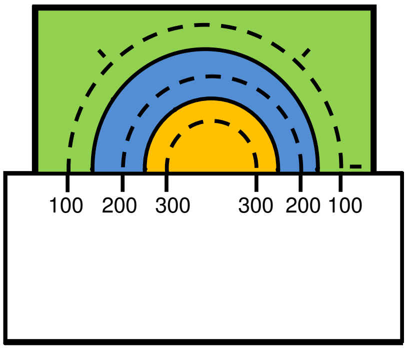
From the Geograph project collection. Copyright Richard Baker, licensed for reuse under the Creative Commons Attribution-ShareAlike 2.0 license.

For the simple geological map of a conical hill (page 2), draw geological cross section A–B by:

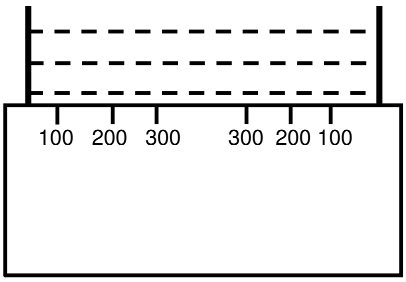
- putting a piece of plain paper on the section line, as shown below;



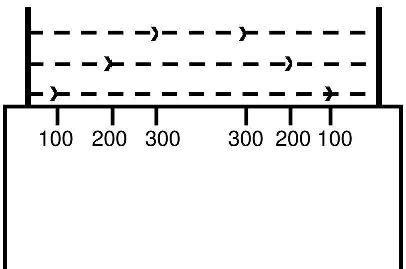
- marking the positions and heights of the dashed-line topographic contours;



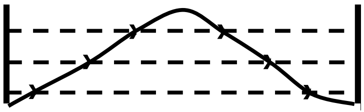
- placing the piece of paper at the bottom of the profile graph;



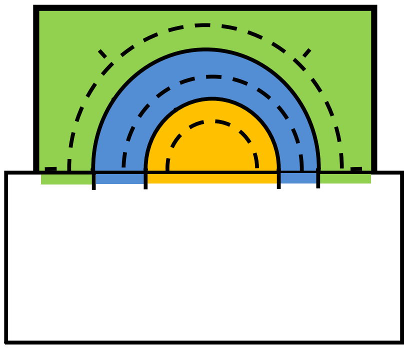
- marking the points where contour lines are in the correct positions on the profile;



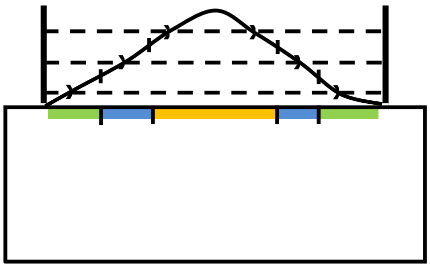
- joining up all the points with a smooth line, to show the topographic profile (relief) of the hill;



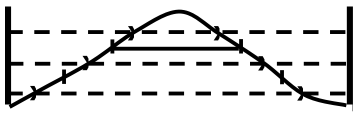
- returning the piece of paper to the section line, and marking the positions of the geological boundaries (it is useful to colour or shade the paper to show which boundaries are which);



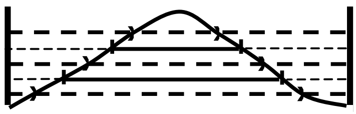
- transferring these to the land surface of the hill profile;



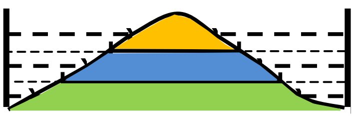
- where the same geological boundary appears twice on the profile, joining these points with a solid straight line;



- repeating with the other geological boundaries – extending them 'into the air' to show where the boundaries used to be, before erosion;



