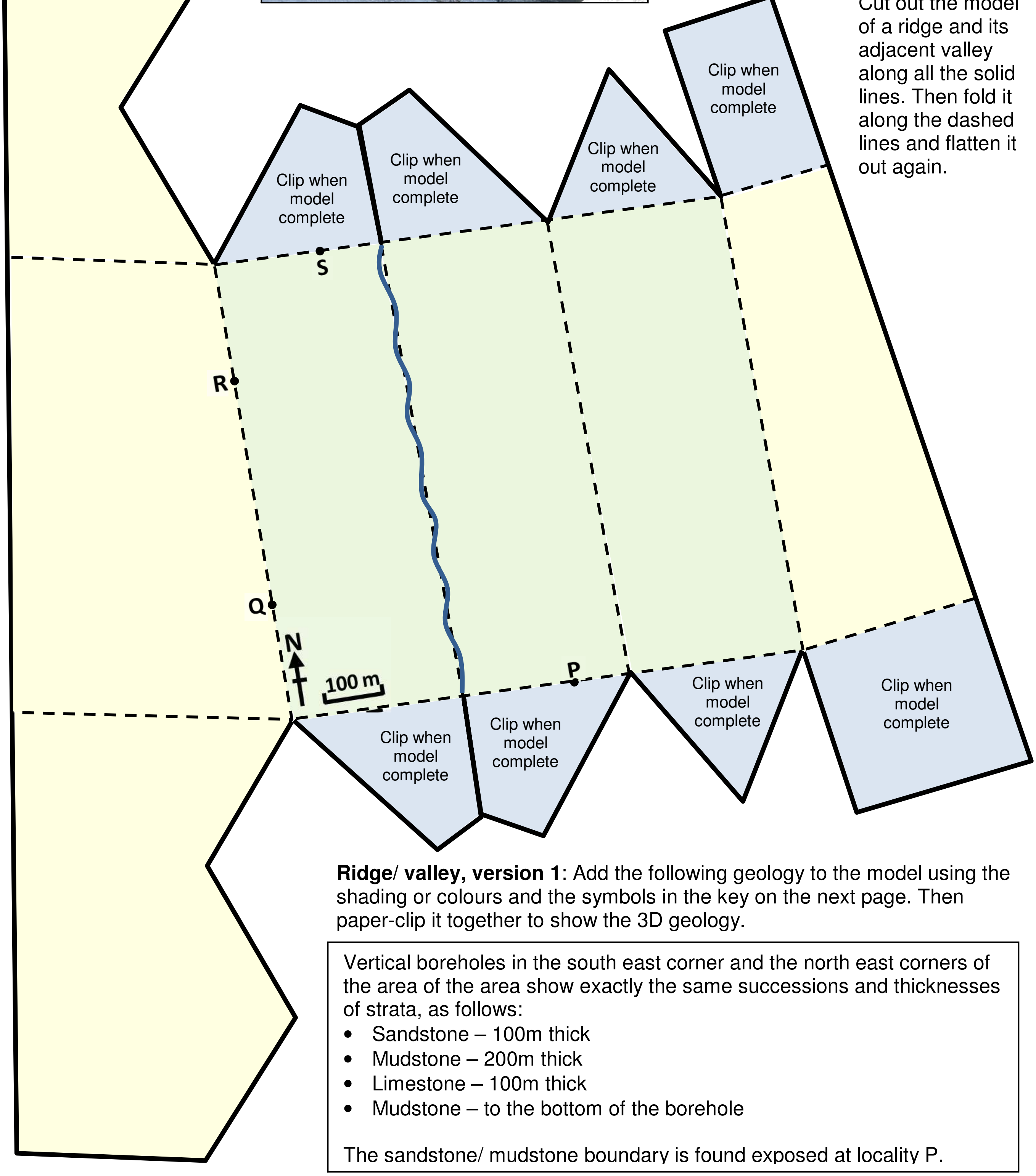
Geological mapwork from models 4: sloping ridge and valley
Draw and make your own 3D models of the geology of a sloping ridge/ valley area

A sloping ridge with an adjacent valley looks like this:

The Arrochar Alps in the south west highlands of Scotland.



Cut out the model of a ridge and its adjacent valley along all the solid lines. Then fold it along the dashed lines and flatten it out again.

Ridge/ valley, 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.

Vertical boreholes in the south east corner and the north east corners of the area of the area show exactly the same successions and thicknesses of strata, as follows:

- Sandstone – 100m thick
- Mudstone – 200m thick
- Limestone – 100m thick
- Mudstone – to the bottom of the borehole

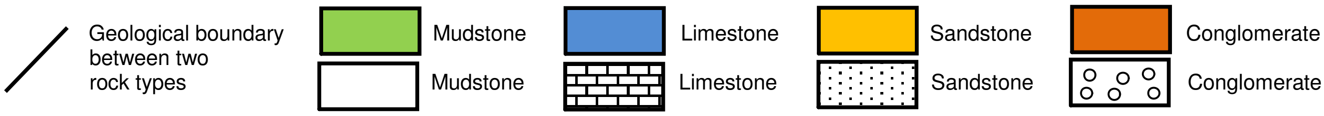
The sandstone/ mudstone boundary is found exposed at locality P.

Then cut out a new model to make version 2.

Ridge/ valley, version 2. Add the geology in the box opposite to the model and clip it together to show the 3D geology of the area.

> The area has a succession of sedimentary rocks with conglomerate at the base, followed by sandstone, then mudstone, with limestone at the top. The boundary between the limestone and the mudstone is found dipping at 20° (from the horizontal) towards the south at locality Q. The boundary between the mudstone and the underlying sandstone is found at locality R, dipping at 20°S as well. The sandstone/ conglomerate boundary crops out at locality S, also dipping 20°S.

Key for coloured and black and white versions of the model



The back up

Title: Geological mapwork from models 4: sloping ridge and valley

Subtitle: Draw and make your own 3D models of the geology of a sloping ridge/ valley area

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 ridge/valley area;
- link up the data with geological boundaries,
- interpret these into a 3D picture of the geology.

Context:
Pupils are shown a photograph of a ridge/ valley area 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 cut out another model to make the second version.

Ridge/ valley, version 1. This is a version of the three point problem, well known to people familiar with geological mapwork; if three points in space on a plane are known, the plane can be constructed; in bedded sequences, the other boundaries can be assumed to have the same orientation as the plane. The formations here form typical scarp/ vale geology, with the tougher formations forming the ridges and the weaker mudstone formations forming the valleys. Pupils should be asked to work out the approximate dip direction of the beds. *Answer: Since the apparent dip on the southern E-W cross section is 32° and the apparent dip on the eastern N-S cross section is 9°, the formations dip approximately towards the East North East at around 35°.*

Ridge/ valley. version 2. Here the geology is dipping at right angles to the dip direction in version 1, so producing V-shaped boundaries on the surface, with the V pointing in the direction of the dip of the beds in the valley (and in the opposite direction on the ridge).

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 rock exposures in the area, what the dip of the beds would be, and how this should be shown on the geological map.

Underlying principles:
- The three dimensional geological structure of an area can be plotted on block diagrams.
- In a valley, the outcrop of a geological boundary always Vs in the direction of dip of the beds (providing the beds dip at a steeper angle than the valley floor) – the opposite is true on a ridge.

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:
- 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, four 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#](http://podcast.open.ac.uk/oulearn/science/podcast-s260_mapwork#)

Source: Devised by Chris King of the Earthlearningidea team, based on exercises 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
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° 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.