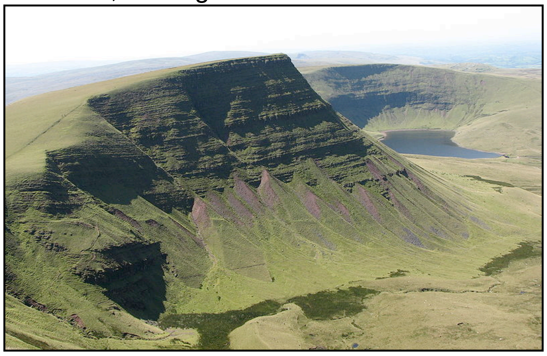
Geological mapwork from models 2: cuesta with simple geology

Draw and make your own 3D models of the geology of a cuesta

A cuesta or escarpment is a ridge with a steep slope in one direction and a shallower slope in the other, looking from the side like this:



Picws Du, the highest peak Brecon Beacons National Park in south Wales.

Cuesta, version 1: Add the following geology to the model using the shading or colours and the symbols in the key on the next page. Then paper-clip it together to show the 3D geology.

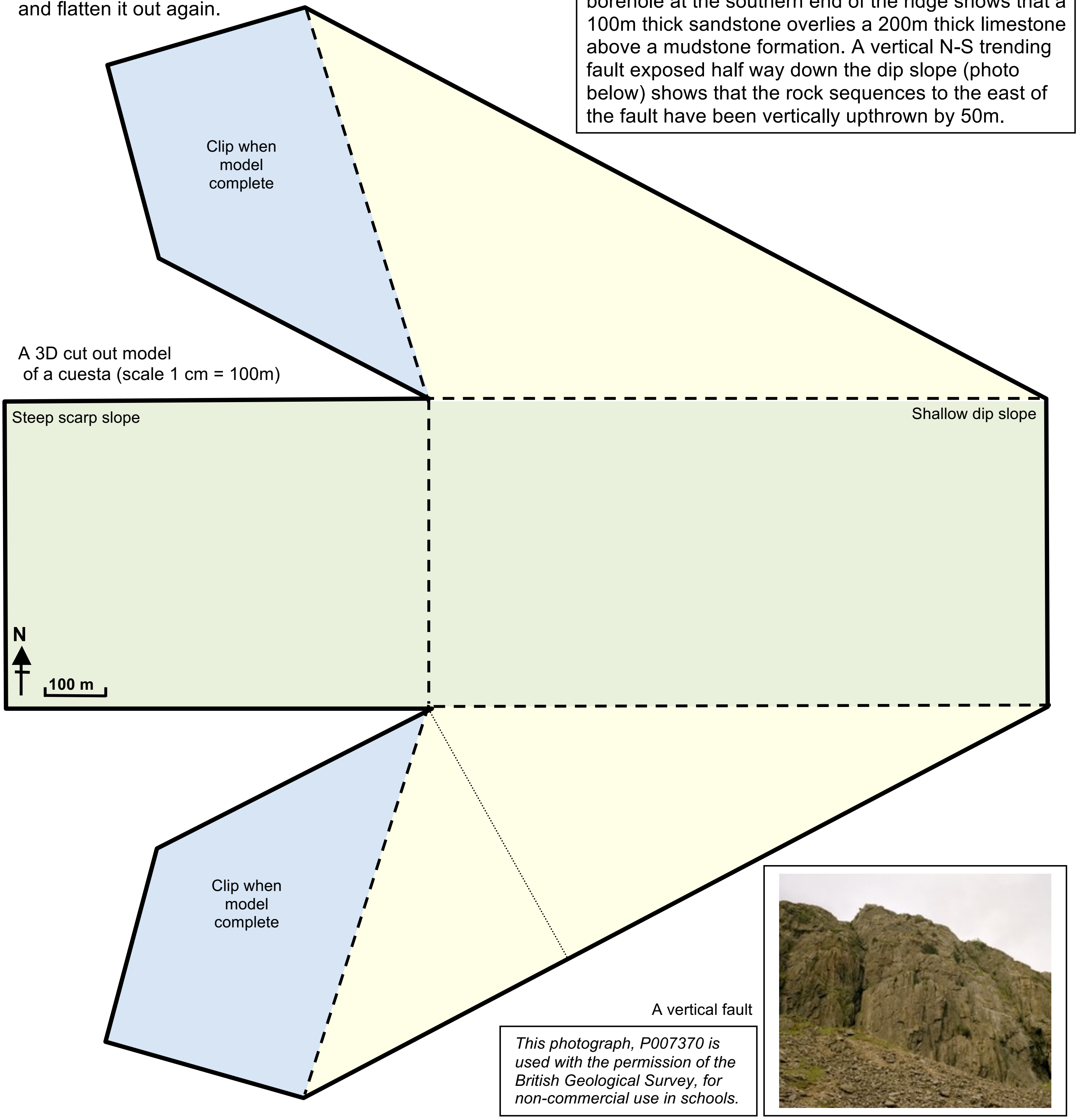
The formations in the area are horizontal. A borehole at the southern end of the ridge shows that a 200m thick limestone overlies a 200m thick sandstone on top of a mudstone formation.