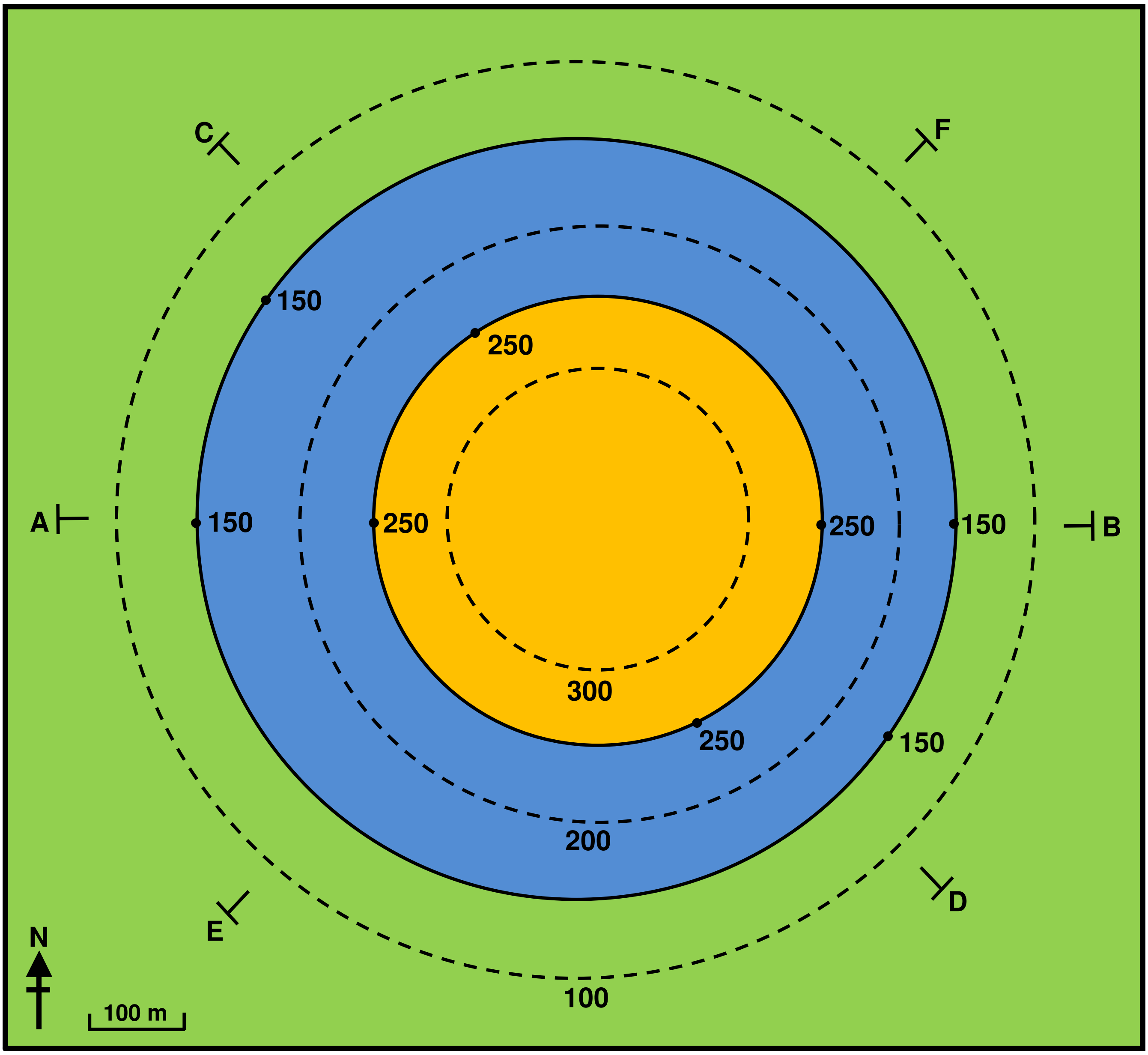
- colouring or shading in the geological cross section, using the same colouring or shading as the map.



Then repeating the procedure:

- first for cross section C–D,
- then for cross section E–F.

Simple geological map of a conical hill or knoll (a black and white version for non-colour printers, is given at the end).



Blank topographic profile (horizontal scale equals vertical scale)

The back up

Title: Geological mapwork from scratch 1: a conical hill.

Subtitle: Draw your own cross sections – of increasing difficulty.

Topic: Part of a series introducing simple geological mapwork. A table of the progression and spiralling of spatial thinking skills involved through the series is given on the final page.

Age range of pupils: 14 – 19 years

Time needed to complete activity: 30 mins

Pupil learning outcomes: Pupils can:
- use contours to draw topographical profiles;
- add geological boundaries to topographical profiles to produce cross sections of geological maps;
- use the exercise and the geological cross sections produced to understand three dimensional topography and how it interacts with three dimensional geology.

Context:
Pupils are shown a photograph of a simple landform, a conical hill or knoll (Brent Knoll in Somerset, UK). They are given a very simple geological map of such a landform, with horizontal beds. They are asked to draw a topographical cross section of the hill, and to add the geology to produce a geological cross section, following a series of instructions. This first section, (A–B) is made as simple as possible, by giving the pupils spot heights to help them to place the geological boundaries in the correct positions.

They are then asked to draw two more cross sections, further away from spot heights, so that they have to use interpolation and higher level three-dimensional thinking skills to complete the cross sections correctly, and to realise that all the geological boundaries and therefore all the beds are horizontal.

Following up the activity:
If the pupils assume that the geological map of Brent Knoll is similar to the one they have been given, they should be able to draw lines on the photograph to represent the sandstone/ limestone and limestone/ mudstone boundaries.

Pupils could be introduced to the symbols used on geological maps to indicate the amount and direction of dip of the beds, and asked, if there were a rock exposure on the hill, what the dip of the beds would be, and therefore which of these symbols would be most appropriate to add to the geological map:

+	horizontal beds
┼	vertical beds (longest line parallel to the bedding)
$\xrightarrow[30^{\circ}]{}$	direction of dip (arrow direction) and amount of dip (in degrees from the horizontal of the beds)

Underlying principles:
- A simple way to show the relief of a topographical map is to use the contours to draw a cross section of the area.
- Geological boundaries can be added to such topographical cross sections, to show the three dimensional geological structure.
- When beds are horizontal, their boundaries follow the contours at the appropriate height.