Then either cut out a new model or turn the version 1 model inside out and draw on the North arrow and scale so you can use it to make version 2.

Cuesta, version 2. Add the following geology to the model and clip it together showing the 3D geology of the area.

Exposures of the rocks in the area show that the formations are dipping at 27° towards the east. A borehole at the southern end of the ridge shows that a 100m thick sandstone overlies a 200m thick limestone above a mudstone formation. A vertical N-S trending fault exposed half way down the dip slope (photo below) shows that the rock sequences to the east of the fault have been vertically upthrown by 50m.

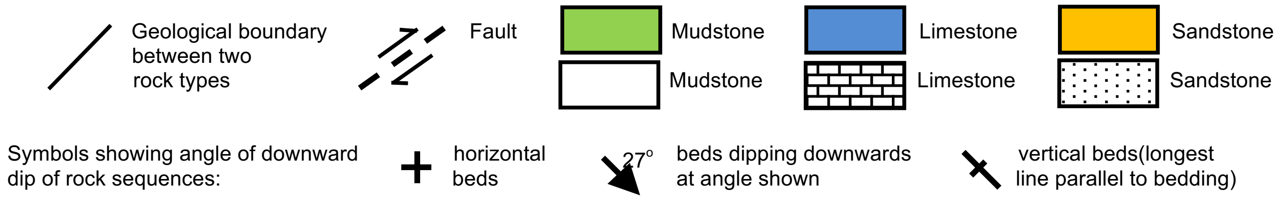
Cut out the model of a cuesta along all the solid lines. Then fold it along the dashed lines and flatten it out again.



A 3D cut out model of a cuesta (scale 1 cm = 100m)

A vertical fault

Key for coloured and black and white versions of the model



The back up

Title: Geological mapwork from models 2: cuesta with simple geology.

Subtitle: Draw and make your own 3D models of the geology of a cuesta.

Topic: Part of a series introducing simple geological mapwork – through 3D models. 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:
- add geological data to a 3D block model of a cuesta – a ridge with slopes of differing angles;
- link up the data with geological boundaries,
- interpret these into a 3D picture of the geology.

Context:
Pupils are shown a photograph of a cuesta and then are asked to cut out a 3D paper model of the landform. They should use the cut-out to make the first version, then either cut out another model, or turn the first model inside out, to make the second version.

Cuesta, version 1. Since, for this model, the geology is horizontal, adding horizontal lines to the cross sections at the sides of the model at the correct depths is relatively simple. Pupils should realise that the map is completed by joining the boundaries from the tops of the cross sections by straight lines. This illustrates that the shallower the slope, the wider the outcrop of the formations.

Cuesta, version 2. This model gives more realistic cuesta geology, since most cuestas are formed by dipping formations, with the dip slope parallel to dipping tougher rocks, and the scarp slope cutting across the weaker rocks. The addition of the fault emphasises that vertical features cut straight across the topography. The direction of throw of the fault should be shown by the half arrow symbols on the sides of the model.

The BGS fault photograph P007370 is actually of bedded pale-coloured tuffs taken on the west side of Llanberis Pass, North Wales.

Following up the activity:
For each of the models, pupils could be asked:
1. to draw a geological map of the area;
2. to construct a geological cross section diagonally across the block;
3. if there were a rock exposure in the area, what the dip of the beds would be, and so which of the symbols above would be most appropriate to add to the geological map.

Underlying principles:
- The three dimensional geological structure of an area can be plotted on block diagrams.
- For formations dipping at a shallower angle than the slope, the shallower the slope, the wider the outcrop; this could be added to a developing list of 'mapwork rules'

Thinking skill development:
The drawing of geology onto three dimensional models involves spatial thinking skills. The more complex the geology becomes, the more spatial interpretation is needed, including interpolation and extrapolation skills.

Resource list:
- one or two print-offs of the page containing the block diagram cut-out, per pupil
- scissors (if these are not available, place a ruler flat along the edge to be cut, and tear the paper along the ruler)
- paper clips, two per model
- drawing materials, including pencil, eraser, ruler, protractor 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 fifth of a series of simple introductory geological map exercises developed by Joe Crossley and Joe Whitehead. Part II 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 1980 (Volume 5, No. 1, pages 15 – 19).

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
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.