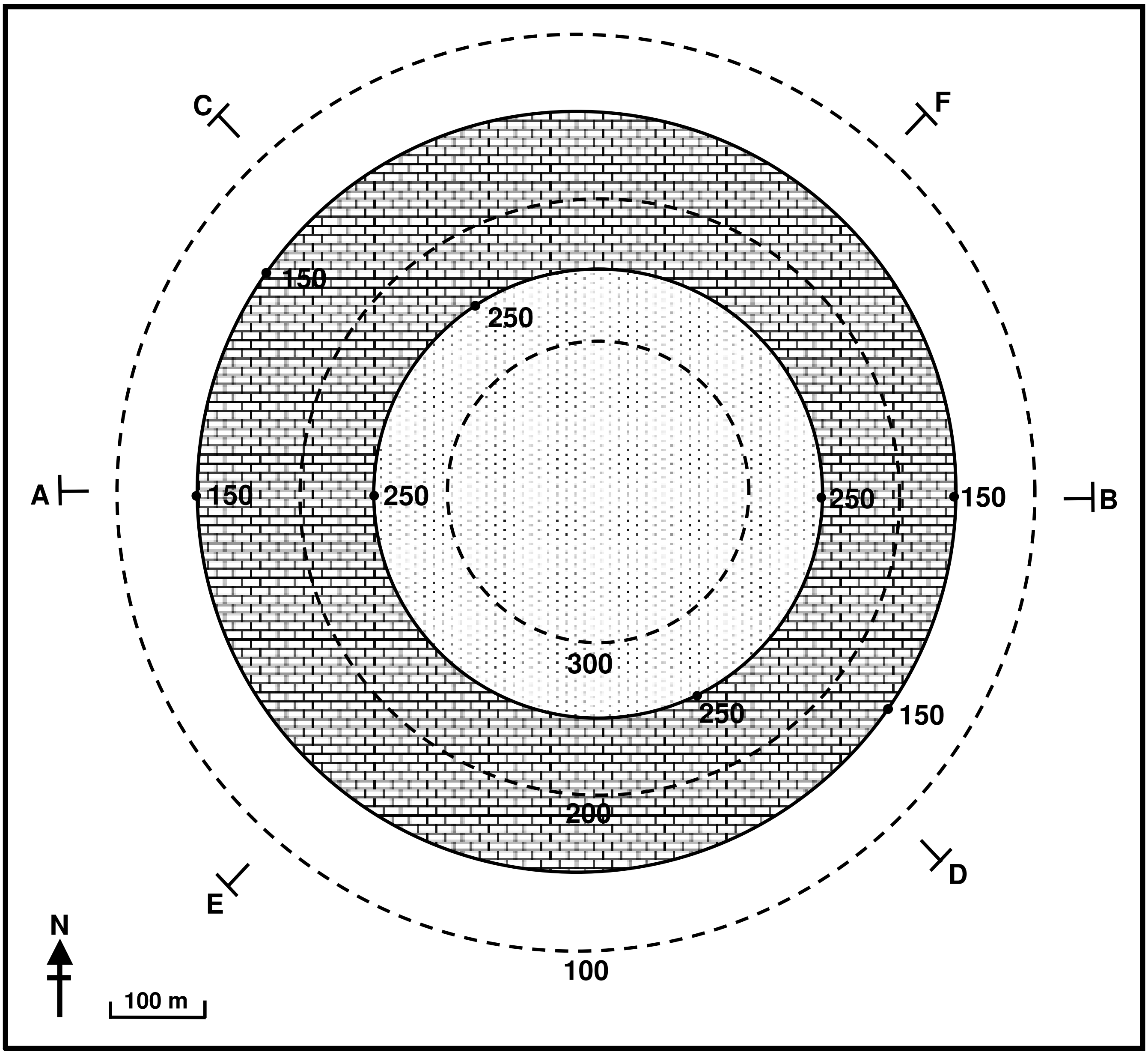
Thinking skill development:
The drawing of topographical and geological cross sections involves spatial thinking skills. The more complex the cross sections become, the more spatial interpretation is needed, including interpolation and extrapolation skills.

Resource list:
- a print off of the map and blank topographic profile, per pupil
- drawing materials, including pencil, eraser, ruler and pencil crayons.

Useful links:
Higher level mapwork exercises with online tutorials are available for free download from the Open University: http://podcast.open.ac.uk/oulearn/science/podcast-s260_mapwork#

Source: This is the first of a series of simple introductory geological map exercises developed by Joe Crossley and Joe Whitehead. Part I of this series of exercises (from which this exercise comes) was published in '*Geology Teaching'* the journal of the Association of Teachers of Geology in 1979 (Volume 4, No. 2, pages 56 – 61).

Simple geological map of a conical hill or knoll.



Key
Contour line, metres
Geological boundary between two rock types
Mudstone
Limestone
Sandstone

Blank topographic profile (horizontal scale equals vertical scale)

The progression and spiralling of spatial thinking skills shown by the Earthlearningidea ‘Geological mapwork from scratch’ exercises and the ‘Geological mapwork from models’ exercises

Exercise		Topographic surface	Geological surfaces	Strategies and skills
Mapwork from scratch 1: a conical hill		Conical hill	Flat and horizontal	• Plot and draw simple topographic cross sections • Add geological boundary intersections and join with straight, horizontal lines
Mapwork from scratch 2: valley with simple geology		Sloping valley	Flat and horizontal	• Plot and draw simple topographic cross sections • Add geological boundary intersections and join with straight, horizontal lines • Sketch geology onto a 3D block diagram
Mapwork from scratch 3: valley with dipping geology		Sloping valley	Dipping surfaces	• Draw true dip on a cross section using a protractor • Add geological boundary intersections and join with straight lines • Appreciate that apparent dip is always less than true dip • Appreciate that, in valleys, geological boundaries usually ‘V’ in the direction of dip. • Sketch geology onto a 3D block diagram • Begin to compile a list of mapwork rules
Mapwork from models 1	Plain version 1	Flat	Flat and horizontal	• Add geological boundary data to cross sections and join with straight, horizontal lines
	Plain version 2	Flat	Dipping surfaces; vertical feature	• Add geological boundary data to cross sections and join with straight lines • Use boundaries on the cross sections which intersect the topographic surface to draw a boundary on the surface • Add a vertical feature (dyke)
Mapwork from models 2	Cuesta version 1	Asymmetrical ridge	Flat and horizontal	• Add geological boundary data to cross sections to construct straight, horizontal lines
	Cuesta version 2	Asymmetrical ridge	Dipping surfaces; vertical feature	• Draw true dip on a cross section using a protractor • Add parallel geological boundaries • Add a vertical feature (fault) that moves a geological boundary • Appreciate the link between tough and weak geological formations and topography
Mapwork from models 3: valley with horizontal floor		Valley with horizontal floor	Dipping surfaces; vertical feature	• Draw true dip on a cross section using a protractor • Add parallel geological boundaries • Use boundaries on the cross sections which intersect the topographic surface to draw in boundaries on the surface • Construct parallel boundaries on the surface • Appreciate that, in valleys, geological boundaries usually ‘V’ in the direction of dip • Appreciate that apparent thickness is always greater than true thickness • Add a vertical feature (dyke)
Mapwork from models 4	Ridge/ valley with sloping floor version 1	Ridge/ valley with sloping floor	Dipping surfaces	• Add geological boundary data to cross sections to construct straight lines • Add parallel geological boundaries • Appreciate the link between tough and weak geological formations and topography • Interpolate approximate true dip from apparent dip
	Ridge/ valley with sloping floor version 2	Ridge/ valley with sloping floor	Dipping surfaces	• Draw true dip on a cross section using a protractor • Add parallel geological boundaries to cross sections • Use boundaries on the cross sections which intersect the topographic surface to draw in boundaries on the surface • Construct parallel boundaries on the surface • Appreciate that, in valleys, geological boundaries usually ‘V’ in the direction of dip and the opposite is true of ridges
Mapwork from models 5: plain; cuesta; valley with horizontal floor; ridge/ valley with sloping floor		All the model landforms above	Surfaces folded into open folds	The strategies and skills described in the box above and, in addition: • Identify folds with equally dipping limbs, and those with limbs dipping at different angles • Appreciate inverted topography • Draw fold axes and fold axial planes • Draw an unconformity and a pluton with a metamorphic aureole
Mapwork from models 6: plain with faulted rocks 1		Flat	Normal and tear dip faults; dipping bedding	• Draw the effects of a normal and a tear dip fault on cross sections • Use these to explain how different types of fault can have similar effects on outcrop patterns of dipping beds (but different effects of vertical features)
Mapwork from models 7: plain with faulted rocks 2		Flat	Normal and reverse strike faults; dipping bedding	• Draw the effects of normal and reverse strike faults on cross sections • Use these to explain how different types of fault can have similar effects on outcrop patterns
Mapwork from models 8: plain with faulted rocks 3		Flat	Normal, reverse, thrust and strike-slip faults at 45^{o} to the strike; dipping bedding	• Draw the effects of different sorts of faults on cross sections • Use this to explain how different types of fault can have similar effects on outcrop patterns
DIY dip and strike model		Dipping surface	Dipping bed	• Measuring dip, strike and apparent dip on a model dipping surface, using a DIY clinometer if no other clinometer is available
Geological mapwork: Surface geology and the geological map		Not given, assumed fairly flat	Relatively complex	• Match surface geological features to places on a geological map where they might be found.